Electronics
Telecommunication
Computers
Automations
Nuclear Technique

Proceedings of Abstracts and Program

3rd International Conference on Electrical, Electronic and Computing Engineering

IcETRAN 2016

In conjunction with the 60th annual meeting of ETRAN Society

Zlatibor, Serbia
June 13–16, 2016

Belgrade, June 2016

ETRAN (Formerly: ETAN) is the oldest, the largest and the most prestigious Serbian professional society. It has been organizing the national conference ETRAN in continuation since 1955. Held each year, typically with 300 – 500 papers, its goal has been to gather in one place researchers from otherwise specialized and diverse fields of electrical and electronic engineering and to ensure their closer contacts and cross-pollination of ideas. The international conference IcETRAN is dedicated to the same topics and intended to extend the event to the international audience. The conference is organized with support of IEEE. The official language of the conference is English.

An Overview of previous ETAN/ETRAN conferences

1. Beograd, November 1955
2. Beograd, November 1957
3. Ljubljana, November 1958
4. Zagreb, November 1959
5. Beograd, November 1960
6. Sarajevo, November 1961
7. Novi Sad, November 1962
8. Zagreb, November 1963
9. Bled, November 1964
10. Beograd, November 1965
11. Niš, June 1967
12. Rijeka, June 1968
13. Subotica, June 1969
14. Sarajevo, June 1970
15. Split, June 1971
16. Velenje, June 1972
17. Novi Sad, June 1973
18. Ulcinj, June 1974
19. Ohrid, June 1975
20. Opatija, June 1976
21. Banja Luka, June 1977
22. Zadar, June 1978
23. Maribor, June 1979
24. Priština, June 1980
25. Mostar, June 1981
26. Subotica, June 1982
27. Struga, June 1983
28. Split, June 1984
29. Niš, June 1985
30. Herceg Novi, June 1986
31. Bled, June 1987
32. Sarajevo, June 1988
33. Novi Sad, June 1989
34. Zagreb, June 1990
35. Ohrid, June 1991
36. Kopaonik, September 1992

37. Beograd, September 1993
38. Niš, June 1994
39. Zlatibor, June 1995
40. Budva, June 1996
41. Zlatibor, June 1997
42. Vrnjačka Banja, June 1998
43. Zlatibor, September 1999
44. Sokobanja, June 2000
45. Bukovička Banja, June 2001
46. Banja Vrućica - Teslić, June 2002
47. Herceg Novi, June 2003
48. Čačak, June 2004
49. Budva, June 2005
50. Beograd, June 2006
51. Herceg Novi, June 2007
52. Palić, June 2008
53. Vrnjačka Banja, June 2009
54. Donji Milanovac, June 2010
55. Banja Vrućica - Teslić, June 2011
56. Zlatibor, June 2012
57. Zlatibor, June 2013
58. Vrnjačka Banja, June 2014
59. Silver Lake, June 2015
60. Zlatibor, June 2016

Organizers

ETRAN Society

Faculty of Electronic Engineering, University of Niš

Mihajlo Pupin Institute, Belgrade

Under the auspices of

Ministry of Education, Science and Technological Development of the Republic of Serbia

With the support of

IEEE – Institute Of Electrical And Electronics Engineers, USA

ETRAN

Society for Electronics, Telecommunications, Computers, Automatic Control and Nuclear Engineering
Kneza Miloša 9/IV, 11000 Belgrade, Serbia

Phone. +381 11 3233 957
E-mail: etran@eunet.rs
http://etran.etf.rs/index_e.html

Collegiate Body of ETRAN Society

Chairman and Legal Representative
Prof. dr. Bratislav Milovanović, *Faculty of Electronics, Niš*

Vice-Chairman
Prof. dr. Predrag Petrović, Full Research Professor, *IRITEL Institute, Belgrade*

Program Committee Chair
Prof. dr. Zoran Jakšić, Full Research Professor, *Institute for Chemistry, Technology and Metallurgy, Belgrade*

Steering Committee of ETRAN Society

Electronics
Prof. dr. Vančo Litovski, *Faculty of Electronics, Niš*
Prof. dr. Branko Dokić, *Faculty of Electrical Engineering Banja Luka*

Telecommunications
Prof. Predrag Petrović, *IRITEL Institute, Belgrade*

Computers
Prof. dr. Dragan Janković, *Faculty of Electronics, Niš*
Prof. dr. Zora Konjović, *Faculty of Technical Sciences, Novi Sad*

Automatic Control
Prof. dr. Milić Stojić, *Faculty of Electrical Engineering, Belgrade*
Prof. dr. Branko Kovačević, *Faculty of Electrical Engineering, Belgrade*

Nuclear Engineering
Prof. dr. Jasmina Vujić, *University of Berkeley, California*

Acoustics
Prof. dr. Miomir Mijić, *Faculty of Electrical Engineering, Belgrade*

Antennas and Propagation
Prof. dr Branko Kolundžija, *Faculty of Electrical Engineering, Belgrade*

Artificial Intelligence
Dr. Srđan Stanković, Professor Emeritus, *Faculty of Electrical Engineering, Belgrade*

Biomedicine
Prof. dr. Dejan Popović*, Academician SASA, Faculty of Electrical Engineering, Belgrade*

Electric Circuits and systems and signal processing
Prof. dr. Branimir Reljin, *Faculty of Electrical Engineering, Belgrade*

Power Engineering
Prof. dr. Vladimir Katić, *Faculty of Technical Sciences, Novi Sad*
Prof. dr. Jeroslav Živanić*, Faculty of Technical Sciences, Čačak*

Metrology
Prof. dr. Božidar Dimitrijević, *Faculty of Electronics, Niš*

Microelectronics and Optoelectronics
Prof. dr. Miloljub Smiljanić, *Institute for Chemistry, Technology and Metallurgy, Belgrade*
Prof. dr. Ninoslav Stojadinović, *Academician SASA*, *Elektronski fakultet Niš*

Microwave and Submillimeter Technique
Prof. dr. Bratislav Milovanović, *Faculty of Electronics, Niš*

Robotics and Flexible Automation
Prof. dr. Veljko Potkonjak*, Faculty of Electrical Engineering, Belgrade*

Programme Committee of ETRAN Society

Dr. Zoran Jakšić, Full Research Professor*, Chairman*, *Institute for Chemistry, Technology and Metallurgy, Belgrade*
Prof. dr. Zorica Nikolić*, vice-chair, Faculty of Electronics, Niš*

Electronics
Prof. dr. Predrag Petković, *Faculty of Electronics, Niš*

Telecommunications
Prof. dr. Zorica Nikolić, *Faculty of Electronics, Niš*
Prof. dr. Aleksandra Smiljanić, *Faculty of Electrical Engineering, Belgrade*

Computers
Prof. dr. Ivan Milentijević, *Faculty of Electronics, Niš*
Prof. dr Miroslav Popović, *Faculty of Technical Sciences, Novi Sad*

Automatic Control
Prof. dr. Željko Djurović, *Faculty of Electrical Engineering, Belgrade*

Nuclear Engineering
Dr Miodrag Milošević*, Institut Vinča, Beograd*

Acoustics
Prof. dr. Dejan Ćirić*, Faculty of Electronics*, *Niš*

Antennas and Propagation
Assist. prof. dr. Miodrag Tasić, *Faculty of Electrical Engineering, Belgrade*

Artificial Intelligence
Prof. dr. Milan Milosavljević, *Faculty of Electrical Engineering, Belgrade*

Electric Circuits and systems and signal processing
Prof. dr. Miroslav Lutovac, *Faculty of Electrical Engineering, Belgrade*

Power Engineering
Prof. dr. Miroslav Bjekić, *Faculty of Technical Sciences, Čačak*

Biomedicine
Prof. dr. Nikola Jorgovanović*, Faculty of Technical Sciences, Novi Sad*

Metrology
Prof. dr. Platon Sovilj*, Faculty of Technical Sciences, Novi Sad*

Microelectronics and Optoelectronics
Prof. dr. Zoran Jakšić, *Institute of Chemistry, Technology and Metallurgy, Belgrade*
Prof. dr. Aneta Prijić*, Faculty of Electronics Niš*

Microwave and Submillimeter Technique
Prof. dr Vera Marković, *Faculty of Electronics Niš*

New Materials
Prof. dr. Nebojša Mitrović, *Faculty of Technical Sciences, Čačak*

Robotics and Flexible Automation
Prof. dr. Aleksandar Rodić, *Institut Mihajlo Pupin, Beograd*

Corporate members of ETRAN

1. School of Electrical Engineering, University of Belgrade
2. Faculty of Electronics, University of Niš
3. Faculty of Technical Sciences, University of Novi Sad
4. Faculty of Technical Sciences, University of Kragujevac, Čačak
5. Faculty of Electrical Engineering, Banja Luka
6. Faculty of Electrical Engineering, Podgorica, Montenegro
7. Faculty of Technical Sciences, Kosovska Mitrovica
8. Faculty of Transport and Traffic Engineering, Belgrade
9. State University, Novi Pazar
10. Singidunum University, Belgrade
11. Metropolitan University, Belgrade
12. Iritel a.d., Belgrade
13. Mihajlo Pupin Institute, Belgrade
14. Nikola Tesla Institute, Belgrade
15. Institute of Chemistry, technology and Metallurgy, Belgrade
16. IMTEL Institute, Belgrade
17. Innovation Center of School of Electrical Engineering, Belgrade
18. Innovation Center of Advanced Technologies, Niš
19. RT-RK, Novi Sad
20. RATEL, Belgrade
21. ICT College of vocational studies, Belgrade
22. College of vocational studies of Electrical Engineering and Computers, Belgrade
23. Technical College of Vocational Studies, Niš
24. Business College of Vocational Studies, Blace
25. School of Electrical Engineering, East Sarajevo
26. Technical Faculty "Mihajlo Pupin", Zrenjanin
27. Faculty of Organisational Sciences, Belgrade
28. Vlatakom Innovation Centre, Belgrade

Honorary members of ETAN/ETRAN

Niš, June 9, 1967.

1. Rajko Tomović, honorary president of ETAN/ETRAN

Zadar, June 12,. 1978.

12 members

Beograd, 1999.

1. Academician Jovan Surutka
2. Prof. Dr. Dimitrije Tjapkin
3. Prof. Eng. Radoslav Horvat

Belgrade, May 15, 2006.

1. Academician Petar Miljanić
2. Academician Momčilo Ristić
3. Academician Miomir Vukobratović
4. Academician Aleksandar Marinčić
5. Academician Ilija Stojanović
6. Academician Pantelija Nikolić
7. Academician Ninoslav Stojadinović
8. Prof. Husnija Kurtović
9. Prof. Petar Pravica
10. Prof. Dušan Hristović
11. Prof. Milić Stojić
12. Prof. Slobodan Lazović
13. Prof. Vojislav Aranđelović

Zlatibor, June 4, 2013.

1. Prof. Srđan Stanković
2. Prof. Borivoj Lazić
3. Prof. Dušan Petrovački

Deceased Honorary Members of ETRAN

Rajko Tomović, Honorary Chairman
Akademik Jovan Surutka, Academician SASA
Prof. dr. Radoslav Horvat
Akademik Aleksandar Marinčić, Academician SASA
Akademik Ilija Stojanović, Academician SASA
Prof. dr. Slobodan Lazović
Miomir Vukobratović, Academician SASA

Distinguished members of ETAN/ETRAN

Zadar, June 12, 1978.

119 members

Belgrade, May 15, 2006.

1. Prof. Georgi Dimirovski
2. Prof. dr Branko Dokić
3. Prof. dr Branimir Djordjević†

4. Prof. Zoran Jakšić
5. Prof. Vladimir Katić
6. Prof. Branko Kovačević
7. Prof. Borivoj Lazić
8. Prof. Bratislav Milovanović
9. Prof. Djordje Paunović
10. Prof. Dušan Petrovački
11. Prof. Miloljub Smiljanić
12. Prof. Zdravko Uskoković
13. Prof. Baldomir Zajc

Zlatibor, June 4, 2013.

1. Prof. Dušan Drajić
2. Prof. Aleksandar Nešić

Founders of the professsional society – ET(R)AN predecessors

1. Dr. Rajko Tomović
2. Eng. Branimir Lolić
3. Eng. Tihomir Aleksić
4. Eng. Jovan Pavlović
5. Eng. Bogosav Kovačević
6. Eng. Lazar Hranisavljević
7. Prof. Vladimir Muljević

Chairs of the professional society

1.	Dr. Rajko Tomović	1953 - 1967
2.	Eng. Slobodan Cicko Ristić	1967 - 1980
3.	Eng. Jovan Pavlović	1980
4.	Eng. Paja Ciner	1981
5.	Eng. A. Mandžić	1982 - 1985
6.	Prof. dr Georgi Dimirovski	1985 - 1990
7.	Eng. Svetozar Zimonjić	1991
8.	Prof. Eng. Dušan Hristović	1992 - 1993
9.	Prof. Dr. Milić Stojić	1994 – 2002
10.	Prof. Dr. Ninoslav Stojadinović	2002 - 2006
11.	Prof. Dr. Bratislav Milovanović	2006 - 2007
12.	Prof. Dr. Srđan Stanković	2007 - 2013
13.	Prof. Dr. Bratislav Milovanović	2013 – 2016

Name of the professional society

1. Electronics Board, since 1953.
2. Federal Center for Electronics, since 1956.
3. Federal Center for Electronics, telecommunications and automatics, since 1957.
4. Yugoslav Committee for ETAN, since 1958.
5. Yugoslav Federation for ETAN, since 1976
6. ETRAN Society, since 1994.

Chairs of the Committee

1.	Dr. Rajko Tomović, Belgrade	1955 - 1967
2.	Eng. Paja Ciner, Zagreb	1967 - 1981
3.	Prof. Dr. Branko Raković, Belgrade	1982 - 1984
4.	Prof. Dr. Milan Osredkar, Ljubljana	1985 - 1987
5.	Prof. Dr. Svetozar Zimonjić, Belgrade	1988 - 1991
6.	Prof. Dr. Petar Pravica, Beograd	1992 - 1994
7.	Prof. Dr. Slobodan Lazović, Belgrade	1995 - 2001
8.	Prof. Dr. Branko Kovačević, Belgrade	2002 - 2006
9.	Dr. Zoran Jakšić, Belgrade	2006 – 2016

Names of the Committee

1. Committee for Yugoslav ETAN conferences
2. Committee for ETAN conferences
3. ETAN Committee for Science and Technical Conferences
4. ETRAN Committee for Science and Technical Conferences

Steering Committee of IcETRAN 2016 Conference

Chair

Bratislav Milovanović, Serbia

Members

Svetlana Avramov-Zamurović, USA
Vera Dondur, Serbia
Mitch Gusat, Switzerland
Branko Kovačević, Serbia
Miroslav Krstić, USA
Vera Marković, Serbia
Predrag Petrović, Serbia
Dejan Popović, Serbia
Gordana Popović, Belgium
Zoran Popović, Serbia
Srđan Stanković, Serbia
Ninoslav Stojadinović, Serbia
Jasmina Vujić, USA
Dušan S. Zrnić, USA.

Technical Program Committee of IcETRAN 2016 conference

Chair

Zoran Jakšić, Serbia

Members

Olga Borić-Lubecke, USA
Djuradj Budimir, United Kingdom
Dejan Ćirić, Serbia
Vesna Crnojević Bengin, Serbia
Mirko Čudina, Slovenia
Branko Dokić, Bosnia and Herzegovina
Željko Djurović, Serbia
Dragan Filipović, Montenegro
Octavian Fratu, Romania
Liljana Gavrilovska, Macedonia
Milan Ilić, Serbia
Vesna Javor, Serbia
Nikola Jorgovanović, Serbia
Vladimir Katić, Serbia
Tom Kazmierski, United Kingdom
Zora Konjović, Serbia
Roumen Kountchev, Bulgaria
Vančo Litovski, Serbia
Miroslav Lutovac, Serbia

Jaroslav Makal, Poland
Vera Marković, Serbia
Vazgen Sh. Melikyan, Armenia
Miomir Mijić, Serbia
Ivan Milentijević, Serbia
Milan Milosavljević, Serbia
Bratislav Milovanović, Serbia
Nebojša Mitrović, Serbia
Cvetko Mitrovski, Macedonia
Vladimir Mladenović, Serbia
Zorica Nikolić, Serbia
Predrag Petković, Serbia
Predrag Petrović, Serbia
David Pokrajac, USA
Veljko Potkonjak, Serbia
Aneta Prijić, Serbia
Aleksandra Smiljanić, Serbia
Dušan Stipanović, USA
Miodrag Tasić, Serbia
Bane Vasić, USA
Zoran Veljović, Montenegro
Branka Vučetić, Australia

Local Organizing Committee of IcETRAN 2016

Chairs

Prof. Dr. Dragan Janković, Faculty of Electronic Engineering, University of Niš, Serbia, Chair

Prof. Dr. Sanja Vraneš, director, Institut Mihajlo Pupin, Belgrade, Serbia, Co-Chair

Members

Prof. Bratislav Milovanović, Singidunum University, Belgrade

Prof. Predrag Petrović, IRITEL Institute, Belgrade

Prof. Zoran Jakšić, ICTM, Belgrade

Mirjana Jovanić, ETRAN Society

Zlatko Jarnević, ETRAN Society

Promotion of Awarded Papers

Prof. Milić Djekić, Faculty of Technical Sciences Čačak

Program and Technical Support

Aleksandra Đorić, ICNT, Niš

Vladica Đorđević, ICNT, Niš

Miloš Kostić, EF, Niš

Miloš Petković, EF, Niš

Zoran Đorđević, EF, Niš

Technical and Marketing Support

Saša Rašković, Academic Mind, Belgrade

Marko Vukadinović, Academic Mind, Belgrade

Organization od Accommodation

Miroslava Jeremić, The Best Solutions, Belgrade

Mirjana Jokić, The Best Solutions, Belgrade

Time and Venue

IcETRAN 2016 conference is held in Mona Hotel, Zlatibor, Serbia, from Monday, June 13 to Thursday, June 16, 2016.

Registration Fee

Each IcETRAN conference participant with a regular contribution is requested to pay the registration fee with the ETRAN Society. Registration is free for participants with keynote or invited presentations, as well as for the committee members and covers the publication cost of one presentation. IEEE members pay a discounted registration fee.

Normal registration fee	180 €
IEEE members	150 €
Collective members of ETRAN Society:	120 €
Students	75 €
Keynote and invited presenters and committee members	free

Discounted student fee is valid for students of undergraduate studies (up to 24 years of age), master students (up to 27 years) and PhD students (up to 30 years). Proofs must be given on their status in order to enjoy a discounted fee. The 50% discount is valid for a maximum of one paper per participant.

50% discount to registration fee and free accommodation for two nights, breakfast included at the "Ratko Mitrovic" student resort, Zlatibor is valid for each young author who is the first author of an IcETRAN 2016 paper and:

1. Bachelor degree students: born after June 13, 1991.
2. Master degree students: born after June 13, 1988
3. Doctora students: born after June 13, 1985.
4. Young researchers with doctorate who received their Ph.D. degree aftern June 13, 2014: born after June 13, 1980.

A participant with a paid registration fee is eligible for the attendance of all conference events including its social programme with welcome party and conference dinner, as well as for conference materials which include printed abstracts proceedings, a disk with the full texts of proceedings (to be sent to the participant address after the conference). The prices are guaranteed for the payments received before May 31, 2016.

The conference proceedings are published after the conference and are distributed to the participants by mail. If a paper has not been presented at the conference by one of the authors or if a fee according to the above has not been paid, the paper will not be published in the proceedings.

Conference Desk

The registration desk of the IcETRAN conference starts with the work on Monday, June 13, 2016, 10:00 h in the lobby of the Mona Hotel, Zlatibor.

The registration desk will register participants, administer conference materials, receive registration fees and offer information to participants.

IcETRAN Events Program

Conference Opening

Monday, June 13, 18:15-20:00
Room B, CC Toledo

a. Welcome address
b. Introductory speech by ETRAN Society chair Bratislav Milovanović
c. Opening of 60th ETRAN Conference
d. Opening of IcETRAN 2016 conference
e. Aleksandar Marinčić Award
f. Best Papers Awards

Plenary Talk

Radars for Probing the Atmosphere

Dušan S. Zrnić, NOAA National Sever Storms Laboratory and the University of Oklahoma
Tuesday, June 14, 10:00-10:45, Room B, CC Toledo

This presentation reviews the types or radars and their applications for probing the atmosphere. The dominant scatterers causing reflections and affecting propagation guide the choice for optimum radar wavelength. This choice has led to a variety of scientific and operational applications of these instruments. Thus, for probing clouds, precipitation, and clear air, microwaves range in length between about 3 mm and 6 m. Probing at optical wavelengths is made with lidars. Primary emphasis of this talk will be on measurements of winds and precipitation but other applications such as determination of temperature and humidity will be mentioned.

Radar characteristics and signal processing to meet the objectives of specific missions are different. Moreover, similar radar types can serve weather surveillance at the ground; can be airborne for observations of all kinds of weather including hurricanes, and even spaceborne for global statistical assessment of climate effects. The differences and common grounds for these observations will be highlighted.

Dual polarization is the latest technology that has been introduced to the weather radar network of the US. Its principles and potency will be discussed. Advantages such as superior quantitative precipitation estimation and separation of meteorological scatterers from other contributors will be demonstrated.

Exploratory new technology on the horizon is the Multi-function Phased Array weather Radar (MPAR). This instrument is slated to satisfy weather observation needs, air traffic control requirements as well as detection/tracking of non-cooperative targets. A proof of concept but without polarization diversity has been tested at the National Severe Storm Laboratory. Some examples of data obtained very fast with this radar will be shown. Challenges and current research concerning this concept will also be discussed.

Plenary Talk

The European Research Council (ERC) and funding opportunities

Gordana Popović, European Research Council Executive Agency, European Commission, Brussels, Belgium and Technical University Vienna, Austria
Tuesday, June 14, 10:45-11:30, Room B, CC Toledo

Set up in 2007, the European Research Council (ERC) is the first pan-European funding organisation for frontier research. It aims to stimulate scientific excellence by encouraging competition for funding between ambitious, creative researchers of any nationality and age. This session will explain the ERC's funding opportunities under Horizon 2020, for researchers, who are keen to develop and fast-track their careers in Europe. The model is simple: one researcher, one host institution in a European Union member state or Associated Country (including Serbia), one project, and one selection criterion.

The session will also provide answers to practical questions such as:

How does the ERC support research careers?
What are the main features of ERC grants?
What are the selection criteria and how long is the selection process?
How does the application process work?
How many researchers are funded each year?
What are the chances of success?

Round table 1: Current Questions of Technological Development of Serbia

(in Serbian)
Tuesday, June 14, 11:30-13:30, Room B, CC Toledo

Moderators: Bratislav Milovanović, Petar Petrović, Predrag Petrović, Dragan Satarić, Miloljub Smiljanić

Tutorial:
Coordination of the Unlicensed Band Shared Access between LTE and WiFi Networks

Zorica Nikolić, Nenad Milošević, Valentina Nejković, Filip Jelenković, Milorad Tošić, University of Niš, Faculty of Electronic Engineering, Serbia
Tuesday, June 14, 14,30 h, Room 2

As 5G is moving towards exploring new bands and access methods for wireless technologies, the coexistence of heterogeneous wireless technologies with different access methods within the same band of frequencies becomes of paramount importance. LTE in unlicensed bands (LTE-U) will play a fundamental role in maximizing the overall capacity of a cell, towards enabling novel bandwidth demanding applications (e.g. 4K video streaming) to be feasible for a wide set of users. In this tutorial, we will use real testbed infrastructure and a real LTE-U setup in order to outline the importance of coordination between heterogeneous technologies, such as LTE and WiFi. The attendees will be guided to use the testbed resources via automated tools and experiment using

different levels of WiFi and LTE mutual interference in coordinated and uncoordinated environments when WiFi and LTE operate at the same, adjacent or distant channels.

14:30-14:45: *Opening* – Zorica Nikolić, University of Niš, Faculty of Electronic Engineering, Serbia

14:45-15:00: *Introduction to the Experiments* – Nenad Milošević, University of Niš, Faculty of Electronic Engineering, Serbia

15:00-15:45: *Coordination Scenario 1* – Nenad Milošević, Valentina Nejković, University of Niš, Faculty of Electronic Engineering, Serbia

This session will demonstrate the spectrum usage coordination between WiFi and LTE-U networks in 2.4 GHz unlicensed band. The following scenario is used in the experiment. There are nine nodes involved. Six nodes are WiFi stations (three pairs of two stations in ad-hoc mode), two nodes are LTE-U base and mobile stations, and one node is used for spectrum sensing (SS). Two WiFi networks are coordinated (CN) and one WiFi network is uncoordinated (UN). LTE-U network may be either coordinated or uncoordinated. At the beginning, UNs are turned on, then the SS is performed. Based on the SS, the coordination server assigns channels to the CNs. CNs are now turned on and SS is performed.

15:45-16:30: *Coordination Scenario 2* – Nenad Milošević, Valentina Nejković, University of Niš, Faculty of Electronic Engineering, Serbia

Session 2 will demonstrate more complex scenario than Session 1, but the same equipment will be used. At first, both CNs and UNs are off. SS is performed and the coordination server assigns channels to CNs. CNs are turned on. UNs are turned on and may interfere with some of the CNs. In order to find out what channels are occupied by UNs, CNs are turned off and SS is performed. The coordination server now assigns new channels to CNs and they are turned on. Finally, SS is performed and the coordinated spectrum may be observed.

Annual meeting of Serbian Society for Microwave Technique, Technologies and Systems

(in Serbian)
Tuesday, June 14, 16:30, Room 3
Chair: Bratislav Milovanović

General Assembly of ETRAN Society

(in Serbian)
Tuesday, June 14, 18:30-20:00, Room B, CC Toledo

Twelfth Annual Workshop nanoETRAN

(in English)
(within the section for Microelectronic and Optoelectronics)
Chair: Zoran Jakšić
Wednesday, June 15, 8:00-10:00, Room 4

The nanoETRAN workshop is dedicated to all aspects of nanoscience and nanotechnology related to electronics and electrical engineering, micro and nanoelectronics, micro and nanosystems, photonics and nanophotonics, as well as the aspects of fundamental science related to it. The papers are published in full in IcETRAN conference proceedings.

Discussion Table "Networking Online Experimentation"

Chair: Željko Đurović, School of Electrical Engineering, University of Belgrade, Serbia
Wednesday, June 15, 10.00 h, Room 2

Maria Teresa Restivo, Faculty of Engineering, University of Porto, Portugal
Radojka Krneta, Faculty of Technical Sciences, University of Kragujevac, Serbia
Dragan Šešlija, Faculty of Technical Sciences, University of Novi Sad, Serbia
Diana Urbano, Faculty of Engineering, University of Porto, Portugal
Javier Zubia, Faculty of Engineering, University of Deusto, Spain

Round table 2

Power Industry of Serbia and Telekom Srbija

(in Serbian)
Wednesday, June 15, 10:00-12:00, Room B, CC Toledo

Moderators: **Boško Buha, Slobodan Vukosavić, Branko Kovačević, Predrag Petrović, Nikola Rajaković, Aleksandra Smiljanić**

Plenary Talk

The Rise of the Super-Datacenter: From Lossless Elasticity, thru Cognitive Analytics, toward the Next Gen. HPC (High Performance Cloud)

Mitch Gusat, IBM Research, Zurich Laboratory, Switzerland
Wednessday, June 14, 12:00-12:45, Room B, CC Toledo

We gaze into a cloudy crystall ball to identify the Top 5 trends likely to shape the next generation cloud/datacenter designs. Why now? Recently a number of remarkable events and big data platforms have 'perturbed' and are already re-shaping the IT landscape. Hence we conjecture that a 'perfect' storm is brewing in the Cloud, driven by: (a) Increasingly latency-sensitive hyperscale analytics, i.e., interactive and/or stream processing workloads; (b) Explosively emerging

distributed 'cognitive', i.e., Deep ML and Neural Networks; (c) Efficient and ubiquitous virtualization/SDN; (d) Sustainable Exascale supercomputing, and, (e) IoT and mobile computing. Accordingly, new networking and processing architectures are competing to address these opportunities for the upcoming heterogenous/hybrid datacenters, while posing new challenges to the data scientist and the Cloud research community.

Plenary Talk

Tesla's discovery of the rotating magnetic field

(in Serbian)
Slobodan Vukosavić, School of Electrical Engineering, University of Belgrade, Serbia
Wednesday, June 15, 12:45-13:30, Room B, CC Toledo

Conference Excursion. Visit to Andrić Grad and Drvengrad

Wednesday, June 15, 14:30

Science Books Exhibition: Academic Mind Publisher

Conference Lobby, throughout the conference

Conference closing

Thursday, June 16, 14:00, Room B, CC Toledo

IcETRAN Sections

A total of 302 contributions has been accepted for oral presentation at the 60th annual meeting of the ETRAN Society.

175 papers have been accepted for presentation at the IcETRAN 2016 International Conference within 30 sessions of 17 sections:

PLEN Plenary Talks (3)
AKI Acoustics (5)
API Antennas and Propagation (4)
AUI Automatic Control (26)
EEI Power Engineering (3)
EKI Electric Circuits and systems and signal processing (17)
ELI Electronics (13)
MEI Biomedicine (17)
MLI Metrology (11)
MOI Microelectronics and Optoelectronics (8)
MTI Microwave and Submillimeter Technique (16)
NMI New Materials (2)
NTI Nuclear Engineering (5)
ROI Robotics and Flexible Automation (12)
RTI Computing (18)
TEI Telecommunications (14)
VII Artificial Intelligence (12)

Besides that, 127 papers have been accepted for 60th national conference ETRAN, to be presented within 25 sessions of 16 sections.

Full papers presented at the conference will be published in CD proceedings. In order to be included in the proceedings, a paper accepted for the Conference must be presented by one of the authors and a registration fee must be paid.

Professional Boards may nominate one award each for the best junior researcher paper (graduate or doctoral student). To be eligible for the Award, a junior researcher must be the first author of the paper and must personaly present the paper at the Conference.

Professional Boards may also propose one paper for the Best Paper Award.

A digital projector is available for presentation and a PC computer with Windows XP or Windows 7 operating system, with MS Power Point. It is advised to use lettering of minimum 18 pt in slides.

The talk duration is 30 minutes for keynote presentations and 20 minutes for invited presentations, while regular papers are presented in 12 minutes, followed by max. 3 minutes of discussion.

Session Chairs

Plenary Sessions

PLEN1	**Zoran Jakšić**
PLEN2	**Aleksandra Smiljanić**

Contributed Sessions

AKI1	**Mirko Čudina, Miomir Mijić**
API1	**Miodrag Tasić**
AUI1	**Radojka Krneta**
RT	**Željko Đurović**
AUI2	**Branko Kovačević**
AUI3	**Stevica Graovac**
AUI4	**Vera Petrović**
EEI1	**Vladimir Katić**
EKI1	**Jelena Ćertić**
EKI1	**Milorad Paskaš**
EKI1	**Djordje Babić**
ELI1	**Vazgen Melikyan, Predrag Petković**
ELI1	**Branko Dokić, Duško Lukač**
MEI1	**Dejan B. Popović**
MEI2	**Mirjana Popović**
MEI3	**Nikola Jorgovanović**
MLI1	**Svetlana Avramov-Zamurović**
MLI1	**Jaroslaw Makal**
MOI1	**Miloljub Smiljanić**
nanoETRAN	**Zoran Jakšić**
MTI1	**Aleksandar Nešić, Bratislav Milovanović**
MTI2	**Đurađ Budimir, Vera Marković**
NMI1	**Nebojša Mitrović**
NTI1	**Marko Ninković**
ROI1	**Aleksandar Rodić**
ROI2	**Veljko Potkonjak**

ROI3 **Giuseppe Carbone, Petar Petrović**
ROI4 **Bojan Nemec, Mirjana Popović**

RTI1 **Miroslav Popović, Ivan Milentijević**
RTI2 **Ivan Milentijević, Ilija Bašičević**
RTI3 **Dragan Janković, Jelica Protić**

TEI1 **Zorica Nikolić**
TEI2 **Milan Bjelica**

VII1 **Milan Milosavljević**
VII2 **Saša Adamović**

Invited and Contributed Papers

PLENARY TALKS

PLENARY 1.
Chair: Zoran Jakšić, Institute for Chemistry, Technology and Metallurgy, University of Belgrade, Serbia
Tuesday, June 14, 10.00 h, Room B, CC Toledo

RADARS FOR PROBING THE ATMOSPHERE

Dušan S. Zrnić, NOAA National Sever Storms Laboratory and the University of Oklahoma

This presentation reviews the types or radars and their applications for probing the atmosphere. The dominant scatterers causing reflections and affecting propagation guide the choice for optimum radar wavelength. This choice has led to a variety of scientific and operational applications of these instruments. Thus, for probing clouds, precipitation, and clear air, microwaves range in length between about 3 mm and 6 m. Probing at optical wavelengths is made with lidars. Primary emphasis of this talk will be on measurements of winds and precipitation but other applications such as determination of temperature and humidity will be mentioned.

Radar characteristics and signal processing to meet the objectives of specific missions are different. Moreover, similar radar types can serve weather surveillance at the ground; can be airborne for observations of all kinds of weather including hurricanes, and even spaceborne for global statistical assessment of climate effects. The differences and common grounds for these observations will be highlighted.

Dual polarization is the latest technology that has been introduced to the weather radar network of the US. Its principles and potency will be discussed. Advantages such as superior quantitative precipitation estimation and separation of meteorological scatterers from other contributors will be demonstrated.

Exploratory new technology on the horizon is the Multi-function Phased Array weather Radar (MPAR). This instrument is slated to satisfy weather observation needs, air traffic control requirements as well as detection/tracking of non-cooperative targets. A proof of concept but without polarization diversity has been tested at the National Severe Storm Laboratory. Some examples of data obtained very fast with this radar will be shown. Challenges and current research concerning this concept will also be discussed.

THE EUROPEAN RESEARCH COUNCIL (ERC) AND FUNDING OPPORTUNITIES

Gordana Popović, European Research Council Executive Agency, European Commission, Brussels, Belgium and Technical University Vienna, Austria

Set up in 2007, the European Research Council (ERC) is the first pan-European funding organisation for frontier research. It aims to stimulate scientific excellence by encouraging competition for funding between ambitious, creative researchers of any nationality and age. This session will explain the ERC's funding opportunities under Horizon 2020, for researchers, who are keen to develop and fast-track their careers in Europe. The model is simple: one researcher, one host institution in a European Union member state or Associated Country (including Serbia), one project, and one selection criterion.

The session will also provide answers to practical questions such as:

How does the ERC support research careers?

What are the main features of ERC grants?

What are the selection criteria and how long is the selection process?

How does the application process work?

How many researchers are funded each year?

What are the chances of success?

PLENARY 2
Chair: Aleksandra Smiljanić, School of Electrical Engineering, University of Belgrade, Serbia
Wednesday, June 15, 12.00, Room B, CC Toledo

THE RISE OF THE SUPER-DATACENTER: FROM LOSSLESS ELASTICITY, THRU COGNITIVE ANALYTICS, TOWARD THE NEXT GEN. HPC (HIGH PERFORMANCE CLOUD)

Mitch Gusat, IBM Research, Zurich Laboratory, Switzerland

We gaze into a cloudy crystall ball to identify the Top 5 trends likely to shape the next generation cloud/datacenter designs. Why now? Recently a number of remarkable events and big data platforms have 'perturbed' and are already re-shaping the IT landscape. Hence we conjecture that a 'perfect' storm is brewing in the Cloud, driven by: (a) Increasingly latency-sensitive hyperscale analytics, i.e., interactive and/or stream processing workloads; (b)

Explosively emerging distributed 'cognitive', i.e., Deep ML and Neural Networks; (c) Efficient and ubiquitous virtualization/SDN; (d) Sustainable Exascale supercomputing, and, (e) IoT and mobile computing. Accordingly, new networking and processing architectures are competing to address these opportunities for the upcoming heterogenous/hybrid datacenters, while posing new challenges to the data scientist and the Cloud research community.

ACOUSTICS – AKI

AKI1. Noise monitoring, Speech, Room acoustics
Chairs: Mirko Čudina, Faculty of Mechanical Engineering, University of Ljubljana, Slovenia
Miomir Mijić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Tuesday, June 14, 8.00 h, Room 1

AKI1.1
Invited talk

USE OF AUDIBLE SOUND FOR MONITORING OF TRANSIENT PHENOMENA IN MECHANICAL ENGINEERING

Mirko Čudina, Faculty of Mechanical Engineering, University of Ljubljana, Slovenia

In mechanical engineering there are different phenomena, which have to be tested and monitored to control undesirable effects. Where these phenomena are connected with the emitted noise like in power and process engineering, and working and machine-tools, audible sound is very useful tool for effective testing and monitoring. In this paper, our findings connected with transient phenomena in turbomachinery (pumps, fans and compressors) and welding processes will be presented. The use of audible sound will be demonstrated:
- in detection of rotating stall and surge at axial and centrifugal turbo machines (fans, compressors and pumps),
- in detection of the cavitation process in centrifugal pumps and for determination of the net positive suction head (NPSH) critical value and
- in quality control of the gas metal arc welding (GMAW) process.
All these phenomena are also theoretical demonstrated. In comparison with other methods, the method based on the use of audible sound is cheap, easy and user-friendly. Instead of a special test stand or boring a hole in the machine wall to mount a sensor, only a microphone placed nearby and a computer with a sound card is needed.

AKI1.2
CIRCULAR MICROPHONE ARRAY FOR ENVIRONMENTAL NOISE MONITORING

Jurij Prezelj, Faculty of Mechanical Engineering, University of Ljubljana, Slovenia
Mirko Čudina, Faculty of Mechanical Engineering, University of Ljubljana, Slovenia

State of the art noise monitoring systems (NMS) are based on digital signal processing. In general, NMS systems enable computation and storage of noise levels (*L*eq), one-third-octave spectral analysis, wave recordings, detection of noise events based on thresholds, or evaluation of statistical indices, and other similar functions. Since the computational power of signal processors keeps increasing, it is likely that NMSs will become capable of more sophisticated processing of the sound data they record in the near future. Consequently, research has been undertaken to develop three new measurement features; automatic exclusion of noise which is not correlated with measured noise source (automatic back erase), automatic identification of dominant noise source location and automatic noise classification, based on the sound recognition algorithms. Application of circular microphone array enables synergy between these three features, leading to a significant reduction of the environmental noise monitoring costs.

AKI1.3
RECOGNITION OF WHISPERED SPEECH BASED ON PLP FEATURES AND DTW ALGORITHM

Branko R. Marković, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia and Technical College, Computing and Information Technology Department, Čačak, Serbia
Slobodan T. Jovičić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Miomir Mijić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Jovan Galić, Faculty of Electrical Engineering, University of Banja Luka, Banja Luka, Bosnia and Herzegovina
Đorđe T. Grozdić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia

In this paper the results of normal and whispered speech recognition using the PLP (Perceptual Linear Prediction) features for front-end and DTW (Dynamic Time Warping) algorithm for back-end are presented. The isolated words used for these experiments are from the Whi-Spe database. The experiments captured four training/test scenarios: normal/normal speech, whispered/whispered speech and their combinations (normal/whispered and whispered/normal) in speaker dependent mode. The results confirm important improvement in recognition after application of the CMS (Cepstral Mean Subtraction) normalization, especially in the mismatch scenarios.

AKI1.4
APPLYING OF WAVELETS IN DE-NOISING OF ROOM IMPULSE RESPONSES

Đorđe Damnjanović, Faculty of Technical Sciences Čačak, University of Kragujevac, Čačak, Serbia
Dejan Ćirić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia

Wavelet transforms can easily be used in the signal de-noising, especially for audio, speech and image signals. However, wavelets are hardly applied for de-noising of room impulse responses (RIRs). Since noise represents one of the most important disturbances of these responses, possibilities for reducing the noise effects by different wavelets are explored here. In that regard, the Daubechies, Haar, Coiflets, Symlet, Biorthogonal, Reverse biorthogonal and Mayer wavelet functions are

applied either to responses to the excitation signal or directly to the extracted RIRs. Both synthesized as well as measured RIRs are used for that purpose. Time and frequency analysis are done in order to compare the RIRs obtained after the wavelets with corresponding noiseless or reference RIRs. In addition, the increase of dynamic range of the backward integrated decay curves obtained by the wavelet application is also analyzed. The results show that this increase can be even more than 20 dB if adequate parameters of wavelets are chosen.

AKI1.5
EVALUATION OF SPHERICAL MICROPHONE ARRAY AND APPLIED BEAMFORMING TECHNIQUES

Ana Đorđević, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Dejan Ćirić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Marko Ličanin, Faculty of Electronic Engineering, University of Niš, Niš, Serbia

Visual technologies have largely advanced especially the in past decade, while the comfort of good sound stands somewhat behind. Microphone arrays are excellent tools that can be used to precisely capture the spatial information of the sound, thus increasing the quality of sound image in recording itself. By applying numerous algorithms in the spatial domain, microphone arrays can be used for many acoustical analyses. They still represent relatively young technology and although there are papers about their design, each of the arrays is rather unique. Recently, a spherical microphone array with 32 microphones in an open sphere has been built. In this paper, the repeatability of latency of the measurement system, repeatability of the amplitude waveform and frequency response are evaluated. Besides, suitability of applying different types of beamforming techniques on the realized array is investigated. For comparison and assessment of these methods, directivity, directivity index and white noise gain are studied.

ANTENNAS AND PROPAGATION – API

API1. Antennas and Propagation
Chair: Miodrag Tasić, University of Belgrade, School of Electrical Engineering, Serbia
Monday, June 13, 11.00 h, Room 3

API1.1
Invited talk

INTERNAL MATCHING OF UHF HELICAL ANTENNA EXCITERS FOR MAGNETIC RESONANCE IMAGING

Milan Ilić, University of Belgrade, School of Electrical Engineering, Serbia
Slobodan Savić, University of Belgrade, School of Electrical Engineering, Serbia
Pavle Djondović, University of Belgrade, School of Electrical Engineering, Serbia

We investigate applicability of simple metallic plate inserts as devices for efficient internal matching of helical antennas. A vertically-profiled metallic plate is attached to the first turn of a helix antenna, thus constituting an impedance transformer with the ground plane. Position and size of the matching plate are systematically varied and optimized through extensive numerical simulations. Comparative computational electromagnetic (CEM) modeling of antennas with matching plates is performed using both the finite element method (FEM) and the method of moments (MoM) for rigorous verification of obtained results. A prototype of a helical antenna is built, matched, and the matching performance is experimentally validated by measurements. Considered antennas are intended for utilization in the ultra high frequency (UHF) band as RF exciters of the circularly polarized magnetic field in modern pre-clinical experimental high-field magnetic resonance imaging (MRI) machines.

API1.2
E-PLANE JUNCTION OF TWO RECTANGULAR WAVEGUIDES WITH HEIGHT RATIO OF 2:1

Dragan Filipović, University of Montenegro, Faculty of Electrical Engineering, Montenegro
Tatijana Dlabač, University of Montenegro, Maritime Faculty, Montenegro

In this paper we investigate symmetrical and asymmetrical E-plane junctions of two rectangular waveguides of equal width and height ratio of 2:1. A very simple formula for the junction susceptance in an equivalent circuit is obtained by solving a relevant singular integral equation in a closed form. Some numerical results are given and compared to the results obtained by other methods.

API1.3
OPTIMIZATION OF RECEIVED SIGNAL IN DETERMINING DIRECTION OF ARRIVAL USING THE MUSIC ALGORITHM

Veljko Nikolić, Technical Test Center, Serbian General Staff, Serbia
Vera Marković, University of Nis, Faculty of Electronic Engineering, Serbia
Aleksandar Kovačević, Technical Test Center, Serbian General Staff, Serbia

This paper presents one of the possible ways of automated acquisition, digital signal processing and multistage optimization of signal pairs, received with linear two element antenna array, as well as further digital signal processing of optimized signal pairs using MUSIC algorithm (MUSIC - Multiple Signal Classification), in order to obtain the value of estimated angle of arrival of the signal from the radiation source. For this purpose, a program was made and implemented in Matlab. The analysis of the obtained results shows that with increasing number of samples of the received signal pairs, the accuracy of the estimated directions of arrival of incoming signals also increases, which means that proposed software solution, for optimally selected number of samples of the received signal pairs, is applicable in practice.

API1.4
OPTIMAL USE OF GAUSS-LEGENDRE INTEGRATION FORMULA FOR EVALUATION OF POTENTIAL INTEGRALS IN ANALYSIS OF AXIALLY SYMMETRICAL WIRE ANTENNAS

Branko Kolundžija, University of Belgrade, School of Electrical Engineering, Serbia
Aleksandra Krneta, University of Belgrade, School of Electrical Engineering, Serbia

Potential integral of exact kernel of the electric field integral equation is a twofold (surface) integral and implies integration along the generatrix of the element and along azimuth angle φ (i.e. along the circumference of axially symmetrical element). In this paper four integration methods for precise evaluation of the second integration (along the azimuth angle) of potential integral are considered on the example of an arbitrary truncated-cone element. In the first of these methods the Gauss-Legendre integration formula is directly applied, while in other three methods it is combined with singularity cancellation techniques that preserve symmetry of integrand. This symmetry is used to reduce the numerical effort in two ways: 1) using integration formula of order n on half-interval, and 2) using integration formula of order $2n$ on the full interval, but calculating integrand only in n points. The second way is shown to be significantly more accurate than the first way, and when combined with properly chosen singularity cancellation technique it enables very efficient calculation of potential integrals.

AUTOMATIC CONTROL – AUI

Session AUI1. Theory And Practice Of Remote Experimentation In Engineering
Chair: Radojka Krneta, Faculty of Technical Sciences, University of Kragujevac, Serbia
Wednesday, June 15, 8.00 h, Room 2

AUI1.1
Invited talk

PDE CONTROL: DESIGNS AND APPLICATIONS

Miroslav Krstić, University of California San Diego, La Jolla, California, USA

Classical physical applications are often modeled by partial differential equations: electromagnetic devices and systems, fluid flows and combustion in engines, thermal dynamics in buildings, flexible wings of aircraft, electrochemistry in batteries, and plasmas in lasers and tokamaks. In its early period PDE control focused on replicating linear control methods (pole placement, LQG, H-infinity, etc) in infinite dimension. This "template"-based approach to research, lasting through the 1960s-1990s, has had limited theoretical achievement (being based on linear templates) and even less engineering impact. Over the last 15 years, a continuum version of the "backstepping" method has given rise to control design tools for nonlinear PDEs, for PDEs with unknown functional coefficients, for each of the major PDE classes, and for compensating delays of arbitrary length. I will present a few design ideas and several applications, including deep oil drilling (where a large uncertainty occurs at the drill-rock interface), extruders in 3D printing (where a large delay is a nonlinear function of the melting location), and estimation in Lithium-ion batteries (with the goal of reducing the automotive battery charge time to 15 minutes).

AUI1.2
REMOTE EXPERIMENT: SERIAL AND PARALLEL RLC CIRCUIT

Miroslav Bjekić, Faculty of Technical Sciences, University of Kragujevac, Serbia
Miloš Božić, Faculty of Technical Sciences, University of Kragujevac, Serbia
Marko Rosić, Faculty of Technical Sciences, University of Kragujevac, Serbia
Sanja Antić, Faculty of Technical Sciences, University of Kragujevac, Serbia

This paper presents the remote experiment „Serial and parallel RLC circuit". Using 12 switches, different connections between a resistor, an inductor and a capacitor, canbe made. There is also a possibility to choose a predefined connection from the list. The remote experiment enables monitoring of: voltages at 8 nods, voltage and current at each element, impedance of each element. Formed phasor diagrams of voltage and current can be monitored and also correlation between the phasors and time values of the voltage and current at the each element can be observed. Measured values and expected values using Ohm's law and Kirchhoff's laws can be compared, as well.

AUI1.3
STEM EDUCATION: CURRENT AND FUTURE TRENDS IN LABORATORY-BASED EDUCATION

Ilona-Elefterya Lasica, European University of Cyprus, Cyprus
Konstantinos Katzis, European University of Cyprus, Cyprus
Maria Meletiou-Mavrotheris, European University of Cyprus, Cyprus
Christos Dimopoulos, European University of Cyprus, Cyprus

Laboratory experiments constitute a significant educational tool in the area of Science, Technology, Engineering and Mathematics (STEM) Education. During the past two decades, a considerable number of published research papers have been devoted to Virtual and Remote Labs (VRLs), the use of which is currently spreading across STEM domains and educational levels. Lately, Augmented Reality Remote Labs (ARRLs) have entered the research field. In this paper, some current trends and challenges are identified and discussed, after a brief overview of the state-of-the-art concerning the different types of labs related to STEM in secondary education and lifelong learning.

AUI1.4
LEARNING BITWISE OPERATIONS IN C USING REMOTE EXPERIMENT ON FLOATING LED'S BLINKING

Vanja Luković, Faculty of Technical Sciences, University of Kragujevac, Serbia
Radojka Krneta, Faculty of Technical Sciences, University of Kragujevac, Serbia
Aleksandar Peulić, Faculty of Technical Sciences, University of Kragujevac, Serbia
Željko Jovanović, Faculty of Technical Sciences, University of Kragujevac, Serbia
Đorđe Damnjanović, Faculty of Technical Sciences, University of Kragujevac, Serbia

The application of remote experiment on floating LEDs blinking in learning bitwise operations in C is described in the paper. The experiment on floating LEDs blinking is realized using Microchip PIC microcontroller placed on the *BIGPIC 5* platform. Lab module with remote access to this experiment is created with the aim of learning programming techniques from the beginning of engineering studies through creation of simple engineering application - program control of LEDs on / off switching. The application is realized using the software tool *MicroC PRO for PIC*. This lab module with

remote experiment was used by students within their first course of C programming language in second year of Electrical, Computer and Mechatronics Engineering study programs at Faculty of Technical Sciences Čačak, University of Kragujevac. Results of student evaluation of this lab module is also presented and discussed.

AUI1.5
USING LOGISIM EDUCATIONAL SOFTWARE IN LEARNING DIGITAL CIRCUITS DESIGN

Vanja Luković, Faculty of Technical Sciences, University of Kragujevac, Serbia
Radojka Krneta, Faculty of Technical Sciences, University of Kragujevac, Serbia
Ana Vulović, Faculty of Technical Sciences, University of Kragujevac, Serbia
Christos Dimopoulos, European University of Cyprus, Cyprus
Konstantinos Katzis, European University of Cyprus, Cyprus
Maria Meletiou-Mavrotheris, European University of Cyprus, Cyprus

The use of Logisim open-source software for learning digital circuits design by students of first and second-year of Electrical, Computer and Mechatronics Engineering study programs of undergraduate studies at the Faculty of Technical Science Čačak, University of Kragujevac, is described in the paper. Because of the simplicity and flexibility of Logisim, this software is utilized as an educational tool in introductory undergraduate courses related to digital circuits design and computer architecture. Logisim provides an easy-to-use graphical environment, enabling students to solve their homework assignments related to designing and simulating digital circuits. For the purpose of measuring effectiveness of this educational software tool, a survey study was conducted among students who used Logisim in learning digital circuits design within the course Foundations in Computer Technics 1. After providing an overview of the Logisim software environment and an example of the process followed in the design of a digital circuit, the paper presents and discusses the student evaluation survey results.

AUI1.6
IMAGE ANALYSIS AS A METHOD OF QUANTIFYING THE EFFECTIVNESS OF PNEUMATIC NOZZLES

Vladimir Srndaljčević, Faculty of Technical Sciences, University of Novi Sad, Serbia
Brajan Bajči, Faculty of Technical Sciences, University of Novi Sad, Serbia
Dragan Šešlija, Faculty of Technical Sciences, University of Novi Sad, Serbia
Jovan Šulc, Faculty of Technical Sciences, University of Novi Sad, Serbia
Vule Reljić, Faculty of Technical Sciences, University of Novi Sad, Serbia
Slobodan Dudić, Faculty of Technical Sciences, University of Novi Sad, Serbia
Ivana Milenković, Faculty of Technical Sciences, University of Novi Sad, Serbia

In addition to all the benefits that compressed air provides, due to improper and inefficient use it could become the most expensive form of energy in the control of industrial processes. This paper deals with the problem of improving energy efficiency of one of the significant consumer of compressed air – pneumatic nozzles. In a scope of development of device for the analysis of energy efficiency of pneumatic systems with nozzles that should be able for remote access a special problem is quantification of pneumatic nozzles effectivness. In this paper is shown how is it possible to use image analysis for solving that kind of a problem. For this purpose an image processing software is developed through which it is possible to determine the amount of blown powder on which the nozzle acts. By using the aforementioned software multiple nozzles, with different constructions, were analyzed and the obtained results are shown.

AUI1.7
EVALUATION OF REMOTE EXPERIMENTS IN TEACHING OF CONTROL THEORY

Aleksandra Marjanović, School of Electrical Engineering, University of Belgrade, Serbia
Darko Hercog, Institute of Robotics, Faculty of Electrical Engineering and Computer Science, University of Maribor, Slovenia
Sanja Vujnović, School of Electrical Engineering, University of Belgrade, Serbia
Predrag Todorov, School of Electrical Engineering, University of Belgrade, Serbia

Todays level of connectedness via internet and the availability of appropriate applications offer new possibilities in the area of electrical engineering education. In particular, regarding teaching of control theory, internet based remote experiment enables the availability of expensive and complex experimental equipment to a wide community of electrical engineering students. However, the question is if this type of non-physical contact is effective in conveying the underlying control principles. This paper analyses the results obtained from questionnaires filled out by students at the School of Electrical Engineering in Belgrade, aiming to improve the effectiveness of this type of education.

Round Table
Chair: Željko Đurović, School of Electrical Engineering, University of Belgrade, Serbia
Wednesday, June 15, 10.00 h, Room 2

AUI1.8
DISCUSSION TABLE "NETWORKING ONLINE EXPERIMENTATION"

Maria Teresa Restivo, Faculty of Engineering, University of Porto, Portugal
Radojka Krneta, Faculty of Technical Sciences, University of Kragujevac, Serbia

Dragan Šešlija, Faculty of Technical Sciences, University of Novi Sad, Serbia
Diana Urbano, Faculty of Engineering, University of Porto, Portugal
Javier Zubia, Faculty of Engineering, University of Deusto, Spain

In the Networking Online Experimentation Discussion Table the promoters, all members of NeReLa Network, will address different topics aiming to promote discussion among all the participants. Under the topic of Online Experimentation for All, the meaning will be explored, the respective ontology, its diversity of resources based in distinct technologies and different examples will be also shortly presented. In particular, the NeReLa Network Consortium will be presented as well as its objectives and examples of its real networking. Some of NeReLa resources based in interesting technologies and examples of a worthy effort for complementing and sharing online experiments at international level will be shown within the topic Complementing Online Experiments. The need of Assessing Online Experiments is now relevant. What should we need to assess efficiently and based in a scientific methodology? Due to the particular characteristics of online experimentation which kind of tool should we use? Finally, in Resources and Sharing Online Experiments some ongoing actions will be referred and some comments to the traditional attitudes among academics should provide some reflexion. Based in these topics the discussion table expects to open a fruitful debate.

Session AUI2. New ideas and solutions for intelligent system maintenance and control
Chair: Branko Kovačević, School of Electrical Engineering, University of Belgrade, Serbia
Wednesday, June 15, 10.30 h, Room 2

AUI2.1
ADAPTIVE INTERNAL MODEL-BASED NEURAL CONTROLLERS WITH THE SGD LEARNING ALGORITHM

Milorad Božić, Faculty of Electrical Engineering, University of Banja Luka, Bosnia and Herzegovina
Jasmin Igić, Faculty of Electrical Engineering, University of Banja Luka, Bosnia and Herzegovina
Igor Krčmar, Faculty of Electrical Engineering, University of Banja Luka, Bosnia and Herzegovina

In this paper we present a Fully Adaptive Internal Model-based Neural Control (FAIMNC) design aimed to control unknown nonlinear industrial processes with stable dynamics. The internal model of the controlled plant is implemented by the NN provided with a Stochastic Gradient Descent (SGD) learning algorithm. To cope with a high variability of process gain at different operational points and possible high errors in estimation of the corresponding sensitivities of nonlinear process model we proposed one practical solution to eliminate offset in a steady state at constant system inputs. Based on the SGD learning algorithm, a variant of an Adaptive Approximate Internal Model-based Neural Control (AAIMNC) is also presented. Some illustrations and performance testing of the proposed adaptive NN controllers are given by examples.

AUI2.2
HARDWARE IN THE LOOP SIMULATION FOR TENSION LEVELER

Aleksandar Bukvić, MIKA Project Servis, Belgrade, Serbia
Nikola Tošić, MIKA Project Servis, Belgrade, Serbia
Vladan Dimitrijević, MIKA Project Servis, Belgrade, Serbia
Milan Bebić, School of Electrical Engineering, University of Belgrade, Serbia

In a metal web processing applications one of the main part of the production line is tension leveler. It contains unwinder, tension bridles and winder. Parameters identification of regulators which control the production line and their testing are needed. The paper presents a simulation and 3D visualization model of tension leveler, for purpose of testing the control strategy. Complete hardware which is installed on the production line (drives, motors, etc.) is emulated by Simulation Unit hardware and is connected with mathematical model of the tension leveler. Visualization model is also represented in 3D and control strategy is tested on hardware-in-the-loop real time simulation. Main goal of this project is to design and test control strategy for the simulated process of web tension leveling, and to represent it as a 3D animation.

AUI2.3
A NEW COMBINED PERFORMANCE CRITERION FOR OPTIMIZATION OF PI CONTROLLER

Marko Bošković, Faculty of Electrical Engineering, University of East Sarajevo, Bosnia and Herzegovina
Tomislav Šekara, School of Electrical Engineering, University of Belgrade, Serbia
Milan R. Rapaić, Faculty of Technical Science, University of Novi Sad, Serbia
Boris Jakovljević, Faculty of Technical Science, University of Novi Sad, Serbia

This paper addresses the problem of optimal tuning of PI controller under constraints to robustness defined in the form of maximum sensitivity function M_s. The optimization procedure is based on the maximization of the combined performance criterion $J_c=\alpha k_i+(1-\alpha)k$, where k_i and k are integral and proportional gain, respectively, and α is user-defined parameter in the range of $0\leq\alpha\leq1$. Effectiveness of the proposed method is verified via numerical simulation on typical representatives of stable, integrating and oscillating processes including dead-time. Obtained results are compared with Åström, Panagopoulos and Hägglund (APH) tuning method of PI controller based on non-convex optimization. It is shown that application of the proposed tuning method results in better performance and robustness indices of the closed loop system compared to those obtained with the APH method.

AUI2.4
MODELING OF SOLAR HEAT GAIN OF THERMAL ZONE

Slađana Lazarević, Faculty of Technical Sciences, University of Novi Sad, Serbia
Velimir Čongradac, Faculty of Technical Sciences, University of Novi Sad, Serbia
Dubravka Bojanić, Faculty of Technical Sciences, University of Novi Sad, Serbia
Luka Mejić, Faculty of Technical Sciences, University of Novi Sad, Serbia
Igor Tomić, Faculty of Technical Sciences, University of Novi Sad, Serbia

This paper presents development of a mathematical model for solar heat gains in one thermal zone of a building based on estimation of Sun altitude on the horizon and incidence angle of solar rays on the window surface for every day of the year. Calculations use a great number of relevant parameters such as geographical longitude and latitude, time zone, dimensions of room and window, albedo of the building surrounding etc. The model is created and tested separately for clear and overcast days in seasonal climate transition periods showing that solar heat gains have significant impact on the room temperature during the day. A comprehensive model described in this paper could be used proper sizing and control of heating/cooling systems.

AUI2.5
APPLICATION OF T^2 CONTROL CHARTS ON ACOUSTIC SIGNALS OF INTERNAL COMBUSTION ENGINES FOR FAULT DETECTION

Emilija Kisić, School of Electrical and Computer Engineering of Applied Studies, Belgrade, Serbia
Dejan Matijević, School of Electrical and Computer Engineering of Applied Studies, Belgrade, Serbia
Vera Petrović, School of Electrical and Computer Engineering of Applied Studies, Belgrade, Serbia

In this paper analysis of recorded acoustic signals of internal combustion engine is performed. Acoustic signals are presented with spectrogram, in order to analyze energy of the signal in time-frequency domain for better detection of fault patterns. For feature extraction in time-frequency domain characteristic fault frequencies are taken. These characteristic frequencies are used for further analysis with T^2 control charts. Obtained results confirmed that T^2 statistic is changed for fault signals, so it is concluded that proposed method could be used for fault detection perspectives of internal combustion engine.

AUI2.6
TORSIONAL RESONANCE COMPENSATION IN AN ELECTRO-MECHANICAL SYSTEM

Sanja Antić, Faculty of Technical Sciences Cacak, University of Kragujevac, Serbia
Miroslav Bjekić, Faculty of Technical Sciences Cacak, University of Kragujevac, Serbia
Milos Božić, Faculty of Technical Sciences Cacak, University of Kragujevac, Serbia
Milentije Lukovic, Faculty of Technical Sciences Cacak, University of Kragujevac, Serbia

The paper discusses the detection and elimination of the torsional resonance effect by designing a notch filter in a real, electro-mechanical system, consisting of a dc motor which is through a final rigidity shaft coupled with a load. To achieve satisfactory closed loop system performance a PI controller was synthesized applying the compensation method. The paper is a useful educational material for the students training and laboratory exercises performance.

Session AUI3. Signal processing in surveillance and tracking systems
Chair: Stevica Graovac, School of Electrical Engineering, University of Belgrade, Serbia
Thursday, June 16, 8.00 h, Room 2

AUI3.1
SOFTWARE-BASED SLIDING WINDOW PLOT EXTRACTOR FOR SECONDARY SURVEILLANCE RADARS, PART 1: OVERVIEW

Miloš Jevtić, University of Belgrade, Institute Mihailo Pupin, Serbia
Ksenija Marković, University of Belgrade, Institute Mihailo Pupin, Serbia
Tanja Pajić, University of Belgrade, Institute Mihailo Pupin, Serbia
Nikola Zogović, University of Belgrade, Institute Mihailo Pupin, Serbia
Stevica Graovac, University of Belgrade, School of Electrical Engineering, Serbia

This paper is first in a series of three papers which present Secondary Extractor (SE), a contemporary software solution for the problem of real-time plot extraction from raw secondary surveillance radar (SSR) signals. SE employs sliding window plot extraction, which makes it applicable with non-monopulse SSR. SE is designed and implemented following the object-oriented paradigm. While this paper is focused on the higher level architecture and overall performance of SE, the two companion papers give more detailed views on two key elements of SE – the reply decoder and the target detector. Performance evaluation conducted in this paper using a software-based simulator shows that in moderate conditions (1000 targets, 2000 Hz false reply rate, and 0.95 reply probability), probability of detection is above 0.92, probabilities of correct code extraction are above 0.97, false alarm rate is below 8 per scan, and that the probabilities of declaring false identification and emergency signals and X pulses are below 0.0075. Companion papers explore how SE performance is influenced by particular system problems.

AUI3.2
SOFTWARE-BASED SLIDING WINDOW PLOT EXTRACTOR FOR SECONDARY SURVEILLANCE RADARS, PART 2: REPLY DECODER

Tanja Pajić, University of Belgrade, Institute Mihailo Pupin, Serbia
Miloš Jevtić, University of Belgrade, Institute Mihailo Pupin, Serbia
Ksenija Marković, University of Belgrade, Institute Mihailo Pupin, Serbia
Stevica Graovac, University of Belgrade, School of Electrical Engineering, Serbia

Reply Decoder is a part of Secondary Extractor which performs processing on video line – segment of raw radar video signal received between two consecutive interrogations. Video line contains series of pulses. The function of Reply Decoder is to detect replies from these pulses and then to determine the code contained in the replies. During this process we performed video line preprocessing, bracket detection, phantom removal, code extraction and detection of special military replies. In this paper we described these algorithms and evaluated their performance on typical scenarios using software-based simulator. Emphasis is placed on scenarios consisting of two close targets which are in some cases interleaved and in some garbled. Experiment has shown that for interleaved targets results are better than for garbled targets, in terms of probability of detection, probability of correct code extraction, number of false alarms, number of false SPI pulses and number of false X pulses.

AUI3.3
SOFTWARE-BASED SLIDING WINDOW PLOT EXTRACTOR FOR SECONDARY SURVEILLANCE RADARS, PART 3: TARGET DETECTOR

Ksenija Marković, University of Belgrade, Institute Mihailo Pupin, Serbia
Miloš Jevtić, University of Belgrade, Institute Mihailo Pupin, Serbia
Tanja Pajić, University of Belgrade, Institute Mihailo Pupin, Serbia
Stevica Graovac, University of Belgrade, School of Electrical Engineering, Serbia

Target detector is the part of secondary plot extractor whose purpose is to detect sequences of replies which originate from real targets based on consecutive video lines. It extracts plots and eliminates false replies unsynchronized in time (FRUIT). We used the approach that slightly differs from the one proposed in literature and it is based on the principles of object tracking. Replies are the equivalent of observations and target "echoes" are the equivalent of tracks and their kinematic state consists of only one variable - range, which is estimated with Kalman filter. Every "echo" has a sliding window where it stores last assigned replies. In each scan sliding windows are analyzed and it is decided whether an "echo" belongs to real target or FRUIT. In this paper we evaluated the performance of the algorithm using software-based simulator while variating FRUIT rate, reply probability and single pulse detection probability. First two caused errors in position and azimuth, while the last one had influence both on these errors, but also on target detection and code extraction.

AUI3.4
A TRACKING OF ON-ROAD OBSTACLES AND CLASSIFICATION REGARDING TO THEIR RELATIVE VELOCITIES

Mourad Bendjaballah, Ministry of National Defense, Algeria, and University of Defense, Belgrade, Serbia
Stevica Graovac, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia

The systems based on processing of sequence of TV images acquired by a camera mounted onboard the moving road vehicle, have a number of applications either as driver-assisting devices or as a part of the autonomous guidance systems. The problem of tracking of road obstacles from frame to frame as well as the calculations related to the estimation of distances between the camera and obstacles and their rates of change (relative velocities), is considered in this paper. The Speeded-up Robust Features Method (SURF) is used in tracking part of the algorithm while classical calculations based on projective geometry have been used in order to determine the distances to the obstacles. Verification of the algorithm steps is made using the real road-traffic images as well as the synthesized sequences of images.

AUI3.5
INTEGRATED PARTICLE FILTER – AN EFFICIENT SINGLE TARGET TRACKING ALGORITHM

Zvonko Radosavljević, Military Technical Institute Belgrade
Taek Lyul Song, Department of Electronic Systems Engineering, Hanyang University, Ansan, Republic of Korea
Branko Kovačević, School of Electrical Engineering, University of Belgrade

In a typical surveillance situation the number and the trajectory of targets are a priori unknown. Each measurement has an unknown source; either clutter, a target being tracked, or a new target. False track discrimination and data association are tools for automatic target tracking in heavy clutter environment. Instead of standard Particle filter, a new particle filter approach which recursively calculates the probability of target existence for the false track discrimination is present. The posterior data association probabilities are calculated to discriminate clutter measurements when updating trajectory probability density function. Through the extended simulations showed the effectiveness of this approach in a number of different single target scenarios.

Session AUI4. Signal processing applications
Chair: Vera Petrović, School of Electrical and Computer Engineering of Applied Studies, Belgrade, Serbia
Thursday, June 16, 10.00 h, Room 2

AUI4.1
SVM CLASSIFIER FOR EMOTIONAL SPEECH RECOGNITION IN SOFTWARE ENVIRONMENT SEBAS

Milana Milošević, School of Electrical Engineering, University of Belgrade, Serbia
Željko Nedeljković, School of Electrical Engineering, University of Belgrade, Serbia
Željko Đurović, School of Electrical Engineering, University of Belgrade, Serbia

Emotional speech recognition as search area is finding more and more applications in everyday life. In aim to systematically compare fundamental features in combination with different classifiers and different databases we developed software SEBAS. In this paper we present comparison of two methods for using data in Serbian Emotional Speech Database GEES for Support Vector Machines (SVM) classifier testing using Mel Frequency Cepstral Coefficients (MFCC) as features – speaker independent and speaker dependent method. First method is closer to real life scenario, but in-vitro gives poorer result for total recognition rate - 62.78%. The second method performs much better with 88.0% for total recognition rate.

AUI4.2
ADAPTIVE CONSENSUS BASED DISTRIBUTED TARGET TRACKING IN CAMERA NETWORKS

Nemanja Ilić, College of Technics and Technology, Kruševac, Serbia and Vlatacom Institute, Belgrade, Serbia
Khaled Obaid Al Ali, Etimad, Abu Dhabi, UAE and Vlatacom Institute, Serbia
Miloš Stanković, Innovation Center, Faculty of Electrical Engineering, University of Belgrade, Serbia
Srđan Stanković, School of Electrical Engineering, University of Belgrade, Serbia and Vlatacom Institute, Serbia

In this paper consensus based algorithms for distributed target tracking in large scale camera networks are discussed and a new algorithm is proposed. The considered networks are typically characterized by sparse communication and coverage topologies - the restrictions that motivate modification of the existing widely adopted consensus based distributed estimation frameworks. We inspect several state of the art algorithms that take into account these restrictions and propose an alternative algorithm that has much weaker requirements for the communication load. The proposed algorithm is based on a subtle adaptation of the communication weights to the problem at hand and achieves performance very close to the optimal centralized algorithm based on the maximum a posteriori principle.

AUI4.3
STOCHASTIC PERTURBATION-DEMODULATION BASED EXTREMUM SEEKING: ALMOST SURE CONVERGENCE USING ADAPTIVE STEP SIZE

Miloje Radenković, College of Engineering and Applied Science, University of Colorado, Denver, USA
Miloš Stanković, Innovation Center, Faculty of Electrical Engineering, University of Belgrade, Serbia
Srđan Stanković, School of Electrical Engineering, University of Belgrade, Serbia and Vlatacom Institute, Serbia

In this paper we propose a novel stochastic approximation algorithm for extremum seeking using stochastic perturbation and demodulation sequences with adaptive diminishing step size. Under mild constraints on the perturbation demodulation sequences and measurement disturbance, and without assuming a priori boundedness of the approximations, we prove that the algorithm almost surely converge to an extremum of the measured criterion function. We allow the measurement disturbance to contain a stochastic and a mean-square bounded deterministic component. The stochastic component can be a nonstationary colored noise, as well as a state dependent random sequence.

AUI4.4
STATISTICS OF ABSOLUTE FINITE DIFFERENCES: AUTOREGRESSIVE MODEL CASE

Slobodan Drašković, School of Electrical Engineering, University of Belgrade and School of Electrical and Computer Engineering of Applied Studies, Belgrade, Serbia
Željko Đurović, Electrical Engineering, University of Belgrade, Serbia
Branko Kovačević, Electrical Engineering, University of Belgrade, Serbia
Vera Petrović, School of Electrical and Computer Engineering of Applied Studies, Belgrade, Serbia

Analysis of non-stationary signals is of great importance in many engineering fields such as speech processing, failure detection, measurement and systems control, etc. Paper considers the problem of non-stationary signal behavior detection and theoretical analysis of absolute finite differences (AFD) in that sense is presented. The first and the second order statistics of AFD are analyzed and their correlation to AR (Auto-Regressive) model parameters is established. The research focuses on the possibility to use AFD statistics as the indicators for signal non-stationarity.

AUI4.5
ADAPTIVE FILTERING USING M-ROBUST VARIABLE FORGETTING FACTOR

Zoran Banjac, School of Electrical and Computer Engineering of Applied Studies, Belgrade, Serbia
Ivana Kostić Kovačević, Faculty of Informatics and Computing, Singidunum University, Belgrade, Serbia
Branko Kovačević, School of Electrical Engineering, University of Belgrade, Serbia

A new robust adaptive finite impulse response (FIR) filter algorithm with variable forgetting factor is proposed in this paper. A method for an adaptive and robust estimation of time-varying filter parameters is presented. To make the effect of non-stationarity and impulsive noise less severe, we extend the concept of an approximate maximum likelihood robust (M robust) estimation, to adaptive M robust algorithm. The robustified extended prediction error is used to define a suitable robust discrimination function, as a normalized

measure of signal non-stationarity. Finally, the variable forgetting factor is introduced by linear mapping of robust discrimination function, which enables the tracking of time-varying filter parameters in the presence of impulsive noise. The feasibility of the approach is demonstrated in a system identification simulation using a FIR filter application.

AUI4.6
ACOUSTIC NOISE DETECTION FOR STATE ESTIMATION

Sanja Vujnović, School of Electrical Engineering, University of Belgrade, Serbia
Asem Al-Hasaeri, School of Electrical Engineering, University of Belgrade, Serbia
Predrag Tadić, School of Electrical Engineering, University of Belgrade, Serbia
Goran Kvaščev, School of Electrical Engineering, University of Belgrade, Serbia

Machine state estimation using acoustic recordings is a procedure which is highly influenced by the surrounding noise. In this paper a noise detection algorithm is implemented which can identify the periods in which recorded acoustic signal is influenced by different types of noise in the form of impulse disturbance or unwanted speech contamination. This algorithm conducts a windowed signal distribution examination by generating a series of QQ plots and appropriate stochastic signal analysis. The purpose of this algorithm is to generate a set of noise free recordings which can later be used for state estimation. The usage of these techniques in an industrial environment is extremely complex due to the intense and nonstationary nature of sound contamination. The proposed solution has been tested on a specific problem of acoustic signal isolation of coal grinding mill in thermal power plant in the presence of intense contaminating sound disturbance from different sources.

AUI4.7
IRIS TEXTURE CLASSIFICATION BASED ON ITS STATISTICIAL CHARACTERISTICS

Jelena Krmar, School of Electrical Engineering, University of Belgrade, Serbia
Veljko Papić, School of Electrical Engineering, University of Belgrade, Serbia

Iris representation and recognition of humans based on characteristic eye features have taken a significant place in security and identification systems in the past two decades. The first steps in this field were made in the early 90's of the last century by John Daugman. Using the iris for identification is one of the most reliable biometric methods. Texture of the iris is completely stochastic and very complex, with high level of detail.This paper will analyze statistical characteristics of iris texture with an attempt to classify irides into separate groups, as well as the impact of this classification on the performance of the Daugman's identification process.

POWER ENGINEERING – EEI

EEI1. Power Engineering
Chair: Vladimir Katić, Faculty of Technical Sciences, University of Novi Sad, Serbia
Tuesday, June 14, 8.00 h, Room C, CC Toledo

EEI1.1
CHARACTERISTICS OF SWITCHED RELUCTANCE GENERATOR OPERATING WITH DERISHZADEH CONVERTER

Martin Ćalasan, Faculty of Electrical Engineering, University of Montenegro, Podgorica, Montenegro
Vladan Vujičić, Faculty of Electrical Engineering, University of Montenegro, Podgorica, Montenegro

This paper presents output characteristics of Switched Reluctance Generator (SRG) operating with Derishzadeh converter. Derishzadeh converter enables continuous current flow through machine phase i.e. Continuous Conduction Mode (CCM). In order to maximize the output power of SRG operating with this converter the optimization of its control parameters was performed, such that the peak and RMS values of the current do not exceed the predefined values. The optimal control parameters vs. rotation speed, as well as the corresponding characteristics of power and efficiency are presented. It is shown that output characteristics depend on the magnetizing inductance and on the coupled inductors turn ratio of the Derishzadeh converter. Furthermore, it is shown that optimal characteristics of SRG operating with Derishzadeh converter, but with high magnetization inductance and with unitary coupled inductors turn ratio, are the same as those with classic converter

EEI1.2
BATTERY CHARGING METHODOLOGIES WITH THE REFERENCE TO THE POWER QUALITY CHARACTERISTICS

Bane Popadić, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia
Vladimir Katić, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia
Boris Dumnić, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia
Dragan Milićević, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia
Zoltan Čorba, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia

With the impending integration of the battery storage systems in the power grid, the research in this area has been approached from two sides. One dealing with charging methodologies, and the other with the influence of the former on grid power quality. This paper looks to present several basic charging methodologies for lead-acid batteries, with the reference to the power quality in the experimental results. For this purpose, a Matlab/Simulink based model for testing battery charging techniques has been developed. This model has been used to obtain the behaviour of the battery current, voltage and SOC during the charging process. In addition, an experimental setup, using commercially available battery charger has been used to investigate the influence of the charging process on power quality.

EEI1.3
OVERVIEW OF THE FACTS CONTROLLERS – DEVICES AND CONTROL OF APPLIED POWER CONVERTERS

Nemanja Savić, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia
Vladimir Katić, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia

In this paper is being described the bond between the power electronics and Flexible AC Transmission Systems. There were being described and stated different elements of power electronics which are being used in new FACTS technologies, as well as the motifs for their introduction, benefits of using and fields of application. The basic division of FACTS devices, analysis of the most frequently used devices for series and shunt compensation – Thyristor Controlled Series Capacitor (TCSC), and Static VAR Compensator (SVC), as well as the device for the power quality improvement – Universal Power Conditioning System (UPQS), are the subject of this paper as well.

ELECTRIC CIRCUITS AND SYSTEMS AND SIGNAL PROCESSING – EKI

EKI1. Trends in Electrical Engineering, Circuit Theory, Digital Filters, and Signal Processing
Chair: Jelena Ćertić, School of Electrical Engineering, University of Belgrade, Serbia
Monday, June 13, 11.00 h, Room 2

EKI1.1
Invited Talk
CONTEMPORARY SYMBOLIC MODELING AND ANALYSIS OF ANALOG INTEGRATED CIRCUITS AND ELECTRICAL ENGINEERING EDUCATION WITH WOLFRAM LANGUAGE AND RASPBERRY PI

Vladimir Mladenović, Faculty of Technical Sciences, Čačak, University of Kragujevac, Serbia

Overview of a new concept of teaching analog and digital electronics courses to electrical engineering students that use a computer algebra system and numeric solvers is presented. For solving electrical engineering problem, the first step is to understand many topics such as electronics, communications, signal and systems, control theory, and power electric systems. The next step is to transfer this knowledge into proper software where the most of time consuming procedures can be carried out by computer. Students and engineers have not always the appropriate mathematical knowledge. They can solve simple problems but can often make mistakes performing by hand. They can obtain the desired result in closed form in the shape of the transfer function, input impedance, voltage gain, current gain, response time or calculation of elements, etc, using symbolic calculation with Wolfram language. Another issue is how to link the theoretical result with implementation or practice. Computer algebra system (CAS) is used to formulate circuit equations and prepare for symbolic solving and thus completely specify an electrical circuit by using Mathematica as CAS. The Raspberry Pi is used as a low cost computer with free software and computer algebra systems.

EKI1.2
TEACHING LOGIC CIRCUITS USING WOLFRAM LANGUAGE

Miroslav Lutovac, Singidunum University, Belgrade, Serbia, Serbia
Maja Lutovac-Banduka, Lola Institute, Belgrade, Serbia

The undergraduate engineering degree programs usually require good mathematical knowledge because the electrical courses, such as Electrical Engineering, and Digital and Analog Electronics, heavily rely on school and advanced basic and discrete mathematics. On the other hand, in order to start with exercises and experiments, appropriate tools and support will benefit for success. In this paper is shown a new approach that describes usage of Wolfram language. It is presented that basic expressions and logic circuit analysis procedures can be transformed into the code for immediate visualization of basic formulas and properties, and expand the logical functions into the form that can be realized with appropriate logic circuits.

EKI1.3
GUI FOR DRAWING ELECTRICAL ENGINEERING SCHEMATICS IN FREE AND OPEN SOURCE SOFTWARE

Miroslav Lutovac, Singidunum University, Belgrade, Serbia, Serbia
Maja Lutovac-Banduka, Lola Institute, Belgrade, Serbia

It is of great importance to use the free and open source software so that each member of virtual groups can follow research results of the whole team. Paper presents graphical user interface (originally written in MATLAB) and its new version in MATLAB based open source software. This way, free and open source software can be used for smooth design upgrade and testability to new software environments.

EKI1.4
FORMATION OF A SERBIAN ENF DATABASE USING AN ADAPTIVE APPROACH TO ELECTRICAL NETWORK FREQUENCY (ENF) EXTRACTION

Milivoje Knežević, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia
Tijana Zrnić, Faculty of Technical Sciences, University of Novi Sad, Novi Sad,Serbia
Danica Despotović, Faculty of Technical Sciences, University of Novi Sad, Novi Sad,Serbia
Anastazia Žunić, Faculty of Technical Sciences, University of Novi Sad, Novi Sad,Serbia
Željana Šarić, Faculty of Technical Sciences, University of Novi Sad, Novi Sad,Serbia
Tijana Delić, Faculty of Technical Sciences, University of Novi Sad, Novi Sad,Serbia

Electric Network Frequency (ENF) is a distinct characteristic of power distribution networks, which has found its application in forensic authentication. Although usually considered an unwanted background noise, it can be used in multimedia forensics to determine the time and place of the creation of a recording. The database for Serbian grid is formed recording 10 hours of power grid using circuit based on Hall effect sensor, thus collecting ground-truth signals. An adaptive approach to ENF extraction from power and audio recordings is presented. The described algorithm employs the simple and efficient fast Fourier transform (FFT) as its core idea, as it can mainly be used for signals with a low signal-to-noise ratio. The ENF signals extracted from both power and audio recordings have low signal-to-noise ratio and high resolution.

EKI1.5
HYBRID ALGORITHM FOR INDOOR/OUTDOOR POSITIONING IN EMERGENCY SITUATIONS

Lazar Berbakov, Mihailo Pupin Institute, Belgrade, Serbia
Bogdan Pavković, Faculty of Technical Sciences, University of Novi Sad, Novi Sad,Serbia
Sanja Vraneš, Faculty of Technical Sciences, University of Novi Sad, Novi Sad,Serbia

In this paper, we propose and develop a positioning system for first responders in emergency situations suitable for indoor and outdoor environments. In particular, we develop an algorithm based on satellite signal quality metric, that is able to rapidly detect indoor environments and switch to the appropriate indoor positioning method. Indoor positioning algorithm is based on step detection along with other data obtained by internal MEMS sensors. Experimental results where user traverses outdoor and indoor path have shown that the proposed algorithm provides positioning accuracy on the order of few meters..

EKI2. Image and Video Processing
Chair: Milorad Paskaš, Innovation Center of School of Electrical Engineering, University of Belgrade, Serbia
Monday, June 13, 13.00 h, Room 2

EKI2.1
DENOISING OF MAMMOGRAPHIC IMAGES USING FRACTAL FEATURES

Milorad Paskaš, Innovation Center of School of Electrical Engineering, University of Belgrade
Marjana Hrašovec, School of Electrical Engineering, University of Belgrade
Ana Gavrovska, School of Electrical Engineering, University of Belgrade
Irini Reljin, School of Electrical Engineering, University of Belgrade

This paper proposes an implementation of adaptive filter based on fractal control on mammograms. Fractal parameters are based on various multifractal measures where each measure emphasizes distinct quality of the texture of the mammographic images. Performed qualitative and quantitative evaluation for different scenarios illustrate advantages and limitations of used model in mammography.

EKI2.2
TOWARDS REAL-TIME BLOB DETECTION IN LARGE IMAGES WITH REDUCED MEMORY COST

Vladimir Petrović, School of Electrical Engineering, University of Belgrade, Serbia
Jelena Popović-Božović, School of Electrical Engineering, University of Belgrade

We propose a method for real-time blob detection in large images by exploiting parallelism in computation which can be easily obtained in a specialized hardware (multi-core platforms, FPGA, ASIC). In this method, image is divided into blocks of equal size to which a maximally stable extremal regions (MSER) blob detector is applied in parallel. Parallelism provides a great speed-up of the algorithm, but the system is then unable to detect all blobs detected by original MSER detection algorithm. Our approach is over 20 times more memory efficient than original algorithm if large images are processed due to processing of smaller image blocks. Although it has some limitations, this method can find its place in many applications like medical imaging if the real time performance is needed, as well as in the video surveillance or in wide area motion imagery (WAMI). Since there is often need for image registration and alignment in these applications, we explored possibilities to use detected blobs for feature-based image alignment as well.

EKI2.3
HOMOMORPHIC EMD ANTI-SCATTER GRID ARTEFACT REMOVAL

Vladimir Ostojić, Faculty of technical sciences, University of Novi Sad, Serbia
Đorđe Starčević, Faculty of technical sciences, University of Novi Sad, Serbia
Vladimir Petrović, Faculty of technical sciences, University of Novi Sad, Serbia

In this paper we propose an algorithm for removal of the artefact in digital x-ray images created by anti-scatter grid. Anti-scatter grid is employed to reduce the scattered radiation, but creates an artefact in the form of stripes in the image. Due to the high frequency nature of the artefact, we utilize Empirical Mode Decomposition (EMD) and its ability to automatically adapt to signal form to remove the artefact. Pairing the EMD with homomorphic approach and multiplicative grid model, we derive a homomorphic EMD. We evaluated the performance of the proposed algorithm both on phantom and real clinical images and observed grid artefact reduction.

EKI2.4
INVESTIGATION OF STRUCTURAL SIMILARITY FOR MEASUREMENT OF DETECTOR LAG ARTEFACTS IN DIGITAL RADIOGRAPHY

Đorđe Starčević, Faculty of technical sciences, University of Novi Sad, Serbia
Vladimir Ostojić, Faculty of technical sciences, University of Novi Sad, Serbia
Vladimir Petrović, Faculty of technical sciences, University of Novi Sad, Serbia

We present initial results of an investigation into the use of structural similarity for identification and quantification of detector lag artefacts in digital radiography. Caused by delayed energy release properties of digital radiography detectors, detector lag results in superposition of anatomical and other structures over subsequently acquired images. These ghosting artefacts

reduce the diagnostic value of images and can, if undetected, cause incorrect radiology findings. We adopt structural similarity concepts developed for image similarity and quality estimation to investigate a specific approach. This approach includes explicit models for candidate structure selection and visibility to identify ghost structures in digital radiographs. Suggested method identifies the potential ghosting locations and uses a simple pooling to derive a single measure that can be used to alert diagnostic radiologists of ghosting presence. While our approach is shown to work well on phantom images, investigation into real clinical images shows that considerable unintended structural similarities exist between subsequent clinical images. We conclude that additional structural analysis is required to separate out and measure true ghosting effects.

EKI2.5
THE IMPACT OF SALT & PEPPER NOISE ON WATERMARKING SCHEME BASED ON AMBTC COMPRESSION TECHNIQUE

Nikola Simić, Faculty of Electronic Engineering, University of Nis, Serbia
Daniela Milović, Faculty of Electronic Engineering, University of Nis, Serbia

This paper discusses the robustness of watermarking scheme based on absolute moment block truncation coding compression technique to Salt & Pepper noise attacks. The paper is part of wider research that has a goal to design a novel watermarking scheme based on modified block truncation coding algorithms in order to provide higher security to attacks as well as higher data hiding capacity.

EKI2.6
VIDEO QUALITY ASSESSMENT FOR DIFFERENT LEVELS OF TRANSMISSION ARTIFACTS

Ana Gavrovska, School of Electrical Engineering, University of Belgrade, Serbia
Marjana Hrašovec, School of Electrical Engineering, University of Belgrade, Serbia
Irini Reljin, School of Electrical Engineering, University of Belgrade, Serbia

There has been a sustained effort in the research community over the years for improving the video delivery, where mobile video services fueled the expectations. This paper analyzes recently available MPEG video content designed for the quality of service and experience (QoS/QoE) assessment. The transport stream sequences are examined for different levels of transmission artifacts. For the experimental purposes, on-screen display (OSD) statistics is used to compare the effects of the artifacts, such as the jitter and packet-loss rate. Statistical analysis is performed for the fixed emulated transmission parameter values to explore the effects on the video sequences characterized by different content, where self-similarity property of the data has been considered. The obtained results are compared to the mean opinion score (MOS) data.

EKI3. Electric Filters and Data Processing
Chair: Djordje Babic, School of Computing, University Union, Belgrade, Serbia
Monday, June 13, 16.30 h, Room 2

EKI3.1
DESIGN OF POLYNOMIAL-BASED INTERPOLATION FILTERS WITH MODIFIED BASIS FUNCTIONS

Djordje Babic, School of Computing, University Union, Belgrade, Serbia

The impulse response of polynomial-based interpolation filters is generated as a piecewise polynomial of the given low order M. The length of polynomial segments T can be selected to be equal to the input or output sampling interval, a fraction of the input or output sampling interval, or an integer multiple of the input or output sampling interval. The advantage of the above system lies in the fact that the actual implementation can be efficiently performed by using the Farrow structure or its modifications. The idea of this paper is to use new basis functions which would result in simpler implementation structure. Here, we introduce two new types of basis functions. With these two new types of basis functions, the coefficients sensitivity to finite wordlengths can be reduced.

EKI3.2
MATHEMATICA® BASED ANALYSIS OF A CRYSTAL FILTER WITH EIGHT CRYSTAL UNITS

Milan Milivojević, School of Electrical Engineering, University of Belgrade, Serbia
Marjana Hrašovec, School of Electrical Engineering, University of Belgrade, Serbia
Snežana Dedić-Nešić, Mihajlo Pupin Institute, University of Belgrade
Marijeta Slavković-Ilić, Innovation Center of School of Electrical Engineering, University of Belgrade
Branimir Reljin, School of Electrical Engineering, University of Belgrade

This paper presents a computer simulation of crystal filter composed by four crystal units. The graphical user interface is implemented in Mathematica® symbolic language environment. The interface provides easy manipulation with the filter components that is followed by automatic calculation of transfer function of the filter. This further leads to adaptation of crystal filter according to particular application.

EKI3.3
IMPLEMENTATION OF LOW COST WIRELESS ACOUSTIC SENSOR BASED ON ESP8266 MODULE

Davor Doder, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Nenad Četić, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia

Jelena Kovačević, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Miroslav Popović, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia

This paper presents an implementation of a low cost wireless acoustic sensor. Sensor is based on Espressif ESP8266 module for Wi-Fi (IEEE 802.11) communication, PCM4201 analog-digital converter and additional electronics for microphone and power management. We try to create low cost solution that can be used in large number of units. In our case this sensors are used for collecting acoustic events from environment and further processing and analysis of collected audio data on more powerful processing node or in the cloud.

EKI3.4
ACCELERATING CYCLOSTATIONARY ANALYSIS BY DFSM ALGORITHM ON A GPU

Nadica Kozić, School of Electrical Engineering, University of Belgrade and Military Technical Institute, Department for electronic systems, Belgrade, Serbia
Mirjana Simić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Ivan Pokrajac, Military Technical Institute, Department for electronic systems, Belgrade, Serbia
Predrag Okiljević, Military Technical Institute, Department for electronic systems, Belgrade, Serbia

Estimation of cyclic spectrum is very important in many applications of signal processing and analysis. The computational efficient algorithms for the estimation of cyclic spectrum are based on frequency smoothing or on time smoothing. In this paper performances of frequency smoothing algorithm – Direct/Digital Frequency Smoothing algorithm (DFSM) are analized. We present some practical results obtained implementing DFSM algorithm on the different processors, CPUs and GPUs.

EKI3.5
ELECTRONIC DENTAL PATIENT RECORD

Marijeta Slavković-Ilić, Innovation Center of School of Electrical Engineering, University of Belgrade
Milan Milivojević, School of Electrical Engineering, University of Belgrade, Serbia
Marjana Hrašovec, School of Electrical Engineering, University of Belgrade, Serbia
Branimir Reljin, School of Electrical Engineering, University of Belgrade, Serbia

Electronic medical record is a generic name of the systematized collection of patient and population electronically-stored health information in a digital format. Usually, this document contains real-time uploaded information about the patient and its health state which is available to authorized users. In this paper an example of electronic dental patient record is described. The input and overview of data is simple which significantly facilitates the service and improves its quality to the mutual satisfaction of patients and medical doctors

ELECTRONICS – ELI

ELI1. Electronic Circuits
Chairs: Vazgen Melikyan, Department of Microelectronics Circuits and Systems, State Engineering University of Armenia, Synopsys Armenia CJSC, Armenia
Predrag Petković, Faculty of Electronic Engineering, University of Niš, Serbia
Monday, June 13, 11.00 h, Room 4

ELI1.1
Invited paper
IC DESIGN WITH FINFET TRANSISTORS: CHALLENGES AND SOLUTIONS

Vazgen Melikyan, Department of Microelectronics Circuits and Systems, State Engineering University of Armenia, Synopsys Armenia CJSC, ARMENIA

During the past decades shrinking of MOSFET transistors and decreasing future sizes of CMOS technology were driving increasing IC complexity. However physical phenomenon occurring in MOS transistors shrunk below 28nm gate size such as increasing leakage currents, decreasing short channel effects, etc. significantly affect circuit operation making usage of MOS transistor of such sizes ineffective. The solution for further decreasing of future size is switching to new kind of devices that could be used as a replacement for MOSFETs while avoiding negative impact of downsizing. FinFET transistors are one of the options that are used as a solution for these issues. Basics of FinFET transistors, their variants and advantages are presented. Novel circuit topologies using FinFETs are presented also covering specifics of physical design implementation of FinFET-based circuits. In addition current works implemented in Synopsys Armenia Education Department for creating Educational Design Kit using 14nm FinFET transistors are covered.

ELI1.2
60 GHZ CMOS RF/DC POWER HARVESTER WITH CONSTANT ON/OFF TIME BUCK CONTROLLER

Marko Ninić, School of the Electrical Engineering, University of Belgrade, Serbia
Radivoje Djurić, School of the Electrical Engineering, University of Belgrade, Serbia

In this paper we present a novel 60 GHz RF/DC powerharvesting system. The system consist of RF to DC rectifier andDC/DC Buck converter with constant on/off time (COOT) control.The rectifier has a structure of voltage doubler but with such diodesthat have lower parasitic capacitances compared to the standarddiodes resulting in improved power conversion efficiency. The peakefficiency of the rectifier with the extracted parasitics for the outputpower of 1mW is about 24 %. The COOT control system in Buckconverter is implemented in order to stabilize the output voltageat 1.2V. Also, compared to the PWM control system, the COOTcontrol has an improved efficiency at the output power as low as1mW. The maximum switching frequency in Buck converter isabout 310MHz and a whole control system has very low staticpower consumption. The power harvesting system is designed in65nm CMOS technology.

ELI1.3
ON THE APPLICATION OF FREE CAD SOFTWARE TO ELECTRONIC CIRCUIT CURRICULA

Aleksandar Pajkanović, Faculty of Electrical Engineering, University of Banja Luka, Republic of Srpska

In this paper, a set of free software tools developed and available under GNU/GPL license is reviewed to the purpose of proposing an analog circuit design toolchain intended for educational purposes at the university level courses in the field of electronics. These tools cover schematic capture software (XCircuit), simulator (ngspice) and a basic waveform viewer in the form of a SPICE post-processing tool (ngnutmeg). This topic is of great importance especially for institutions that mainly focus on education, as the implementation of this solution can reduce costs severely.

ELI1.4
AN FPGA IMPLEMENTATION OF DDR3 SDRAM-BASED VIRTUAL FIFO CONTROLLER WITH SELECTABLE DATA WIDTH

Vladimir Milovanović, Faculty of Engineering, University of Kragujevac, Serbia
Darko Tasovac, NovelIC Microsystems, New Belgrade, Serbia

Data acquisition systems sometimes require offline data processing as the throughputs are too large to do it in real time. Therefore, large first-in-first-out (FIFO) data buffers are necessary for data storage. It is ideal to use DRAM-based FIFOs for medium storages as they are fairly quick and inexpensive. Due to necessary refresh, memory controller is needed to deal with SDRAM physical layer communication. As memory controllers are by the rule random-access (RAM) based, a FIFO-based access wrapper has to be made. This paper is presenting a DDR3 SDRAM-based input/output virtual FIFO controller wrapper that supports independent read and write clock domains and preselectable data widths up to 1024 bits. The measurements verify the predicted joint data throughputs of nearly 50 Gb/s.

ELI1.5
A NETWORK FOR LOW-PASS FIR FILTERS REALIZATION WITH SHORT WORDLENGTH

Miljan Petrović, Faculty of Electronic Engineering, University of Niš, Serbia
Branislav Petrović, Faculty of Electronic Engineering, University of Niš, Serbia

This paper presents a design method for low-pass digital filters with finite impulse response (FIR). Although many design procedures have been invented, a problem of filter sensitivity is still present. Acceptable system behaviour at short wordlengths for transfer function coefficients representation requires a different design approach. Here, a method based on a transform of FIR filters is examined. Namely, an endomorphism of vector space of polynomials is used to derive a structure, which, as opposed to standard realizations, yields in greater minimal attenuation in the filter stopband at short wordlengths. A slight change of the cutoff frequency of the described realization network is negligible. The described procedure was applied on design of low-pass Hamming window-based FIR filters. However, it is emphasized that it can be generalized to other filter types and design methods

ELI1.6
COMPLEXITY ANALYSIS OF THE QUADRATIC PHASE IIR DIGITAL FILTERS

Goran Stančić, Faculty of Electronic Engineering, University of Niš, Serbia
Bojan Jovanović, Faculty of Electronic Engineering, University of Niš, Serbia
Miljan Petrović, Faculty of Electronic Engineering, University of Niš, Serbia

This paper gives complexity analysis of different structures suitable for the implementation of the quadratic phase IIR digital filters. More precisely, an elliptic filter in cascade with the group delay corrector (phase corrector) is compared with the parallel connection of two all-pass filters. Proposed parallel all-pass structure gives opportunity to realize digital filter with arbitrary phase characteristic. Design of all-pass filters is based on solving phase approximation problem, taking into account the fact that magnitude characteristic of the resulting filter exhibits straightforward dependence with all-pass filters phase difference. Equiripple phase approximation is adopted. Such filters with quadratic phase could be used for chirp signal compression or expansion in radar systems. According to the fact that phases of both all-pass filters approximates ideal quadratic phase in min-max sense, resulting selective filter has elliptic-like magnitude characteristic. Given examples indicate that the parallel all-pass structure has lower complexity compared to the elliptic filter with the same attenuation followed by the phase (group delay) corrector which provides approximately the same group delay error.

Session ELI2. Electronic Circuits
Chairs: Branko Dokić, Faculty of Electrical Engineering, University of Banja Luka, Bosnia and Herzegovina
Duško Lukač, University of Applied Sciences Cologne, Köln, Germany
Monday, June 13, 13.00 h, Room 4

ELI2.1
Invited paper
DESIGN OF ENERGY EFFICIENT CMOS DIGITAL SYSTEMS

Branko Dokić, Faculty of Electrical Engineering, University of Banja Luka, Bosnia and Herzegovina

Generally, energy efficiency of a digital system depends on the energy consumption and the speed of signal processing. Therefore, the design of such systems is based on two strategies: minimal consumption in proposed speed scale and maximum speed in allowed level consumption. CMOS technology is, without doubt, absolutely dominant in the areas of low consumption. The energy efficiency of CMOS digital systems depends on many factors, such as: CMOS regime, system architecture, parameters of MOS transistors and basic cells topology. In the last 15 years, beside standard CMOS regime, in systems with ultra low consumption (sensor and medical systems), sub-threshold and hybrid (mixed) CMOS regimes are highly actual. The compared characteristics of digital logic for all three CMOS regimes are presented. It is shown that the minimal power-delay product is in hybrid regime. The overview of the impact of technologic parameters on consumption and logic delay is given. The techniques of optimization of energy efficiency systems with multiple level power supply voltage and MOS transistor threshold voltage (multi Vdd/ Vt techniques), including the power and clock gating techniques, as well as variable threshold voltages method. Also, the gate leakage current reduction using transistor stacking is shown. A part of the paper is dedicated to alternative CMOS logics, such as: Pass-transistor Logic, Non Threshold Logic, Complementary Pass-transistor Logic, Push-pull Pass-transistor Logic, Differential Cascode Voltage Switch Logic, and Adiabatic Logic.

ELI2.2
HIGHER EDUCATION ACCORDING TO INDUSTRIAL REQUIREMENTS - ECS AS A SUCCESSFUL EXAMPLE

Duško Lukač, University of Applied Sciences Cologne, Köln, Germany
Miljana Milić, Faculty of Electronic Engineering, University of Niš, Serbia

Universities' Curricula and especially those of Applied Sciences should be, in the best case, developed in such way, that graduates' knowledge reflects contemporary requirements of the industry, without compromising the assertion of the knowledge universality as the central perspective of the higher education. This awareness is often identified, but in a real case, the organization of the courses and lectures at the university according to the industrial requirements, often does not function efficiently

enough. The key reason for this is the dynamic and rapid progression of the industrial and technological development, which can't adequately be followed at the university side. This paper presents one solution for this problem. The collaboration between EPLAN Software and Services GmbH & Co.KG, as one of the worldwide key industrial company working in the domain of development of Electro-CAD software applications and the University of Applied Sciences from Cologne, Germany, is described in this paper. Special attention is given to development of the certification program called EPLAN Certified Student (ECS).

ELI2.3
SELECTION OF PRIMARY SOURCE OF ENERGY FOR ORGANIZATION OF UNINTERRUPTIBLE POWER SUPPLY

Miroslav Lazić, IRITEL doo Beograd, Serbia
Milan Pajnić, IRITEL doo Beograd, Serbia
Dragana Petrović, IRITEL doo Beograd, Serbia
Zoran Cvejić, IRITEL doo Beograd, Serbia

Precondition for reliable work of telecommunications centers is uninterruptible power supply. It is widely accepted that primarily source of energy is electro-distributive network and as back-up fossil fuel generators are considered. Energy from battery sources are usually used during transient's period. In systems of power supply located in rural areas designed for users with special needs, this kind of realization is not acceptable. In rural areas, energy from electric distribution network is considered unreliable and fossil fuels are difficult to manage. Only energy source that is under user control is battery, which is considered as primarily source of energy. Owing to the fact that voltage in a single battery cell is inherently low, battery cells connected in series are usually employed in this kind of systems. Cell voltage imbalance within a series string can be attributed to the differences of cell internal resistance, imbalanced state-of-charge (SOC) between cell, degradation, and the gradients of ambient temperature of the battery pack during charging and discharging. Therefore, maintaining cell voltage at an equalized charging/discharging level is significant for enhancing battery life. In this paper one realization of telecommunication center uninterruptible power supply, located in rural area is presented. Also, concept of using bidirectional dc–dc converter for battery equalization is presented.

ELI2.4
COMPARATIVE ANALYSIS OF THE ERROR PREDICTION OF ELECTRICITY CONSUMPTION ON A MONTHLY AND WEEKLY LEVEL

Jelena Milojković, Innovation centre of advanced technologies, Niš, Serbia
Vančo Litovski, Retired

One month and one week ahead predictions of suburban average electricity load are presented. Although we have a lot of data available for our work, only the most recent of it may be of importance. Consequently, we managed with limited amount of data, and we proposed two independent mutually supporting solutions of artificial neural networks (ANN). ANN have been proven as very reliable in real time system such is electricity consumption. Prediction with ANN is the topic of our previous work where we obtained small prediction errors. In this paper it will be shown a comparative analysis of the prediction error in the cases of monthly and weekly forecasting of the electricity load. In this way, we will try to emphasize importance to undertake these predictions in order to reduce the cost of production, transmission, consumption and other, of electricity load.

ELI2.5
PROGRAMMABLE PHASE SHIFT CIRCUIT FOR AN INTEGRATED POWER-METER

Miljana Milić, Faculty of Electronic Engineering, University of Niš, Serbia
Nikola Stojanović, Faculty of Electronic Engineering, University of Niš, Serbia
Nemanja Mišić, Faculty of Electronic Engineering, University of Niš, Serbia
Jelena Milojković, Innovation centre of advanced technologies, Niš, Serbia
Predrag Petković, Faculty of Electronic Engineering, University of Niš, Serbia

An architecture of the digital phase shift circuit implemented as a Programmable Delay Line (PDL) is presented in this paper. This block represents an important part of the Decimation filter block, for a particular Power-meter integrated circuit. The chosen architecture is very simple for implementation and uses logic blocks such as multiplexers and buffers. The circuit is described and verified using VHDL language and simulator, and is satisfying the needed requirements.

ELI2.6
ROBUST INDOOR METHOD FOR ROBOT LOCALISATION

Miloš Petković, Faculty of Electronic Engineering, University of Niš, Serbia
Vladimir Mitić, Faculty of Electronic Engineering, University of Niš, Serbia
Vladimir Sibinović, Faculty of Electronic Engineering, University of Niš, Serbia
Goran S. Đorđević, Faculty of Electronic Engineering, University of Niš, Serbia

Paper presents a version of trilateration indoor localisation method using beacon on robot and anchors on the walls. Anchors are positioned on strategic places within a room and with fixed and known positions. Distances are measured in 3D, with cost-effective tools. We combined data redundancy and previous robot positions to increase accuracy and remove occlusion problems. Robot localisation is determined as a solution to the optimization problem. We found Nelder-Mead algorithm satisfactory for finding optimal solution for 5 cm range of positioning error. For practical implementation we used Gnu Scientific Library.

Algorithm has been tested on Intel based embedded computer. It passed as quick and reliable, at least for navigation of small mobile robotic platform. Further increase in performance is expected in improvement of the distance measuring system and increased bandwidth and quality of data collection.

ELI2.7
CAMERA BASED POSITIONING SYSTEM USING A WIDE ANGLE USB CAMERA AND OPENCV LIBRARY

Dragiša Popović, Faculty of Electronic Engineering, University of Niš, Serbia
Vladimir Sibinović, Faculty of Electronic Engineering, University of Niš, Serbia
Darko Todorović, Faculty of Electronic Engineering, University of Niš, Serbia
Goran S. Đorđević, Faculty of Electronic Engineering, University of Niš, Serbia

Tracking a position of the object can be done with different approaches, one of the easiest way is using optical feedback. A cheap USB camera and free software library can be used to track different color markers in space. To maximize the space covered we used a camera with a 120 degrees' view angle, and to remove distortion from the wide angle lens we calibrate the system. Height difference between camera and the target is a crucial variable and is taken in to account during calibration. Once calibrated we can use the system for that height difference, if we change the height we must do the calibration again. The whole system has a latency of around 260mS, and a small error. Using two markers we are able to get even the orientation of the target.

BIOMEDICINE – MEI

MEI1. Biomedical Technique
Chair: Dejan B. Popović, Institute of Technical Sciences, Serbian Academy of Sciences and Arts, Serbia
Wednesday, June 15, 8.00 h, Room 3

MEI1.1
Invited talk

QUANTITATIVE APPROACHES FOR PARAMETRIC NUCLEAR MEDICINE IMAGING

Milica M. Janković, University of Belgrade, School of Electrical Engineering, Serbia
Milorad Paskaš, University of Belgrade, Innovation Center of School of Electrical Engineering, Serbia
Vera Miler-Jerković, University of Belgrade, School of Electrical Engineering, Serbia
Ana Koljević-Marković, Institute of Oncology and Radiology of Serbia

The importance of dynamic nuclear medicine imaging lies in obtaining of temporal component of tracer distribution that could not be available from static images. Tracer kinetics models include compartmental and non-compartmental approaches. Compartmental models provide precise results of estimated parameters, but they are time-consuming and usually based on a priori knowledge. Non-compartmental approaches are computationally fast, no a priori knowledge is required, and visualization of calculated parameters gives valuable information about the spatiotemporal distribution of tracers. This paper is a review of compartmental and non-compartmental methods for interpretation of time activity curves and topographic presentation of estimated quantitative indices. Parametric imaging has an important diagnostic impact in nuclear medical imaging and is recommended to be included in daily clinical practice, especially in nuclear neurology, cardiology, endocrinology and oncology.

MEI1.2
EMG MAPS FOR ESTIMATION OF MUSCLE ACTIVITIES DURING THE GRASPING

Ivan Topalović, Institute of Technical Sciences, Serbian Academy of Sciences and Arts, Serbia
Dejan B. Popović, Institute of Technical Sciences, Serbian Academy of Sciences and Arts, Serbia

The electromyography (EMG) and mechanomyography (MMG) are indirect noninvasive methods which provide the information that is correlated with the muscle force and the level of recruitment. EMG is accepted as a standard clinical method for diagnostics related to the status of the sensory-motor system. EMG is often used as an interface for control of prosthetic and orthotic devices and the biofeedback. Conventional surface EMG is the time course of the voltage between two points on the skin. The map presenting the electrical potentials at the skin provides precious information comprising many more details about the muscle activity compared with the conventional bipolar recordings. We show the system that is convenient for the recording of the EMG map. The system comprises the electrode-array and the multichannel digital amplifier which wirelessly send signals to a PC. This new system with two electrode-arrays and two Smarting was tested for defining the grasping synergies of the forearm muscles during the grasp movements. Results show that the system provides the spatial and temporal representation of the course of particular muscles being activated during the motor act.

MEI1.3
MUSCULAR SYNERGIES DURING THE GRASPING ESTIMATED FROM SURFACE EMG RECORDINGS

Antonina Aleksić, School of Electrical Engineering, University of Belgrade, Serbia
Ivan Topalović, Institute of Technical Sciences, Serbian Academy of Sciences and Arts, Serbia
Dejan B. Popović, Institute of Technical Sciences, Serbian Academy of Sciences and Arts, Serbia

Electrical activity of muscles (EMG) recorded at the surface of the body is the method most often used for estimation of the force and the muscle recruitment. EMG is a medical routine for diagnostics related to the status of the sensory-motor system; but, also a tool for the biofeedback, and interface for control of prosthetic and orthotic devices. To obtain reliable and reproducible information about the muscle activity multi-channel EMG recordings are favorable. The multichannel activity relies on the application of electrode-arrays and multichannel signal conditioners. The new system with two electrode-arrays and two Smarting® units for defining the grasping synergies of the forearm muscles during the grasp movements is described in this paper. We show that the system provides spatial and temporal representations of the course of particular muscles being activated during the motor act.

MEI1.4
SURFACE ARRAY ELECTRODES FOR INTERFACING MOTOR SYSTEMS: A REVIEW AND NEW SOLUTIONS

Lana Popović-Maneski, Institute of Technical Sciences, Serbian Academy of Sciences and Arts, Serbia

The recordings of electrical activity and external activation of muscles by surface array electrodes are of interest for diagnostics and treatment. The array electrodes save time for finding the optimal position for recording or stimulation. These electrodes are positioned on the skin only once, and each active area can be

addressed manually or remotely based on the current static or dynamic requirements. Relative movement of the skin with respect the underlying tissues can also be resolved with arrays electrodes. The interface provided by surface array electrodes with small contact pads spatially arranged to cover the skin area over a large muscle or muscle group allows the estimation of many muscle activity characteristics. Multicontact arrays with the pads sized to secure safe stimulation are convenient for selective and less fatigable stimulation. Here we review the state-of-the-art and describe novel solutions for the research and clinical applications.

MEI1.5
THE USE OF INERTIAL MEASUREMENTS UNITS FOR THE EVALUATION OF SPASTICITY: PENDULUM TEST

Marija M. Petrović, School of Electrical Engineering, University of Belgrade, Serbia
Radoje Čobeljić, Clinic for rehabilitation "Dr Miroslav Zotović", Serbia
Dejan B. Popović, Institute of Technical Sciences, Serbian Academy of Sciences and Arts, Serbia

The reduction of spasticity is significant for the rehabilitation of patients with an injury/disease of the central nervous system. One method for objective quantification of the spasticity is the pendulum test. We present an instrument based on a single inertial measurement unit (IMU) which wirelessly sends digital signals to a computer. We developed the software in MatLab which based on the recordings generates numbers that are characterizing the spasticity. Results show that the IMU provides reproducible and precise enough information. The validation of the results was performed by comparing the results with the results obtained from the experienced clinician.

MEI1.6
ELECTROMYOGRAPHY-BASED GESTURE RECOGNITION: FUZZY CLASSIFICATION EVALUATION

Aleksandar Gogić, School of Electrical Engineering, University of Belgrade, Serbia
Nadica Miljković, School of Electrical Engineering, University of Belgrade, Serbia
Đorđe Đurđević, School of Electrical Engineering, University of Belgrade, Serbia

We designed electromyography–based system for online recognition of hand gestures. The system encompasses of dual-channel electromyography recordings, preprocessing techniques, and Fuzzy logic classification. Online performance of the system was evaluated on five able-bodied subjects. Forearm flexor and extensor muscles were measured in each subject. The obtained classification accuracies were compared to the commercial Myo Armband operation that uses 8 channel electromyography recordings from forearm muscles. The presented results showed that averaged classification accuracy of designed system was 94.6% and the commercial system had averaged classification accuracy of 82.8% in all subjects. These results indicate the potential application of the system in various human-computer interface applications.

MEI1.7
NOVEL ESTIMATION OF THE GAIT RESTORATION BASED ON STEP-BY-STEP VARIABILITY ANALYSIS

Jovana Malešević, Tecnalia Serbia, Serbia
Suzana Dedijer, Clinic for Rehabilitation "Dr Miroslav Zotović", University of Belgrade, Serbia
Aleksandra Vidaković, Faculty of Medicine, University of Belgrade, Serbia
Nebojša Malešević, School of Electrical Engineering, University of Belgrade, Serbia
Thierry Keller, Tecnalia, Spain

Foot drop is a common cause of gait impairment in stroke survivors. The aim of this study was to evaluate change of gait parameters linked to walking balance and risk of falls as a result of functional electrical stimulation (FES) therapy based on multi-pad FES system for correcting foot drop during gait. Four patients with foot drop who were at least 3 months post-stroke participated in the study. Stride time variability and stride length were determined during 10 m walking test at baseline, after 2 and after 4 weeks of the FES therapy. Both observed gait parameters showed orthotic and therapeutic effects of the FES system.

MEI2. Biomedical Technique
Chair: Mirjana Popović, School of Electrical Engineering, University of Belgrade, Serbia
Wednesday, June 15, 10.00 h, Room 3

MEI2.1
IMPLEMENTATION OF DISCRETE WAVELET TRANSFORMATION IN REPETITIVE FINGER TAPPING ANALYSIS FOR PATIENTS WITH PARKINSON'S DISEASE

Minja Belić, University of Belgrade, Serbia
Milica Djurić-Jovičić, Innovation Center, School of Electrical Engineering, University of Belgrade, Serbia
Milica Ječmenica Lukić, Neurology clinic, Clinical Center of Serbia, Medical faculty, University of Belgrade, Serbia
Igor Petrović, Neurology clinic, Clinical Center of Serbia, Medical faculty, University of Belgrade, Serbia
Saša Radovanović, Institute for Medical Research, University of Belgrade, Serbia
Mirjana Popović, School of Electrical Engineering, University of Belgrade, Serbia
Vladimir Kostić, Neurology clinic, Clinical Center of Serbia, Medical faculty, University of Belgrade, Serbia

Finger tapping is one of the standard tests in diagnostics of Parkinson's disease. The motor performance on this test is in clinical practice assessed through visual observation, which makes it susceptible to subjectivity and challenging for detection of small changes in tapping

pattern. To help increase the reproducibility and reliability of the test, in this paper we present a simple, inexpensive and lightweight assessment system based on a single inertial sensor which, combined with signal processing based on discrete wavelet transformation (DWT) discriminates healthy persons from those with Parkinson's disease. The study included 12 patients with Parkinson's disease and 12 age and gender matched healthy controls. The signals were gathered from a gyrosensor mounted on the subjects' fingertip of the index finger during the 15 s long assessment of repetitive finger tapping. The signals were decomposed to the 7th order of DWT, and subsequently extracted features used as input to a support vector machine classifier. High success rate of 92% in classification suggests the presented system could be used as assistance in diagnostics for Parkinson's disease.

MEI2.2
FREQUENCY ANALYSIS OF REPETITIVE FINGER TAPPING – EXTRACTING PARAMETERS FOR MOVEMENT QUANTIFICATION

Vladislava N. Bobić, School of Electrical Engineering, University of Belgrade, Serbia
Milica Djurić-Jovičić, Innovation Center, School of Electrical Engineering, University of Belgrade, Serbia
Nathanael Jarrasse, Inst itut des Syst emes Int elligent s et de Robot ique, Universit é Pierre et Marie Curie, Paris, France
Milica Ječmenica-Lukić, Neurology clinic, Clinical Center of Serbia, Medical faculty, University of Belgrade, Serbia
Igor N.Petrović, Neurology clinic, Clinical Center of Serbia, Medical faculty, University of Belgrade, Serbia
Saša M. Radovanović, Institute for Medical Research, University of Belgrade, Serbia
Nataša Dragašević, Neurology clinic, Clinical Center of Serbia, Medical faculty, University of Belgrade, Serbia
Vladimir Kostić, Neurology clinic, Clinical Center of Serbia, Medical faculty, University of Belgrade, Serbia

In clinical practice, the finger tapping movement is often validated visually, thus resulting in a coarse diagnostic resolution. However, by using miniature inertial sensor mounted on fingertip of index finger, finger tapping performance can be quantified, allowing objective assessment of specific characteristics or changes in the finger tapping pattern over time. Various parameters such as cadence, tappi ng duration, speed, and tapping angle can be extracted for detailed analysis of pati ent's motor performance. However, the l i ste d paramete rs, although intuitive and simple to interpret, do not always carry all necessary i nformation regardi ng subje ct's motor performance. Here we present kinematic parameters extracted from spectral analysis that are significant for finger tapping assessment. With these paramete rs, tappi ng's i ntravari abi l i ty, movement smoothness and anomalies that occur within the tapping performance can be identified and observed, providing significant information for further diagnostics and monitoring progress of the disease of response to therapy.

MEI2.3
A COMPARISON OF CLASSIFIERS FOR DAILY ACTIVITY RECOGNITION USING MOBILE DEVICES

Zoran Ćirović, School of Electrical and Computer Engineering of Applied Studies, Belgrade, Serbia
Aleksandar Simović, School of Electrical and Computer Engineering of Applied Studies, Belgrade, Serbia
Nataša A. Ćirović, School of Electrical Engineering, University of Belgrade, Serbia

In this paper we present a part of the research regarding several classifiers for recognition of daily physical activities using sensors on mobile devices. The results of recognition using the HART sample database are presented and the analysis based on the applied classifiers and selection features is done. The features of the signals from accelerometer and gyroscope sensors are considered.

MEI2.4
IS THE N170 EVENT-RELATED COMPONENT SENSITIVE TO RED EYE COLOR CHANGE IN FACE STIMULI?

Milica S. Isaković, School of Electrical Engineering, University of Belgrade, Serbia
Vladimir R. Kojić, Innovation Center, School of Electrical Engineering, University of Belgrade, Serbia
Milica M. Janković, School of Electrical Engineering, University of Belgrade, Serbia
Andrej M. Savić, School of Electrical Engineering, University of Belgrade, Serbia

Face perception is a neurological mechanism that plays an important role in the social interaction. The N170 event-related potential (ERP) component is linked to face recognition, and can be evoked by visual stimuli of face images. We have developed a platform for image presentation and EEG data acquisition based on EMOTIV EPOC+, a wireless, portable, high-resolution, multi-channel EEG system. Various studies showed that important information for face recognition is principally extracted from the eyes. The aim of this study was to determine to what extent is the N170 component affected by minimal image manipulation (changing eyes' iris color to red) that significantly changes the perception of stimuli. In order to assess the sensitivity of N170 component, we analyzed the differences in processing faces, faces with red eyes and non-face objects.

MEI2.5
WHAT IS HIDDEN BEHIND HANDWRITING OF CHILDREN WITH ADHD? – KINEMATIC ANALYSIS –

Nikola Ivančević, Clinic of neurology and psychiatry for children and youth, Belgrade, Serbia
Vera Miler-Jerković, School of Electrical Engineering, University of Belgrade, Serbia
Vladimir Kojić, School of Electrical Engineering, University of Belgrade, Serbia

Dejan Stevanović, Clinic of neurology and psychiatry for children and youth, Belgrade, Serbia
Blažo Nikolić, Clinic of neurology and psychiatry for children and youth, Belgrade, Serbia
Jasna Jančić, Clinic of neurology and psychiatry for children and youth, Belgrade, Serbia
Mirjana B. Popović, School of Electrical Engineering, University of Belgrade, Serbia

Handwriting analysis can be used to study function and organization of structures from the brain cortex all way down to the fingers. Graphic rules and kinematic parameters are suitable for assessing handwriting features in many disorders including attention deficit/hyperactivity disorder (ADHD).

MEI2.6
HUMAN BRAINWAVE SONIFICATION BASED ON DATA MODULATION

Nebojša Malešević, School of Electrical Engineering, University of Belgrade, Serbia
Jelena Ćertić, School of Electrical Engineering, University of Belgrade, Serbia
Milica M. Janković, School of Electrical Engineering, University of Belgrade, Serbia

Conversion of EEG waves into audible sounds (EEG sonification) has been in focus of many researchers in recent years. Systems that allow this conversion have one of the following purposes: EEG monitoring or neurofeedback (Brain Computer Music Interface systems). The aim of this paper is to present an algorithm for EEG sonification. The methodology is based on the transformation between characteristic features of EEG signal (alpha, beta, gamma and theta waves) and the desired human hearing spectrum ("target spectrum") based on data modulation. Frequency band of the "target spectrum" is selected according to the subjective criterion of "relaxation effect" produced by a sound. By the suggested EEG spectrum transformation we are able to generate audio signals of desired spectral characteristics that can be used in open loop or closed loop applications**.**

MEI3. Biomedical Technique
Chair: Nikola Jorgovanović, Faculty of Technical Sciences, University of Novi Sad, Serbia
Thursday, June 16, 8.00 h, Room 3

MEI3.1
CLINICAL EFFECTS OF LOW LEVEL LASER THERAPY IN PATIENTS WITH LOW BACK PAIN IN RELATION WITH APPLIED DOSE

Suzana Dedijer, Clinic for Rehabilitation "Dr Miroslav Zotović", University of Belgrade, Serbia
Jovana Malešević, Tecnalia Serbia, Serbia
Ljubica Konstantinović, Faculty of Medicine, University of Belgrade, Serbia

Low level laser therapy (LLLT) with different dose has been widely used to relieve pain caused by different musculoskeletal disorders, because of different anti-inflammatory effects. The aim of this study was to assess the effectiveness of different dose of LLLT on pain and functional recovery in patients with low back pain. Results show statistically significant improvement in both groups, although, better in all outcome measures in Group 2. Low level laser therapy can modulate inflammatory processes in a dose-dependent manner and can be titrated to significantly reduce acute inflammatory pain in clinical settings.

MEI3.2
ANALYSIS OF THE MYOELECTRIC SIGNAL FEATURES DURING GRASPING

Luka Mejić, Faculty of Technical Sciences, University of Novi Sad, Serbia
Nikola Jorgovanović, Faculty of Technical Sciences, University of Novi Sad, Serbia
Strahinja Došen, Dept. of Neurorehabilitation Engineering, Georg August University Goettingen, Germany
Vojin Ilić, Faculty of Technical Sciences, University of Novi Sad, Serbia
Željko Tepić, Faculty of Technical Sciences, University of Novi Sad, Serbia

Electromyography (EMG) is a well-known technique used for recording of the electrical activity produced by human muscles. EMG signals are mainly used to determine if the muscle is in a good condition. In the last few decades it is also used as a control signal for prosthetic hand. There are several multifunctional myoelectric prosthetic hands for amputees on the market, but so forth, none of these devices permits the natural control of more than two degrees of freedom. In this paper we examine differences in EMG signals during some commonly used hand grips. This differences lead us to the possible improvement of the natural control of the hand movement to more than two degrees of freedom at amputees.

MEI3.3
BURST MODULATED ALTERNATING CURRENT AFFERENT STIMULATION

Nikola Popov, Faculty of Technical Sciences, University of Novi Sad, Serbia
Predrag Vukov, Faculty of Technical Sciences, University of Novi Sad, Serbia
Goran Krajoski, Faculty of Technical Sciences, University of Novi Sad, Serbia
Darko Stanišić, Faculty of Technical Sciences, University of Novi Sad, Serbia
Dubravka Bojanić, Faculty of Technical Sciences, University of Novi Sad, Serbia

The aim of this study was to introduce the burst modulated alternating current (BMAC) stimulation of afferent neural pathways. Electro-tactile sensation, produced by this type of stimulation, can be used as feed-back communication channel in different man-machine

interface applications. The custom made electrical stimulator was developed to generate BMAC stimulation waveform. Properties of the BMAC stimulation can be adjusted by four parameters: signal amplitude, burst duration, burst frequency and carrier frequency. In this paper, connection between intensity of the electro-tactile sensation and burst duration was analyzed, while other parameters keep unchanged. Pilot test conducted on four healthy subjects suggests that the sensation intensity is highly correlated to burst duration and that this type of stimulation can be used to transmit information from machine to human.

MEI3.4
HEART FAILURE DETECTION USING MULTIPARAMETRIC CARDIAC MEASUREMENT SYSTEM

Marjan Miletić, Vinca Institute of Nuclear Sciences, University of Belgrade, Serbia
Marija D. Ivanović, Vinca Institute of Nuclear Sciences, University of Belgrade, Serbia
Boško Bojović, Vinca Institute of Nuclear Sciences, University of Belgrade, Serbia

Heart failure (HF) is the single most expensive diagnosis in medicine and it is reaching 'epidemic' proportions. 2–3% of adult population in developed countries have HF diagnosis. It is not detectable by ECG test and it is commonly detected in a late stage, when the process is irreversible. Ejection fraction (EF) is the most used parameter for characterisation of HF condition. EF is commonly calculated using echocardiography, which is an expensive method and not used in primary healthcare. Systolic time intervals (STI) represent a non-invasive and inexpensive method for determination of EF. In this paper, a multiparametric cardiac measurement system for determination of STI is presented. Measurement system consists of sensors for simultaneous acquisition of electrocardiographic (ECG), phonocardiographic (PCG), photopletysmographic (PPG) and cardiovascular (CV) pulsation signals. CV pulsation signals are measured by long period grating (LPG) fiber-optic sensors. Using ECG, PCG and CV pulsation signals, measured on carotide arthery with PPG and LPG sensors , obtained on a set of 6 healthy volunteers, two non-invasive methods for measuring systolic time intervals (STI) are constructed. EF calculated from obtained STI with the first method, which include measuring CV carotide pulsations with PPG sensor, is in range from 0.60 to 0.68, with maximal standard deviation 0.05 per volunteer. Also, EF calculated from obtained STI with second method, which include measuring CV carotide pulsations with LPG sensor, is in range from 0.60 to 0.66, with maximal standard deviation 0.06 per volunteer. Calculated value of EF with both methods is in 0.55 to 0.75 range which corresponds to healthy individuals.

MLI1. METROLOGY

Chair: Svetlana Avramov-Zamurović, United States Naval Academy, USA
Thursday, June 16, 8.00 h, Room 1

MLI1.1
Invited Talk
PARTIALLY COHERENT LASER BEAMS

Svetlana Avramov-Zamurović, United States Naval Academy, USA

One of the defining properties of a laser beam it is its coherence. Temporally and spatially coherent He-Ne laser beam exits the source aperture with the Gaussian beam profile, with all of the photons oscillating at the same frequency and perfectly in-phase. When the laser beam encounters the atmosphere, the paths of the photons are altered through refraction, scattering, etc. The beam observed at the receiver has fluctuating intensity due to the interference. This phenomenon is called beam scintillation. Laser beam scintillation is detrimental for various applications, including the free space optical communication systems. The promising benefit of the laser beam bandwidth could be diminished due the signal fading caused by the atmospheric turbulence. Mitigation of the scintillation effects is one of the crucial tasks for improving reliability of laser communication systems. Theory shows that perfectly coherent laser beam is deteriorated by propagation through random medium far more than spatially partially coherent laser beam. Partially coherent beams are created by spatially distributed beamlets with prescribed varying phase that change over time. Each beamlet propagates via different path through the atmosphere, but overall spatially partially coherent beam is less degraded on atmospheric propagation and has better scintillation at the receiver. This talk will introduce spatially partially coherent laser beams and will demonstrate experiments that confirm the scintillation reduction up to 50%, on propagation in weak turbulence.

MLI1.2
SOFTWARE SUPPORTED EXPERIMENTAL SYSTEM FOR POWER QUALITY MEASUREMENT BASED ON WIRELESS SENSOR NETWORK

Milan Simić, University of Niš, Faculty of Electronic Engineering, Serbia
Dragan Denić, University of Niš, Faculty of Electronic Engineering, Serbia
Dragan Živanović, University of Niš, Faculty of Electronic Engineering, Serbia
Peter Planinšič, University of Maribor, Faculty of Electrical Engineering and Computer Science, Slovenia
Marko Malajner, University of Maribor, Faculty of Electrical Engineering and Computer Science, Slovenia
Dušan Gleic, University of Maribor, Faculty of Electrical Engineering and Computer Science, Slovenia

Software supported experimental system based on wireless sensor network (WSN), applicable in measurement of electrical power quality (PQ) parameters and disturbances, is presented in this paper. System includes PC based generator of standard voltage signals, software application for measurement of power quality parameters and two microcontroller based wireless sensor modules for transmitting and receiving of measurement results. Reference voltage signals for testing are provided using generator of standard three-phase waveforms, with possibility for simulation of typical network disturbances, presented and described in previously published papers. This signal generator is functionally supported by virtual instrumentation software and data acquisition board. Measurements of basic power quality parameters for reference test waveforms are performed using the software application in LabVIEW environment. Time interval for each measurement cycle is 1 sec. For communication is used wireless sensor network based on communication standard IEEE 802.15.4 (Zigbee). It includes three segments: hardware, software and simulation software. Hardware part includes two wireless sensor modules SPaRCMosquito v.2, based on microcontroller with Cortex M3 architecture. Communication and transfer of measurement data, between computer and microcontroller based wireless sensor modules on transmitter and receiver points of experimental system, are provided using standard USB interface.

MLI1.3
AMPLITUDE RESPONSE MEASUREMENT USING PULSE TRAIN SIGNAL

Milos Subotic, RT-RK Computer based systems, Novi Sad, Serbia
Nebojsa Pjevalica, University of Novi Sad, Faculty of Technical Sciences, Serbia
Laszlo Palfi, University of Novi Sad, Faculty of Technical Sciences, Serbia
Milos Nikolic, RT-RK Computer based systems, Novi Sad, Serbia

Measurement of the impulse response of the system is a classical problem in electronic, acoustic and control theory. This paper presents a novel method for amplitude response measurement, using pulse train as excitation signal. Theory of operation is presented. Simulation of proposed method is presented along with experimental measurement of the simple electronic filters. Comparison with existing methods from the literature is presented as well. Simplicity makes this method easy to implement.

MLI1.4
A NOVEL METHOD FOR GIBBS PHENOMENON REDUCTION IN STOCHASTIC MEASUREMENT OF EOG SIGNAL

Jelena Đorđević-Kozarov, University of Niš, Faculty of Electronic Engineering, Serbia
Platon Sovilj, University of Novi Sad, Faculty of Technical Sciences, Serbia
Vladimir Vujičić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Dejan Mitić, University of Niš, Faculty of Electronic Engineering, Serbia
Dragan Radenković, University of Niš, Faculty of Electronic Engineering, Serbia

Well-known method of digital stochastic measurement (DSM) is based on stochastic analog-to-digital conversion, with a low-resolution analog-to-digital converters (ADCs) and accumulation. This method has been tested and used for the measurement of stationary signals, and also was applied for measurement of nonstationary signals. This paper presents a model development for an example of electrooculography (EOG) signal measurement in the time domain. Analysis of the obtained results shows that the great influence in the measurement errors has the Gibbs phenomenon. In order to eliminate Gibbs phenomenon and decrease measurement error, a method with overlapping measurement intervals has been developed. This novel method can be named as modified stochastic digital measurement method (MDSMM). The obtained measurement errors are decreased.

MLI1.5
ANALYSIS OF THE DVB-C SIGNAL GRABBER/GENERATOR SYSTEM IMPLEMENTATION MEASUREMENT PROBLEMS

Laszlo Palfi, University of Novi Sad, Faculty of Technical Sciences, Serbia
Milos Subotic, RT-RK Computer based systems, Novi Sad, Serbia
Nebojsa Pjevalica, University of Novi Sad, Faculty of Technical Sciences, Serbia
Milos Nikolic, RT-RK Computer based systems, Novi Sad, Serbia

During the hardware and software development of the set top boxes and television sets supporting DVB-C streams it is necessary to have proper test equipment. Special-purpose signal generators and signal grabbers are needed for testing DVB-C devices. This equipment is very expensive, because it is not ubiquitous. Signal generators usually cannot be used as signal grabbers too. In this paper, a cheap system for DVB-C signal generating and grabbing is presented. The presented solution does not have a demodulator, only a modulator. The presented solution does not work with transport streams. This solution works with IF instead. The system's architecture is presented. The development process is presented with focus on signal measurement and generation problems. The functionality of the grabber is verified. The verification of the generator and the system PCB is in progress.

MLI2. METROLOGY

Chair: Jaroslaw Makal, Byalistok University of Technology, Faculty of Electrical Engineering, Poland
Thursday, June 16, 10.00 h, Room 1

MLI2.1
Invited Talk
HOLISTIC APPROACH TO METROLOGY TEACHING ON UNDERGRADUATE STUDIES FOR ELECTRICAL ENGINEERS

Jaroslaw Makal, Byalistok University of Technology, Faculty of Electrical Engineering, Poland

This paper briefly presents metrology teaching based on the classical model of lecture and laboratory, which includes a set of exercises. Students should learn the content of the lecture and pass a theory test, while the assignment of laboratory work relies on demonstrating knowledge of each issue, providing the measurements and elaborating the final results. This manner works as long as students are motivated to explore and acquire new engineering skills. However, today's young people, raised on smartphones, tablets, not conceiving of a world without computers and using the unlimited Internet resources, are not interested in the activities impossible to perform only by clicking a mouse or shifting an image on the screen. A more and more pervasive lack of willingness is observed among young people to make handwritten notes and to read academic books. The use of Power Point presentation during a lecture does not contribute to a better understanding of the lectured content, and on the contrary, it causes a kind of mental laziness. To maintain good quality of education in the field of metrology, the author proposed to a team of academic teachers some modifications in teaching and in assigning laboratory works. During some debates the teachers' team has developed for each measurement the learning outcomes and scenarios for practical tests. These tests enable to assess the ability of each student to perform specific measurement in a limited time. Examples of these tests are described in this paper. Students may replace the lab work by a project. A team of 2-3 students can realize a simple engineering project such as for example assembling a measuring device. The way of selecting team members, the implementation of the entire project and the results are mentioned in this work as well. To make the subject more attractive for students, a part of the lecture has been developed in the form of e-learning course on the university educational platform. Students from anywhere and at any time can familiarize themselves with the theory and can make self-evaluation tests after each topic. The teacher notices the student's activity and also consults them at the chat-room. Some of the harder problems can be addressed at the lecture. All these activities were introduced progressively for the last few years in metrology teaching on the Faculty of Electrical Engineering at Bialystok University of Technology. In this paper the author explains also the advantage of the examination way with the use of notes and books so as to create the conditions as in a professional environment.

MLI2.2
HUMAN-MACHINE INTERFACE BASED ON MEASUREMENT OF EYE MOVEMENTS

Jovan Mitrović, University of Novi Sad, Faculty of Technical Sciences, Serbia
Miloš Glogovac, University of Novi Sad, Faculty of Technical Sciences, Serbia
Platon Sovilj, University of Novi Sad, Faculty of Technical Sciences, Serbia
Zoran Mitrović', University of Novi Sad, Faculty of Technical Sciences, Serbia

This paper presents one of the practical applications of electrooculography (EOG) measurement by using a stepper motor as an actuator. In this application cup electrodes (primarily intended for use in electroencephalography) were chosen. The developed system implements basic filtering of measured signal (by BrainBay software), communicates with an external hardware where the stepper motor is located, and enables a real-time response to eye movement, thus moving the stepper motor clockwise or counterclockwise and changing its speed.

MLI2.3
MEASUREMENT OF DEFINITE INTEGRAL OF SINUSOIDAL SIGNAL ABSOLUTE VALUE THIRD POWER BY USING DIGITAL STOCHASTIC METHOD

Željko Beljić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Boris Ličina, University of Novi Sad, Faculty of Technical Sciences, Serbia
Platon Sovilj, University of Novi Sad, Faculty of Technical Sciences, Serbia
Dragan Pejić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Vladimir Vujičić', University of Novi Sad, Faculty of Technical Sciences, Serbia

This paper presents special case of digital stochastic measurement of the definite integral of sinusoidal signal absolute value third power by using 2-bit AD converters. This special case of digital stochastic method had emerged from a need to measure power and energy of the wind which are proportional to the third power of wind speed. Because the integral of the third power of sinusoidal signal is 0, two approaches are proposed for the third power calculation. One approach is to calculate absolute value of sinusoidal signal before AD conversion. Another approach is to calculate absolute value of the result after AD conversion.

MLI2.4
INTELLIGENT ENERGY MANAGEMENT FOR A SMART HOME WITH AN EXAMPLE OF MEASUREMENT RESULTS

Josif Tomić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Vladimir Katić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Miodrag Kušljević, Termoelektro Enel AD, Belgrade, Serbia
Zoltan Čorba, University of Novi Sad, Faculty of Technical Sciences, Serbia
Nemanja Gazivoda, University of Novi Sad, Faculty of Technical Sciences, Serbia

Grid voltage and frequency are the most important factors in an electrical energy system. A mismatch between the produced and consumed energy within a system can lead to significant deviations from the nominal voltage and frequency within a grid. This problem becomes particularly actualized in small power systems that can operate in an island regime and which are not permanently connected to large systems, which is most often the case with renewable sources of energy, which can include: photovoltaic power plants, wind generators or bio-fuel power plants. This is a particularly interesting topic when it comes to Smart Home systems that are powered by photovoltaic collectors. When the produced power is less than the consumed, a decline in voltage and frequency occurs. On the other hand, if a given load is suddenly disconnected from the network, then an increase in the voltage and frequency of the network occurs. In both of these cases it is necessary to react intelligently and quickly in order to prevent any adverse effects on the electrical devices that are connected to the energy system.

MLI2.5
RANDOMIZING OF PSEUDORANDOM NOISE SOURCE

Dragan Pejić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Marjan Urekar, University of Novi Sad, Faculty of Technical Sciences, Serbia
Marina Bulat, University of Novi Sad, Faculty of Technical Sciences, Serbia

The paper describes different types of generating noise with uniform probability density function values. Two main groups are compared: true random and pseudorandom noise sources. Combination of these two types of sources is described for generating composite noise signal with best features from both types of sources. A novel method for generating composite noise is given, with simulation results that confirm theoretical values.

MLI2.6
EEG NOISE FLOOR MEASUREMENT USING STOCHASTIC A/D CONVERTER

Marjan Urekar, University of Novi Sad, Faculty of Technical Sciences, Serbia
Platon Sovilj, University of Novi Sad, Faculty of Technical Sciences, Serbia

Measuring level of self-induced noise in an EEG system is essential for it's calibration and obtaining valid results when measuring biopotential signals in microvolt range. Those signals range to sub-hertz range, so for valid results long time measurements with large quantity of data must be performed. An novel idea is given for using stochastic

method of measuring over a long interval for this purposes. 4-bit Stochastic Flash A/D Converter is used for fast processing of recorded data, and when measured over 100 seconds interval, it's error falls below 50 parts-per-million. Example of measurements for self-contained EEG Analog Front End chip ADS1299 is given. Overview of benefits and possible further development is given in order to incorporate this converter in EEG system for regular self-calibration process.

MICROELECTRONICS AND OPTOELECTRONICS – MOI

MOI1. Optoelektronics and Microsystems
Chair: Miloljub Smiljanić, Academy of Engineering Sciences of Serbia, Serbia
Tuesday, June 14, 16.30 h, Room 4

MOI1.1
A COMPARISON OF DIFFERENT LIGHT SOURCES FOR USE IN FIBER OPTIC INTERFEROMETRIC SENSORS

Miloš Tomić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Zoran Djinović, Austrian Center for Medical Innovation and Technology, ACMIT Gmbh, Wiener Neustadt, Austria

In this paper we investigated different light sources regrading to their suitability for employment in various fiber-optic interferometric sensors. We considered the influence of source characteristics such as coherence length, relative intensity noise, phase noise and optical power, on dynamic range, sensitivity, accuracy and overall power consumption of a fiber-optic sensors. It was shown that a low coherence sources such as a superluminescent diode is the most suitable for high sensitivity measurement, but in a limited dynamic range. On the other hand, the high coherence sources, like DBF, FBG and VCSEL laser diodes, offer a much wider measuring range, unfortunately accompanied by a reduced sensitivity and accuracy, especially in the measuring range below half of wavelength.

MOI1.2
THE THERMOGRAPHIC ANALYSIS OF PHOTONIC CHARACTERISTICS OF *ROSALIA ALPINA* SURFACES

Goran Dikić, Military Academy, University of Defence, Belgrade, Serbia
Danica Pavlović, Photonics Center Institute of Physics, University of Belgrade, Belgrade, Serbia
Ljubiša Tomić, Military Technical Institute, Belgrade, Serbia
Dejan Pantelić, Photonics Center Institute of Physics, University of Belgrade, Belgrade, Serbia
Darko Vasiljević, Photonics Center Institute of Physics, University of Belgrade, Belgrade, Serbia
Dejan Stojanović, Fruška Gora National Park, Sremska Kamenica, Serbia

Materials developed by nature during the evolution, have a significant impact in search for artificial materials having useful absorptive properties, especially for solar energy collection, thermal energy dissipation and camouflage. Four prominent black spots on the elytra of *Rosalia alpina* have attracted our attention. We have found that the light absorption is not the sole consequence of dark pigments, but that it is strongly influenced by the underlying structure. We decided to perform thermo-physical investigations of the optical mechanism responsible for the absorption of light in *Rosalia alpina*. This paper presents the results obtained using testing procedure applied in pulsed thermography.

MOI1.3
PSPICE MODELING OF IONIZING RADIATION EFFECTS IN p-CHANNEL POWER VDMOS TRANSISTORS

Miloš Marjanović, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Aneta Prijić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Danijel Danković, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Zoran Prijić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Vojkan Davidović, Faculty of Electronic Engineering, University of Niš, Niš, Serbia

In this paper the results of modeling and PSPICE simulation of ionizing radiation effects in p-channel power VDMOS transistor have been presented. Based on the experimental results, the threshold voltage shifts induced by the radiation under different gate voltages have been modeled. Dependencies of the threshold voltage shift and mobility changes with radiation dose have been defined and implemented in the PSPICE model of the IRF9520 transistor. Transfer characteristics of the transistor are simulated on the basis of the threshold voltage value before stressing, and radiation dose and gate voltage values during the radiation stress. These characteristics are within 11.84% limits in respect to the measured ones, which represents a good agreement.

MOI1.4
A SYSTEM FOR MEASUREMENT OF A PHOTODIODE RELATIVE SPECTRAL SENSITIVITY

Miloš Mitić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Aleksandar Ilić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Emilija Živanović, Faculty of Electronic Engineering, University of Niš, Niš, Serbia

The method for determination of photodiode spectral response using a microcontroller and several light emitting diodes is proposed in this paper. To evaluate the spectral response, the current induced when the photodiode is illuminated by the light of different wavelengths, is measured. Current measurement method can be implemented using only a microcontroller. The proposed method is implemented in a system used to determine spectral sensitivity of several different photodiodes. Obtained results are compared with the data from technical documentation. Scope of the system's applicability is determined based on this comparison.

MOI2. nanoETRAN
Chair: Zoran Jakšić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia
Wednesday, June 15, 8.00 h, Room 4

MOI2.1
TEMPERATURE DEPENDENCE OF THE REFRACTIVE INDEX FLUCTUATIONS DUE TO STOCHASTIC ADSORPTION-DESORPTION PROCESS IN PLASMONIC SENSORS

Olga Jakšić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia
Ivana Jokić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia
Miloš Frantlović, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia
Zoran Jakšić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia

Adsorption-desorption (AD) process of gas particles from the surrounding medium occurs on the plasmonic sensor surface and causes an effective refractive index change at the gas-solid interface. This is used as a very sensitive sensing mechanism in adsorption-based chemical plasmonic sensors. Due to its stochastic nature, AD process is known as a source of AD noise which manifests itself in the form of refractive index fluctuations, and influences plasmonic sensor performance. In this paper we investigate the temperature dependence of these fluctuations in equilibrium, where the measurement of the sensor output signal is performed. We analyze the case of monolayer adsorption, first by using the linear adsorption model (which is widely used in a majority of practical situations in closed volume sensor systems). Then we expand the analysis by using a more detailed and more complex nonlinear second-order adsorption model, which is necessary at low gas pressures.

MOI2.2
ENHANCEMENT OF SEMICONDUCTOR DETECTORS FOR FAR INFRARED RANGE BY OPTICAL VORTICES IN EXTRAORDINARY OPTICAL TRANSMISSION ARRAYS

Marko Obradov, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia
Zoran Jakšić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia
Dragan Tanasković, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia
Dana Vasiljević Radović, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia

A very broad class of plasmonic metamaterials are perforated thin laminated films composed of alternating metal and dielectric layers. The simplest case is a single thin metallic film surrounded by dielectric with arrays of subwavelength holes. These thin perforated metallic films are known as extraordinary optical transmission arrays (EOT). EOTs act as impedance-matching structures between dielectric materials and their resonant frequency can be tailored by design. Since EOT spectral properties are highly sensitive to minute changes of material composition in subwavelength openings they have an important place in chemical and biological sensing. EOT arrays are also used in transformation optics as light concentrators. Optical vortices have been used for enhancement of solar cells utilizing plasmonic nanoparticles. The main problem with this approach is that nanoparticles need to be incorporated in the active region and at the same time arranged in an orderly fashion to form a diffractive structure to achieve spots of destructive interference which act as centers of circulating energy flow. In this paper we show a possibility of utilizing EOT arrays, diffractive structures by a default, to form optical vortices in a detector active area by simply depositing them onto the detector surface. We simulated the optical response of our EOT arrays utilizing finite element method. The spectral properties are tuned specifically to be used for detector enhancement in far infrared. We demonstrate circulation of optical energy in detector active area caused by destructive interferance with possibility of tuning spectral and spatial positioning of vortices by changing the structure geometry. The obtained increase in density of optical states within the photodetector active area due to optical vortices leads to increased photodetector responsivity and specific detectivity.

MOI2.3
CORRUGATED THIN METAL FILMS AS COUPLERS BETWEEN PROPAGATING AND SURFACE MODES FOR PLASMONIC ENHANCEMENT OF PHOTOCATALYTIC OPTOFLUIDIC MICROREACTORS

Milena Rašljić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia
Zoran Jakšić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia
Milče M. Smiljanić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia
Žarko Lazić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia
Katarina Cvetanović, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia

Dana Vasiljević Radović, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia

Surface plasmons polaritons (SPP) ensure extreme concentrations of electromagnetic near fields at interfaces between materials with negative and positive dielectric permittivity (i.e. between metals and dielectrics), usually several orders of magnitude compared to fields in free space. This is useful for a number of practical applications, including chemical and biological sensing, enhancement of photodetectors and improvement of photocatalytical reactions. One of the problem to be solved with plasmonic field localization is that wavevectors of SPPs may vastly exceed those of propagating waves, so that a coupler is mandatory between them. In photocatalytic microreactors one often uses nanoparticles with localized SPP as both couplers and field enhancers. In this contribution we consider the possibility to utilize surface corrugation of thin gold films to simultaneously ensure coupling between propagating and plasmon modes and enlarge effective catalytic surface. To this purpose we utilize wet chemical etching (chemical micromachining). Different surface corrugations are obtained by varying etching conditions. A combination of gold thin film over corrugated surface and titanium dioxide nanoparticles is used. The setup can be used for different photocatalytic processes.

MOI2.4
SPIN-POLARIZED TRANSPORT THROUGH FERROMAGNETIC AND ANTI-FERROMAGNETIC BARRIERS IN MoS_2

Predrag M Krstajić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia

In this work ballistic electron transport through a double barrier made of one ferromagnetic (FM) barrier and one antiferromagnetic (AFM) barrier on monolayer MoS_2 is investigated. Both barriers have the same width d and are separated by a usual monolayer of MoS_2 of width b. The total conductance g_c, its spin up and spin down components both oscillate with d or distance between the barriers b. The corresponding oscillation periods are different. There is a irregularity in the oscillations due to the fact that the double barrier is heterogeneous, i.e. made of one FM and one AFM barrier.

MICROWAVE TECHNIQUE, TECHNOLOGIES AND SYSTEMS – MTI

MTI1. Microwave Antennas and Propagation
Chairs: Aleksandar Nešić, Company for Microwave and Millimeter-Wave Techniques and Electronics IMTEL-Komunikacije Joint-Stock Company Belgrade, Belgrade, Serbia
Bratislav Milovanović, University Singidunum, Belgrade, Serbia
Monday, June 13, 16.30 h, Room 3

MTI1.1
THE INVESTIGATION OF REFLECTOR INFLUENCE ON THE WIDEBAND OF SYMMETRICAL PRINTED ANTENNA STRUCTURES

Marija Milijić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Aleksandar Nešić, Company for Microwave and Millimeter-Wave Techniques and Electronics IMTEL-Komunikacije Joint-Stock Company Belgrade, Novi Beograd, Serbia
Bratislav Milovanović, University Singidunum, Belgrade, Serbia

The influence of various reflector plates on the wideband characteristics of symmetrical printed antenna structures is examined. Besides plane reflector plate, the corner reflector with different angles is also researched. The symmetrical pentagonal dipole as single element and its arrays are investigated. All considered antennas are intended for X frequency range. The other antenna parameters as gain and side lobe suppression are inspected as well.

MTI1.2
EFFICIENCY OF OF CIRCULAR MICROSTRIP ANTENNA MODELLING IN CYLINDRICAL TLM MESH

Jugoslav J. Joković, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Tijana Z. Dimitrijević, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Nebojša S. Dončov, Faculty of Electronic Engineering, University of Niš, Niš, Serbia

The goal of this paper is to investigate possibilities and efficiency of the TLM (Transmission Line Matrix) method for modelling of up-to-date microstrip antennas with circular geometry that have significant application in modern wireless communication systems. The coaxially fed microstrip antenna configurations with conventional and inverted circular patch are modelled by using the in-house 3DTLMcyl_cw solver based on computational electromagnetic TLM method adapted to the cylindrical grid and enhanced with the compact wire model. To provide accuracy of simulated results that is dependent on a relevantly created model, investigations related to appropriate mesh resolution and a relevant extension of a mesh around the considered antennas is conducted. The resonances obtained using TLM cylindrical model are compared with results reached by the corresponding model in a rectangular grid as well as with experimental ones.

MTI1.3
ULTRA-WIDEBAND ARRAY COMPOSED OF LTCC CHIP ANTENNAS

Siniša Jovanović, Company for Microwave and Millimeter-Wave Techniques and Electronics IMTEL-Komunikacije Joint-Stock Company Belgrade, Novi Beograd, Serbia
Marko Paraušić, NovelIC Microsystems, Belgrade, Serbia

This paper explores employing LTCC chip antennas as elements of antenna arrays to achieve higher antenna gain over a broad frequency range. The paper presents the analysis, practical realization and measuring results of several antenna prototypes. A partial 3D model of the radiating element is developed based on the accessible data of commercially available chip antennas. The antennas' maximum gains and matching are simultaneously acquired over a wide frequency range from two port S-parameters obtained by measuring the free space loss of antenna pairs on a network analyzer. The obtained results are in accordance with theoretical predictions.

MTI1.4
LOW COST TEM HORN ANTENNA WITH MIXED CANTILEVER-CIRCULAR TAPER

Miloš Radovanović, Institute of Physics Belgrade, Belgrade, Serbia
Branka Jokanović, Institute of Physics Belgrade, Belgrade, Serbia
Radomir Žikić, Institute of Physics Belgrade, Belgrade, Serbia

Here we present a variation of TEM horn antenna based on the mixed cantilever-circular taper. This taper is based on inherent substrate bending curve that is described by the principle of a thin, point loaded, uniform, rectangular section cantilever, which is the simplest type of the mechanical beam bending model. Printed taper pattern is based on the circular sections. This design enables a very good antenna characteristics in C and X band and extreme reduction in the antenna fabrication cost.

MTI1.5
ANALYSIS OF ANTENNA IMPACT ON RF POWER AMPLIFIER PERFORMANCES

Aleksandra Đorić, Innovation Centre of Advanced Technology Niš, Serbia
Tijana Dimitrijević, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Marija Milijić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Nataša Maleš-Ilić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Aleksandar Atanasković, Faculty of Electronic Engineering, University of Niš, Niš, Serbia

In this paper, the analysis of the amplifier performances loaded by a real antenna instead of 50 Ω termination is considered. The influence of two antennas, circular microstrip patch antenna that is narrowband and pentagonal dipole that is type of broadband antenna, is examined. Additionally, we analyzed the effects of the linearization approach that uses the second- and fourth-order nonlinear signals for suppression of the third- and fifth-order intermodulation products on the amplifier-antenna chain for both cases. The linearization of the system is carried out for two-tone test characterized by different frequency interval between signals for the various signal power levels.

MTI1.6
ANALYSIS OF INCIDENT PLANE WAVE POSITION ON SHIELDING EFFECTIVENESS USING TLM AIR-VENT MODEL

Nataša J. Nešić, College of Applied Technical Sciences Niš, Niš, Serbia
Nebojša S. Dončov, Faculty of Electronic Engineering, University of Nis, Nis, Serbia
Slavko M. Rupčić, Faculty of Electrical Engineering Osijek, Osijek, Croatia

In this paper, a numerical Transmission-Line Matrix (TLM) model for the metal enclosure with an airflow aperture array is created to analyse the effect of incident plane wave position on the shielding effectiveness (SE) of the enclosure. To conduct numerical simulations, a compact air-vent model incorporated into the TLM algorithm is used. In the SE measurement process, an imprecise set up of transmitting antenna may occur, and thus resulting in a direction change of the incident plane wave. Therefore, the SE level may change even with a small azimuth and elevation angles shifts of the plane wave propagation direction. Due to this, some additional resonant modes inside the enclosure may appear. It is of interest to perform an accurate assessment the enclosure's shielding properties.

MTI1.7
RECEIVER AND TRANSMITTER FRONT-ENDS IN HIGHER MILLIMETER RANGES – MOUNTING METHODS AND INTEGRATION WITH ANTENNA

Ivana Radnović, Company for Microwave and Millimeter-Wave Techniques and Electronics IMTEL-Komunikacije Joint-Stock Company Belgrade, Novi Beograd, Serbia
Aleksandar Nešić, Company for Microwave and Millimeter-Wave Techniques and Electronics IMTEL-Komunikacije Joint-Stock Company Belgrade, Novi Beograd, Serbia
Bratislav Milovanović, University Singidunum, Belgrade, Serbia

The paper presents design and integration solution for the millimeter-wave link receiver and transmitter front-ends operating in frequency ranges around 50 GHz to 90 GHz. Both front-ends are realized on the deaurate brass plate and integrated with the antennas on the common dielectric substrate. All used active and passive ICs are in open chip package in order to prevent degradation of electrical characteristics due to parasitic effects that occur at high millimeter frequencies and are caused by chip encapsulation. Both receiver's and transmitter's antennas are realized as axial arrays of 16 printed pentagonal dipoles placed in the cylindrical-parabolic reflector. Differing from conventional solutions for mounting open chips where chip pads are connected to the next chip pads through a microstrip line between them, in presented solution all contacts are realized by connecting chips directly one to another by bonding, which results in higher compactness, lower number of contacts to bond and lesser losses due to absence of connecting microstrip lines. Presented concept can be applied to even higher frequency ranges that are also suitable for ultra high capacity digital radio transmission.

MTI1.8
CONCEPT AND REALIZATION OF THE HIGH CAPACITY LINK IN HIGHER MILLIMETER-WAVE RANGES

Aleksandar Nešić, Company for Microwave and Millimeter-Wave Techniques and Electronics IMTEL-Komunikacije Joint-Stock Company Belgrade, Novi Beograd, Serbia
Ivana Radnović, Company for Microwave and Millimeter-Wave Techniques and Electronics IMTEL-Komunikacije Joint-Stock Company Belgrade, Novi Beograd, Serbia

The paper presents concept of the millimeter-wave link which can be applied in frequency ranges from 50 GHz to 90 GHz, especially in outdoor high-capacity communication networks (1-2 Gb/s), as weel as in radars and radiometric devices. Receiver and transmitter front-ends are separated and have antennas with mutually crossed polarizations in order to obtain isolation of around 50 dB between the receiver and the transmitter. Since the requirement for Rx/Tx isolation is 70 dB, there is a band-stop filter at the receiver's input providing additional 20 dB of isolation. With respect to the frequency range (high millimeter waves), particular problem is mounting of passive and active semiconductor chips that are in open packages. Intermediate frequency ranges are around 15 GHz depending on the RF signal. Local oscillator signal, after being generated in the synthesizer is multiplied by four. Two versions of the mm-wave links are presented: for (1) ASK (OOK) and FSK or (2) BPSK, QPSK and 16 QAM modulations.

MTI2. Microwave Electronics
Chairs: Djuradj Budimir – Wireless Communications Research Group, University of Westminster, London,

UK; Vera Marković, Faculty of Electronic Engineering, University of Niš, Serbia
Tuesday, June 14, 8.00 h, Room 3

MTI2.1
INKJET-PRINTED DUAL BAND BRANCH LINE COUPLERS

Branko Bukvić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia and Company for Microwave and Millimeter-Wave Techniques and Electronics IMTEL-Komunikacije Joint-Stock Company Belgrade, Serbia
Djuradj Budimir, Wireless Communications Research Group, University of Westminster, London, UK

In this paper, a fully inkjet-printed microstrip dual band branch line coupler is designed. The design and flexibility characterization of an inkjet-printed coupler on flexible 50 μm thick Kapton polyimide (ε_r = 3.4) substrate are presented. Kapton is chosen due to its good balance of physical, chemical and electrical properties with a low loss factor of 0.0021.The dual band branch line coupler is designed to operate at 0.9 GHz and 1.9 GHz. The circuit was simulated and the simulation results are presented.

MTI2.2
VHF QUADRATURE HYBRID COUPLER

Veljko Crnadak, Company for Microwave and Millimeter-Wave Techniques and Electronics IMTEL-Komunikacije Joint-Stock Company Belgrade, Novi Beograd, Serbia
Siniša Tasić, Company for Microwave and Millimeter-Wave Techniques and Electronics IMTEL-Komunikacije Joint-Stock Company Belgrade, Novi Beograd, Serbia

In this paper the improved design of the VHF quadrature hybrid coupler is presented. It is a continuation of the prior work of the same authors, about the design of VHF quadrature hybrid coupler. Knowing, before the production, what are the conditions that coupler has to satisfy, has enabled us to acquire, through computer simulation, the dimensions of the coupler that was later produced. Values of the s-parameters of the simulated coupler are being compared, to values of the s-parameters of the produced coupler to validate the design process. Coupler is designed as a broadside-coupled strip-line coupler, for frequency range from 150 MHz to 200 MHz, with central frequency at 175 MHz. It consists of two overlapping brass strips of equal widths, placed on the top and bottom surface of a Teflon substrate, which is sandwiched between the top and bottom of an aluminum casing and separated from them by air layers of equal thickness. Purpose of the coupler is to combine two input signals in quadrature, who each have 16 KW of power, in to an output signal of 32 KW.

MTI2.3
OPEN AND SHORT STUB-LOADED RESONATORS: INVERTER-BASED MODELING AND FREQUENCY BEHAVIOUR

Biljana P. Stošić, Faculty of Electronic Engineering, University of Nis, Nis, Serbia
Nebojša Dončov, Faculty of Electronic Engineering, University of Nis, Nis, Serbia

The frequency-dependent behavior of microstrip circuits with stub-loaded resonators is studied through the newly developed methodology for their modeling and analyzing. Inverter-based models of open and short stub-loaded resonators are developed based on their equivalent circuits with impedance inverters.

MTI2.4
A NEW TYPE OF MICROSTRIP RESONATOR FOR PERMITTIVITY MEASUREMENT

Dušan Nešić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia

In this paper a new type of microstrip resonant sensor is introduced. It is a T-junction with an open stub as a sensing part. The sensing part is a pair of two metal strips in the form of balanced microstrip without substrate. According to lack of substrate, all fields around the stub strips are inside the measured material. The proposed sensor is designed, fabricated and tested.

MTI2.5
ANALYSIS OF RF MEMS OHMIC SWITCHES BASED ON THEIR NEURAL MODELS

Tomislav Ćirić, Faculty of Electronic Engineering, University of Nis, Nis, Serbia
Zlatica Marinković, Faculty of Electronic Engineering, University of Nis, Nis, Serbia
Marija Milijić, Faculty of Electronic Engineering, University of Nis, Nis, Serbia
Olivera Pronić-Rančić, Faculty of Electronic Engineering, University of Nis, Nis, Serbia
Vera Marković, Faculty of Electronic Engineering, University of Nis, Nis, Serbia
Larissa Vietzorrreck, Lehrstuhl für Hochfrequenztechnik, TU München, München, Germany

This paper illustrates an efficient approach for analysis of RF MEMS ohmic switch behavior against the small deviations of the switch dimensions originating from the switch fabrication process. The analysis is done by using a previously developed switch neural model relating switch dimensions and the its S-parameters. Due to its simulation speed, the switch neural model provides performing a number of simulations in relatively short time, allowing efficient analysis of differently sized devices. The most illustrative analysis results are presented and corresponding conclusions are derived.

MTI2.6
ANALYTICAL PROCEDURE FOR EXTRACTION OF HEMT NOISE WAVE TEMPERATURES

Vladica Đorđević, Innovation Centre of Advanced Technology Niš, Serbia

Zlatica Marinković, Faculty of Electronic Engineering, University of Nis, Nis, Serbia
Olivera Pronić-Rančić, Faculty of Electronic Engineering, University of Nis, Nis, Serbia
Vera Marković, Faculty of Electronic Engineering, University of Nis, Nis, Serbia

This paper presents a complete analytical procedure for extraction of the noise wave temperatures of a HEMT device working under different ambient temperature and frequency. The first step in the presented procedure is de-embedding of the noise parameters of transistor intrinsic circuit from the noise parameters of entire transistor. The second step is determination of the noise wave temperatures based on the de-embedded intrinsic noise parameters. The accuracy of the presented approach is validated by comparison of the transistor noise parameters obtained using the extracted noise wave temperatures with the measured noise parameters.

MTI2.7
MODELING OF METAMATERIAL BASED ON EFFECTIVE PARAMETERS USING THE Z-TLM METHOD

Miloš Kostić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Nebojša Dončov, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Zoran Stanković, Faculty of Electronic Engineering, University of Niš, Niš, Serbia

Previously developed approach, based on one-dimensional (1-D) TLM method with Z-transforms, for an efficient effective parameters-based representation of dispersive lossy metamaterial structure described by its scattering matrix, is extended in this paper for the three-dimensional (3-D) case. One-cell split ring resonator (SRR) rod slab, exhibiting double negative metamaterial (MM) properties in THz frequency range, is used here to verify the accuracy and stability of the 3-D approach. The effective permittivity and permeability of single cell SSR-rod MM slab, extracted from **S** parameters, show different frequency dependencies, such as negative real parts at different frequencies and different losses, therefore two discrete-time models are required to accurately capture slab behavior in the considered frequency range. Presented approach can be used for an efficient design of any MM-based device as it allows to numerically explore how changes in effective parameters can adjust its scattering parameters in the operating frequency band.

MTI2.8
WIDEBAND BAND-STOP FILTER IN BALANCED MICROSTRIP TECHNIQUES FOR A HIGHER MILLIMETER FREQUENCY RANGE

Siniša Jovanović, Company for Microwave and Millimeter-Wave Techniques and Electronics IMTEL-Komunikacije Joint-Stock Company Belgrade, Novi Beograd, Serbia
Aleksandar Nešić, Company for Microwave and Millimeter-Wave Techniques and Electronics IMTEL-Komunikacije Joint-Stock Company Belgrade, Novi Beograd, Serbia

This paper features printed band-stop filters suitable for application in low cost transmitters and receivers operating in a higher millimeter-wave frequency range. The basic filter consists of a pair of slow-wave open-loop resonators coupled on both sides with a balanced microstrip transmission line. A higher band stop isolation can be achieved by cascading several basic filters, while the broader band-stop range can be achieved by the subsequent scaling of the resonators' size. Such a filter is suitable for integration with high gain printed antenna arrays for achieving a better transmitter to receiver isolation.

NEW MATERIALS – NMI

NMI
Chair: Nebojša Mitrović, Faculty of Technical Sciences, Čačak, University of Kragujevac
Monday, June 13, 11.00 h, Room 1

NMI 1.1
Invited talk

MECHANICALLY ACTIVATED FERROELECTRIC MATERIALS

Vera Pavlović, Faculty of Mechanical Engineering, University of Belgrade, Serbia
Branislav Vlahović, North Carolina Central University, Durham, NC, USA
Darko Kosanović, Institute of Technical Sciences of SASA, Belgrade, Serbia
Vladimir Djoković, Vinča Institute of Nuclear Sciences, University of Belgrade, Serbia
Marwin Wu, North Carolina Central University, Durham, NC, USA
Vladimir Pavlović, Institute of Technical Sciences of SASA, Belgrade, Serbia

In this article the influence of mechanical activation on synthesis, structure and properties of ferroelectric materials has been presented. Development of materials with defined properties has been primarily discussed from the viewpoint of the influence of mechanical activation of polydispersed systems on the reaction activity increase due to powder particle diminution, the rise of the specific surface area, change of the particle and pore size distribution and morphology, decrease in total porosity, generation of the microstrains, formation, motion and interaction of the structural defects, surface amorphization, crystal lattice changes, phase transformations, etc. From that aspect, the impact of mechanical activation on the sintering process, the densification and microstructure evolution of the sintered samples, including the changes of the domain structure and appearance of the new phases have been further interpreted. The influence of structural changes in mechanically activated powders on the phase constitution of ferroelectric polymer composites with mechanically activated fillers has been analyzed as well. Finally, a correlation between structure changes and certain properties of ferroelectric materials has been also considered, mainly from the viewpoint of changes in dielectric properties, electrical impedance spectra, non-linear ferroelectric behavior and some piezoelectric properties. It has been concluded that mechanical activation can be used as an important step in processing of the both ceramic and polymer composite ferroelectric materials, in order to optimize and improve their final properties.

NMI 1.2
CFD SIMULATION OF THERMAL PERFORMANCES OF BUILDING STRUCTURE WITH EXPANDED POLYSTYRENE (EPS) AS THERMAL INSULATION

Milica Mirković, Faculty of Civil Engineering, University of Belgrade, Serbia
Zorana Petojević, Faculty of Civil Engineering, University of Belgrade, Serbia
Radovan Gospavić, Faculty of Civil Engineering, University of Belgrade, Serbia
Goran Todorović, Faculty of Civil Engineering, University of Belgrade, Serbia

In this paper a three dimensional (3D), Computational Fluid Dynamics (CFD) simulation for indoor air flow and heat transfer in a single room was developed. The multi-layer structure building envelop, with expanded polystyrene (EPS) as thermal insulation inside, has been included into simulation and its influence on thermal performances were analysed. The indoor air flow and temperature distribution were analysed for different thicknesses of EPS insulations and were compared to the case without insulation. The commercial software FLUENT has been used in the simulation. The air flow due to natural convection is included into the model through a buoyancydriven flow. The realizable k-ε model, based on Reynolds-Averaged Navier-Stokes (RANS) equations, is used for modelling of the turbulence in air flow. The radiator model with thermal flux as input parameter is used for simulation of heating of the room. In order to resolve flow in boundary layer high resolution grid near walls and low-Reynolds number has been used. According to the presented results the thickness of thermal insulation has significant influence on the indoor air flow and the temperature distribution inside the building.

NUCLEAR ENGINEERING – NTI

NT1. Using Nuclear Radiation
Chair: Marko Ninković, Vinča Institute of Nuclear Sciences, Vinča, Belgrade, Serbia
Monday, June 13, 13.00 h, Room 1

NTI1.1
CALCULATION OF INDUCED ACTIVITY IN THE GRAPHITE REFLECTOR OF THE RA NUCLEAR REACTOR

Miodrag Milošević, Public Company Nuclear Facilities of Serbia, Belgrade, Serbia
Ivana Maksimović, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia; Public Company Nuclear Facilities of Serbia, Belgrade, Serbia
Milan Petrović, Public Company Nuclear Facilities of Serbia, Belgrade, Serbia

A complete radiological characterisation has to be prepared in order to support the decommissioning planning effort of the RA shut down research reactor. In this paper the methods for assessment of neutron induced activity in the RA reactor material are presented. On the basis of fuel burnup determination and operational history of the RA nuclear reactor, the 25 effective configuration (e.g., geometry, fuel enrichment and fuel burnup) were prepared to represent the spatial and energy distribution of the neutron flux throughout the neutron irradiated components. The RA nuclear reactor irradiated components were divided into large number of volume zones (about one hundred in each component), and the average energy distributions of neutron flux were calculated. Two procedures were used for these calculations. In the first procedure, the neutron sources were prepared using keff-eigenvalue functions obtained with the KENO-V.a code or MCNP-5 code, and in the second one, based on the MCNP-5 code, the reaction rates in each of 25 represent cores were calculated. Finally, the results of induced activity calculations in the RA nuclear reactor vessels, graphite reflector and concrete shielding are summarised.

NTI1.2
ASSESSING OF THE RADIOLOGICAL CONSEQUENCES OF RADIONUCLIDES RELEASE TO THE ENVIRONMENT FOR POTENTIAL ACCIDENT IN THE RA NUCLEAR REACTOR BUILDING

Milan Petrović, Public Company Nuclear Facilities of Serbia, Belgrade, Serbia
Ivana Maksimović, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia; Public Company Nuclear Facilities of Serbia, Belgrade, Serbia
Miodrag Milošević, Public Company Nuclear Facilities of Serbia, Belgrade, Serbia

Current obligations related to preparation of the Safety report for planned activities in the building of the RA shut down nuclear reactor have raised the necessity for analysis of the potential impacts of radionuclides released under normal and accident conditions. Radiological measurement and numerical characterisations, completed so far, confirmed that the highest activity in the building of the RA nuclear reactor is induced activity located in a steel reactor vessel and graphite reflector in a form of hard-to-detect radionuclides. This paper demonstrates that the graphite near the core of a nuclear reactor RA accumulated high amount of Wigner's hidden energy during its exploitation. In the case of fire in the building of this nuclear reactor, the presence of Wigner's energy could contribute to the release of radionuclides into the environment. Methodology standardised by regulatory body of the United States (NRC) for the purposes of assessing the impact of radionuclides released over short distances (up to 10000m) is briefly overviewed and analysis of the two potentially most dangerous scenarios during a fire in the RA nuclear reactor building is given. The first scenario analyses the consequences of the release of radionuclides from the graphite reflector of the RA nuclear reactor, and in the second scenario the release of ^{241}Am from the fire affected room number 208, which contains strips used in smoke detectors, is analysed.

NTI1.3
SURFACE ACTIVITY MEASUREMENT OF ALPHA AND BETA EMITERS IN THE RA NUCLEAR REACTOR HALL

Miodrag Milošević, Public Company Nuclear Facilities of Serbia, Belgrade, Serbia
Ivana Maksimović, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia; Public Company Nuclear Facilities of Serbia, Belgrade, Serbia
Dragana Cekerevac-Mirković, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia, Public Company Nuclear Facilities of Serbia, Belgrade, Serbia

Current worldwide efforts to develop the non-destructive methods for determining the activity of alpha emitters accumulated on the paper filters of air monitors, and our need for a reliable determination of surface activity of the contaminated and controlled zones, stimulated the development of domestic non-destructive methods for these needs. This paper summarises the results of the development of methods for determining the activity of pure beta emitters and low activity alpha emitters of dry paper smears by using numerically calibrated beta and alpha spectrometers. Demonstrated methodology for determination of the density of particles removed with dry paper filters is based on the matching of energy spectra of beta and alpha particles obtained from measurements and numerical simulations with verified models for used alpha

and beta spectrometers. Densities of particles from dry paper filters (obtained either by sweeping the test area or gathered on the air monitor), determined in this manner, are used for the direct determination of beta emitter activities and for determining the efficiency of sources of alpha particles. Final activities of alpha emitters were determined on the basis of the measured detector efficiency and calculated source efficiency. Introduced methodology is applied for the determination of alpha and beta activity of dry paper smear taken in the contaminated zone of the RA nuclear reactor hall.

NTI1.4
COMPARISON OF THE ENERGY AND ANGULAR RESPONSES OF THERMOLUMINESCENT AND ELECTRONIC PERSONAL DOSIMETERS

Filip Haralambos Apostolakopoulos, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Nikola Kržanović, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia; Vinča Institute of Nuclear Sciences, Vinča, Belgrade, Serbia
Luka Perazić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia; Public company Nuclear Facilities of Serbia, Vinča, Belgrade, Serbia
Miloš Živanović, Vinča Institute of Nuclear Sciences, Vinča Institute of Nuclear Sciences, Vinča, Belgrade, Serbia
Koviljka Stanković, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia.

Determination of the response of thermoluminescent and electronic personal dosimeters as a function of photon energy and angle of incidence has a crucial impact on their application in poly-energetic multidirectional photon radiation fields. In the experimental part of this paper, in order to determine the energy dependence of the dosimeter responses, the dosimeters were mounted on an ISO slab phantom, irradiated in X and gamma ray fields, defined in the IAEA SRS 16, within the energy range of 33 keV - 1,25 MeV. Tested dosimeters have not shown an adequate response in the low photon energies relative to their Cs-137 responses, while in the middle and high energy photon ranges they performed well and have shown a deviation relative to their Cs-137 responses up to ±20%. In order to determine the angular dependence of the dosimeters the N-200 narrow beam radiation quality has been used. The angles of incidence for which the dosimeters were tested range from 0° to 80°, with an increment of 20°. Most of the dosimeters have behaved as expected, except for certain dosimeters due to their significant increase in response caused by the influence of the scattered radiation.

NTI1.5
NON-DESTRUCTIVE METHOD FOR MEASUREMENT OF IRRADIATION OF LEU FUEL ELEMENT OF THE RB ZERO POWER CRITICAL ASSEMBLY

Miodrag Milošević, Public Company Nuclear Facilities of Serbia, Belgrade, Serbia
Dragana Nikolić, Vinča Institute of Nuclear Sciences, Vinča, Belgrade, Serbia
Dragana Žarković, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia; Public Company Nuclear Facilities of Serbia, Belgrade, Serbia

Determination of ^{137}Cs activity in the fuel elements of critical systems running on low powers (zero power), or in irradiated uranium samples, can provide reliable insight into the level of irradiation of the examined fuel elements or samples. The methodology based on a geometry model developed for the numerical determination of efficiency of Ge detectors, dedicated for in situ measurements for samples with high densities, such as samples with metal uranium and uranium dioxide, is presented in this paper. Its specificity is the inclusion of the spatial distribution of ^{137}Cs in the irradiated uranium samples in the process of efficiency calculation. The relationship between the measured activity of ^{137}Cs and irradiation (fuel burnup) in the irradiated samples with uranium is achieved by using the MWO2 coupled computer tool. This tool uses the MCNP-5 Monte Carlo code to determine the spatial distribution of neutron flux and the modified ORIGEN 2.2 code with problem-independent three groups library. The presented methodology is applied for the determination of irradiation of the fuel elements used during exploitation of the RB heavy water critical assembly.

ROBOTICS AND FLEXIBLE AUTOMATION – ROI

RO1. ROBOT DESIGN, DYNAMICS, MODELING AND CONTROL

Chair: Aleksandar Rodić, Institute Mihajlo Pupin, Belgrade, Serbia
Thursday, June 16, 8.00 h, Room 4

RO1.1
REALIZATION AND COMPARATIVE ANALYSIS OF COUPLED AND DECOUPLED CONTROL METHODS FOR BIDIRECTIONAL ANTAGONISTIC DRIVES: QBmove maker pro

Branko Lukić, University of Belgrade, School of Electrical Engineering, Serbia
Kosta Jovanović, University of Belgrade, School of Electrical Engineering, Serbia
Aleksandar Rakić, University of Belgrade, School of Electrical Engineering, Serbia

In this paper, several control approaches to simultaneous position and stiffness control of antagonistic joint with bidirectional springs – QBmove maker pro are elaborated. Control methods are validated both in simulations and on the laboratory setup. Two basic control concepts are distinguished. The first is indirect (decoupled) control of output shaft position and stiffness by controlling prime movers positions in accordance to the mathematical model. Second concept is direct (coupled) control of position and stiffness, where stiffness estimation is based on mathematical relations given in manufacturer's specifications. In this paper we present control strategies, their implementation and comparative analysis.

RO1.2
ENHANCED PULLER-FOLLOWER APPROACH FOR STIFFNESS CONTROL OF ANTAGONISTIC DRIVES

Kosta Jovanović, University of Belgrade, School of Electrical Engineering, Serbia
Branko Lukić, University of Belgrade, School of Electrical Engineering, Serbia
Veljko Potkonjak, University of Belgrade, School of Electrical Engineering, Serbia

The paper presents extension of feedback-linearization based puller-follower control towards simultaneous position and stiffness control of antagonistic drives in robotics. Initially introduced puller-follower control concept enables simultaneous control of stiffness and antagonistic tendon force of antagonistic actuators. In this work, we present more user-oriented goal in variable stiffness actuators - command of desired joint stiffness instead of desired antagonistic tendon force. We show that introduced upgrade in the puller-follower control scheme preserves stability and controllability. The concept is validated through simulations.

RO1.3
COMPARATIVE ANALYSIS OF THE SHRUG MECHANISMS FOR HUMANOID ROBOTS

Marko Penčić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Maja Čavić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Srđan Savić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Branislav Borovac, University of Novi Sad, Faculty of Technical Sciences, Serbia

In this paper comparative analysis of shrug mechanism for humanoid robots is presented. The research is performed within the project based on development of socially acceptable robot named "SARA", that presents a mobile anthropomorphic platform for research of socially acceptable robot behavior. Based on the required demands two lever mechanisms are proposed for shrug of humanoids. The first one consists of four links and requires small space for integration and the second has six links, larger transmission ratio, but requires larger space for integration. Mechanisms have 1 DOF each and allow shrug of one or both shoulders in the same time, depending on the configuration. Comparative analysis is performed from the aspects of stroke of shrug, pressure angles and driving forces. Large stroke of shrug is opposite to the request for smaller driving force, so the final solution must be a compromise of kinematical parameters. This problem is solved with optimal synthesis.

RO1.4
DESIGN OF AN UNDERACTUATED ADAPTIVE ROBOTIC HAND WITH FORCE SENSING

Srđan Savić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Mirko Raković, University of Novi Sad, Faculty of Technical Sciences, Serbia
Marko Penčić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Milutin Nikolić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Slobodan Dudić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Branislav Borovac, University of Novi Sad, Faculty of Technical Sciences, Serbia

In this paper the design of an underactuated anthropomorphic robotic hand is presented. The hand is highly-underactuated and passively adaptive to the shape of an object, due to a tendon-driven mechanism and torsional spring in each finger joint. Each of five fingers has three DOFs (Degrees Of Freedom), except the thumb which has an additional DOF, for the rotation in its base. The fingers are tendon-driven, actuated with five DC motors, embedded in the palm. Flexion and extension of

the little and ring finger are coupled, since they are actuated with a single motor. The middle and index finger are actuated with one motor each, while the thumb has one motor for flexion/extension and another for the rotation in its base. Custom made 3-axis force sensors are integrated at the tip and in the base link of each finger. Force sensors consist of four Hall sensors and a small permanent magnet in the middle, sealed in a silicon base. The design of the robotic hand is highly anthropomorphic and biologically inspired by the human hand.

RO1.5
ANALYSIS OF DYNAMICS BASED SOFTWARE SIMULATORS FOR ROBOTICS RESEARCH

Vladimir Petrović, University of Belgrade, School of Electrical Engineering, Serbia
Veljko Potkonjak, University of Belgrade, School of Electrical Engineering, Serbia

Computer simulation represent one of the most important parts of the research process in robotics. In order to fully exploit the possibilities of simulating some system, its virtual behavior should be as similar as possible to the real world behavior. Thus, including system dynamics can be considered as a precondition for successful simulation. In this paper, several dynamics based software simulators that can be used for various robotics applications, will be analyzed and compared. Final goal of the study is to provide necessary information and analysis of potential advantages and drawbacks, in that way helping researchers to choose the most adequate software simulator for their research.

RO1.6
MODELING AND SIMULATION OF THE CLOUD-ROBOTS IN THE SMART MULTI-TASKING SCENARIOS

Aleksandar Rodić, University of Belgrade, Mihajlo Pupin Institute, Serbia
Miloš Jovanović, University of Belgrade, Mihajlo Pupin Institute, Serbia
Milica Vujović, University of Belgrade, Mihajlo Pupin Institute, Serbia
Djordje Urukalo, University of Belgrade, Mihajlo Pupin Institute, Serbia

Paper concerns with structure and management of application-driven, cloud-based, smart, multi-robot scenario to be implemented in a typical megastore environment where people (consumers and staff) intertwine with goods flow and service robots operating in the store. Heterogeneous models of human actors, things and robots making a unique dynamic system, were developed. The system operates as a distributed, wireless, robot-sensor network configured in the information structured environment of megastore. The smart store is modeled and simulated at several networked PC computers connected to the cloud architecture. The aim of cloud system configuration is to control collaborative strategies of multi-robotic system in the considered application – high automated megastore. Research results are verified by simulation experiments instead furnishing and configuring expensive real experimental system. Particular models of physical environment (megastore infrastructure), different-purpose service robots, consumers, staff and goods (things) together with wireless sensorial and communication system are developed and simulated in parallel at several cloud computers.

RO2. ROBOT APPLICATIONS

Chair: Veljko Potkonjak, University of Belgrade, School of Electrical Engineering, Belgrade, Serbia
Thursday, June 16, 10.00 h, Room 4

RO2.1
SIMULATION AND CONTROL OF FLIGHT SIMULATOR

Nataša Kablar, Lola Institute - Belgrade, Serbia
Vladimir Kvrgić, Lola Institute - Belgrade, Serbia

In this paper we present basic challenges when designing flight simulator – designing a 6DOF robotic system whether as Stewart platform or Robot arm, choosing control as PID, and ability to follow supermanuvarable flight trajectories, and pilot tests under the inputs and forces while performing these supermanuvers.

RO2.2
AN APPROACH TO MODELING AND CONTROL OF UNDERWATER REMOTELY OPERATED VEHICLE FOR RIVER MANIPULATION TASKS

Aleksandar Ćosić, University of Belgrade, Mihajlo Pupin Institute, Serbia
Ilija Stevanović, University of Belgrade, Mihajlo Pupin Institute, Serbia
Aleksandar Rodić, University of Belgrade, Mihajlo Pupin Institute, Serbia

Remotely operated vehicles (ROVs) are widely used in broad variety of applications, from space exploration and mapping, surveillance and supervision, inspection of hazardous environments to service tasks in healthcare facilities. Up to now, many different ROVs for various underwater tasks have been proposed and they are mostly designed for maritime environments. However, when it comes to river applications, tasks become more challenging, due to strong currents. In this paper, two different design approaches to underwater ROVs for manipulation tasks in rivers have been proposed. The mathematical models based on Lagrange formulation have been derived and simple PID controller for trajectory tracking is designed. Simulations for both robots have been carried out and the results are compared. Lastly, obtained results suggest necessity of full actuation of underwater ROV, due to strong disturbances which heavily affects the motion of the robot during operation.

RO2.3
A COMPARATIVE ANALYSIS BETWEEN THE RSCPR AND CPR-A SYSTEMS

Mirjana Filipović, University of Belgrade, Mihajlo Pupin Institute, Serbia
Ljubinko Kevac, University of Belgrade, School of Electrical Engineering, Innovation center, Serbia
Ana Djurić, Wayne State University, Detroit, US

In this paper, we present the comparative analysis between the two different constructions of cable suspended parallel robots (CPR systems). We compare these two systems: RSCPR system and CPR – A systems. These two systems have a same shape of end effector's workspace, but they have completely different configuration. We present these two systems and then we analyze their behavior in completely identical conditions: same type of actuators (DC motors), same shape of trajectory, same maximal value of composite velocity, same radii of all winches which wind (unwind) the cable and same mass of end effector. All the analysis are performed with adequate simulation experiments which are discussed in the end of the paper.

RO2.4
ROBOT INTEGRATED CONSTRUCTION – AUTOMATED MASONRY

Milica Vujović, University of Belgrade, Mihajlo Pupin Institute, Serbia
Aleksandar Rodić, University of Belgrade, Mihajlo Pupin Institute, Serbia
Ilija Stevanović, University of Belgrade, Mihajlo Pupin Institute, Serbia

This paper presents the design of an innovative robotic system for building constructions. The proposed robotic system has a modular structure and reconfigurability so that it can adapt to different construction requirements. The robotic system developed in this paper is applied in residential low-rise buildings (ground floor plus three floors and attic). Reconfigurable system presented in this paper implies the possibility of applying three different types of robots: the parallel SCARA, construction Delta robots and redundant, hyper articular robot for infrastructure inspection. The modular structure ensures rapid assembly and disassembly, functionality of the system even in the event of failure of one component of the module The robotic system design is conceived on the model of 3D printers with the possibility of easy replacement of various end effectors to manipulate the material in construction, assembly installation and final processing of the facade and walls. In conclusion, of the paper it will be given a brief comparative analysis of conventional ways of constructing and innovative approach for the use of robots for design and high automation of the process of building construction.

RO2.5
ROBOTIZED 3D LARGE SPACE SCANNER REALISATION

Ilija Stevanović, University of Belgrade, Mihajlo Pupin Institute, Serbia
Miloš Jovanović, University of Belgrade, Mihajlo Pupin Institute, Serbia
Aleksandar Rodić, University of Belgrade, Mihajlo Pupin Institute, Serbia

3D scanner is useful hardware device platform especially for unstandardized mechanical developments. Precision and working space is the most important for the 3D scanners. Because of this, such devices are extremely expensive in the market. To realize reliable and inexpensive 3D scanner with high scan precision and capable to accept large pieces of scanned elements is a challengeable task. One such device with relatively large scanner space (up to 2m) capable to realize high scan precision is presented in the paper. Realized 3D scanner is partially robotized in term to control time and scan speed. Scanner is expandable and it is possible to be networked.

RO2.6
OVERVIEW OF METHODS FOR ROBOTIC MANIPULATORS CALIBRATION

Zaviša Gordić, University of Belgrade, School of Electrical Engineering, Serbia
Veljko Potkonjak, University of Belgrade, School of Electrical Engineering, Serbia

This paper presents an overview of methods for calibration of robotic manipulator parameterss. The main goal of the paper is to present calibration techniques developed to acquire Denavit–Hartenberg parameters using partial or full pose measurements. Algorithms, as well as theoretical background of currently available approaches are explained, and their performances are analyzed. Potential for industrial and practical application is considered for each of the presented methods, pointing out their advantages and disadvantages.

RTI1. Systems Software, Tools, and Applications
Chairs: Miroslav Popović, Faculty of Technical Sciences, University of Novi Sad, Serbia
Ivan Milentijević, Faculty of Electronic Engineering , University of Niš, Serbia
Monday, June 13, 11.00 h, Room C, CC Toledo

RTI1.1
COMPUTATION OF FAST SPECTRAL TRANSFORMS OF LOGIC FUNCTIONS ON MULTI-CORE CPU PLATFORM WITH DIFFERENT PARALLEL PROGRAMMING FRAMEWORKS AND OPERATING SYSTEM SERVICES

Miloš Radmanović, Faculty of Electronic Engineering, University of Nis, Serbia

Spectral transform is a useful mathematical tool for the analysis, synthesis, and optimization of logic functions. The fast spectral transform algorithms have been one of the most popular numerical computational methods which are applied for efficient practical application. These algorithms can be executed much faster using parallel processing, especially nowadays, as many multi-core CPU personal computers offer the capability of parallel processing. For that reason, various parallel programming frameworks offer different possibilities for programming of these algorithms. In this paper, we investigate computation performance of spectral transform of logic functions on multi-core Central Processing Units (CPUs) using different parallel programming frameworks running on different operating system services. For computation of spectral transform algorithms, it is used MPICH, Open-MPI, Intel-MPI, and Microsoft-MPI programming frameworks on Linux and Windows. Experimental results present a comparison of time efficiency of implementations of the fast Reed-Muller and the fast Walsh spectral transform in the specific framework, tested on an Intel's Core i7 processor. The experiments performed on randomly-generated logic functions show that the computation performance may vary by up to +/– 5% from the average computation time values.

RTI1.2
IMPLEMENTATION OF INDUCTION VARIABLE STRENGTH REDUCTION OPTIMIZATION IN AN EMBEDDED PROCESSOR ORIENTED COMPILER INFRASTRUCTURE

Marko Krnjetin, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Ivan Považan, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Miodrag Đukić, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Jelena Kovačević, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia

Induction variables are variables whose value is increased or decreased by the same amount in every iteration of the loop. Replacing calculation of these variables with increment or decrement is a common compiler optimization technique. This optimization is especially valuable for DSP class of processors as it enables utilization of their address generation unit. In this paper we implement an induction variable strength reduction optimization using RTCC, an embedded processor oriented compiler infrastructure. Using this infrastructure simplifies implementation of the optimization and allows us to automatically exploit processors address generator. We measure performance gains of this optimization using existing implementation of this compiler for a custom DSP processor.

RTI1.3
BENCHMARKING PERFORMANCE OF EXT4, XFS, AND BTRFS AS GUEST FILE SYSTEMS UNDER LINUX ENVIRONMENT

Dejan Vujičič, Faculty of Technical Sciences in Čačak, University of Kragujevac, Serbia
Dušan Marković, Faculty of Agronomy in Čačak, University of Kragujevac, Serbia
Borislav Đorđević, Mihajlo Pupin Institute, University of Belgrade, Serbia
Siniša Ranđić, Faculty of Technical Sciences in Čačak, University of Kragujevac, Serbia

The benchmark results of three most common file systems under Linux environment were given in this paper. Btrfs is one of the most popular newly created file systems, and was benchmarked against ext4 and xfs. These file systems were benchmarked in the Filebench tool measuring I/O throughput and I/O latency in emulated file server, web server, and mail server environment. The results showed in general better performance of ext4 file system, mainly because of using the same file system as a guest.

RTI1.4
PERFORMANCE ANALYSIS OF EXT4, XFS AND BTRFS FILESYSTEMS MOUNTED ON MAGNETIC DISK

Nikola Davidović, Faculty of Electrical Engineering at University of East Sarajevo, BiH
Borislav Đorđević, Institute Mihajlo Pupin, University of Belgrade, Serbia
Valentina Timčenko, School of Electrical Engineering, University of Belgrade, Institute Mihajlo Pupin, University of Belgrade, Serbia
Slobodan Obradović, Faculty of Electrical Engineering at University of East Sarajevo, BiH

This paper considers different types of file systems in Linux environment and analysis of the efficiency of data storage when using magnetic disks in Linux environment. Magnetic disks represent the dominant technology for data storage and preservation, while a large number of

Linux distributions are actually free for use. The performance analysis results are obtained by testing the performance of EXT4, XFS and BTRFS file system under Linux CentOS, on Toshiba magnetic disk. All the measurements were performed by two benchmark applications, Postmark and Bonnie ++.

RTI1.5
A FRAMEWORK FOR CONSUMER DEVICES RELIABILITY METRICS ESTIMATION

Branislav Kordić, Faculty of Technical Sciences, University of Novi Sad, Serbia
Ivan Kaštelan, Faculty of Technical Sciences, University of Novi Sad, Serbia
Miloš Pilipović, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Darko Lulić, Faculty of Electronic Engineering, University of Nis, Serbia

This paper presents a framework for consumer devices reliability metrics estimation utilizing tools and systems based on statistical usage testing and black box testing methodology. The framework aims to provide modularity and adaptability due to fact that most often a testing system is composed of different tools and subsystems. The proposed solution is evaluated by means of particular case study using commercially available and industry proven statistical usage testing tools and black-box testing system. Finally, brief overview of available test systems and tools, and lessons learned are given.

RTI1.6
IMPLEMENTATION OF TV METADATA CACHING FOR ENHANCED USER EXPERIENCE

Darko Vidaković, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Nenad Jovanović, Faculty of Technical Sciences, University of Novi Sad, Serbia
Jaroslav Hlavač, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Darko Dejanović, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia

User experience is one of the main selling points in modern TV devices as much as responsiveness is one of the main factors for high quality user experience. One of the elementary ways of tackling the problem of responsiveness is by using a local cache when fetching metadata from the service backend. Depending on the capabilities of the server, we have described two different ways that can be undertaken. The solution described in the paper bases itself on the capabilities typical for a certain class of metadata servers. As such, it is applicable to a range of backend solutions. Based on this class of servers, a cache management algorithm has been implemented with special care for metadata validity. The algorithm has been tested and results prove that it provides a viable solution for reducing request response time. The software developed was implemented using a commercially available metadata service backend.

RTI2. Computer Networks and Applications
Chairs: Ivan Milentijević, Faculty of Electronic Engineering , University of Niš, Serbia
Ilija Bašičević, Faculty of Technical Sciences, University of Novi Sad, Serbia
Monday, June 13, 13.00 h, Room C, CC Toledo

RTI2.1
A PRIVATE IOT CLOUD PLATFORM FOR PRECISION AGRICULTURE AND ECOLOGICAL MONITORING

Milija Bajčeta, Faculty of Electrical Engineering, University of Montenegro, Montenegro
Petar Sekulić, Faculty of Electrical Engineering, University of Montenegro, Montenegro
Božo Krstajić, Faculty of Electrical Engineering, University of Montenegro, Montenegro
Slobodan Djukanović, Faculty of Electrical Engineering, University of Montenegro, Montenegro
Tomo Popović, Faculty of Electrical Engineering, University of Montenegro, Montenegro

This paper describes an implementation of a private Internet of Things (IoT) cloud platform for the use in precision agriculture and ecological monitoring. The paper discusses functional requirements for the project using use cases. The primary goal is to collect the IoT data for research purposes, but also for the use by end users. The solution has been implemented using open source tools: Linux, LAMP stack, PHP programming language, and Laravel framework. The data integration has been tested using sensor nodes based on Arduino, Raspberry Pi, Libelium Plug and Sense, and PC. IoT nodes have been deployed in the field at the end user facilities and the platform is being evaluated by the researchers on the project. The solutionis open for further development with respect to additional IoT protocols, data types, and interfacing to analytics tools.

RTI2.2
ADVANCED SCENE IMPLEMENTATION IN HOME AUTOMATION SYSTEM

Ivan Lazarević, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Milan Pandurov, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Boris Radin, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Istvan Papp, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia

This paper presents idea and implementation for advanced scene mechanism. Because standard scene mechanism, existing in many home automation solutions on market, is too simple, new one is proposed. It is intended to provide possibility of fully automated smart home environment, while keeping simplicity necessary for user interaction.

RTI2.3
MULTI-STREAMING SOFTWARE UPGRADE OF CI PLUS V1.4

Marina Vučković, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Nenad Šoškić, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Miroslav Dimitrašković, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Ilija Bašičević, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia

The paper specifies multi-streaming upgrade of the CI Plus V1.4 [1], an extension to the CI Plus V1.3 specification [4], which is the industry standard for access to protected TV channels in set-top-box devices. The purpose of this paper is to introduce software upgrade of the resources in previous version of CI Plus V1.3 with the multi-streaming functionality of some resources in the new version of CI Plus V1.4, in a simple manner in order to enhance capabilities of the previous version of CI Plus.

RTI2.4
GRAPHICAL USER INTERFACE FOR DATA DISPLAY ON THE VEHICLE DASHBOARD BASED ON ANDROID PLATFORM

Mihajlo Marinković, Faculty of Technical Sciences, University of Novi Sad, Serbia
Marko Kovačević, Faculty of Technical Sciences, University of Novi Sad, Serbia
Tomislav Maruna, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Gordana Velikić, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia

This paper describes an approach of realization of graphical user interface for data display on the vehicle dashboard based on Android. Solution covers displaying vehicle speed, engine revolutions (rpm), fuel level, oil level, engine temperature and the position of the throttle pedal using the standard Android user interface framework. 3D (eng. Three dimensional) UI effects are realized upon the user's interaction with a specific (speed, fuel etc.) indicator. In order to improve the user experience, optimization of graphic components rendering is done.

RTI2.5
AN ECLIPSE PLUGIN FOR MEMORY MAP VISUALIZATION

Stefan Stanivuk, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Momčilo Krunić, RT-RK Institute for Computer Based Systems, Novi Sad, Serbia
Jelena Kovačević, Faculty of Tech. Sciences, University of Novi Sad, Serbia

This paper describes one solution of Eclipse Plugin used for embedded platform memory map visualization and editing. The solution solves the problem of inefficient representation of used memory in firmware applications during debugging session. This plugin obtains information from memory map, a file generated after process of application building, and graphically displays it in a clear manner where each symbol defined in firmware application is graphically outlined by its name, processor core, memory name, section name, address and size. Also, values of presented symbols can be easily edited. This software tool is implemented using Java programming language with SWT (Standard Widget Toolkit) and JFace toolkit used for GUI (Graphical User Interface) widgets implementation.

RTI2.6
COMBINATION OF TRANSPOSITION TABLES FOR COMPUTER CHESS GAME TREE REDUCTION

Vladan Vučković, Faculty of Electronic Engineering, University of Niš, Serbia

In this paper, the basic heuristic methods on game tree cutting with transposition table are presented. In modern PCs,operating memory is no longer a critical factor, making it possible to use large segments of memory to remember positions that have already been analyzed in the game tree, along with their attributes. This will be done with greatly accelerating of the search maximizing the number of sub-tree cutting in every new iteration. The paper also presents the methods and algorithms to the original combination of several transposition techniques significantly improving the process of the tree game. The tests and tournament games against grandmasters experimentally prove the value of implemented ideas.

RTI3. Education, Knowledge Management and New Software Packages
Chairs: Dragan Janković, Faculty of Electronic Engineering , University of Niš, Serbia
Jelica Protić, School of Electrical Engineering, University of Belgrade, Serbia
Monday, June 13, 16.30 h, Room C, CC Toledo

RTI3.1
A NEW CUDA WEB-BASED LEARNING ENVIRONMENT

Dejan Dundjerski, School of Electrical Engineering, University of Belgrade, Serbia
Boško Nikolić, School of Electrical Engineering, University of Belgrade, Serbia
Milo Tomašević, School of Electrical Engineering, University of Belgrade, Serbia

In this paper the idea of CUDA web-based learning environment is elaborated first. One of the main concerns is to alleviate the initial setup which is usually complex for a new student. After a survey of existing solutions, the architecture and key implementation details are described. The architecture of the system is based on modern cloud service platforms like Windows Azure, Compose and BitBucket. Distribution of responsibilities between

different components relies on Docker container technology which makes the overall deployment and maintenance of the cloud service system easy to develop and use.

RTI3.2
ROLE OF THE UNIVERSITY'S LIBRARY INFORMATION SYSTEM MODEL IN KNOWLEDGE MANAGEMENT

Natasa Blazeska-Tabakovska, Faculty of Information and Communication Technologies, University St.Kliment Ohridski-Bitola, Macedonia
Elena Vlahu-Gjorgievska, Faculty of Information and Communication Technologies, University St.Kliment Ohridski-Bitola, Macedonia
Ilija Jolevski, Faculty of Information and Communication Technologies, University St.Kliment Ohridski-Bitola, Macedonia
Mimoza Bogdanovska-Jovanovska, Faculty of Information and Communication Technologies, University St.Kliment Ohridski-Bitola, Macedonia

Universities as complex institutions composed of multiple units (faculties and associate members) need information systems to easily share information, coordination and decision making. The implementation of information systems in university libraries, improves communication between all stakeholders and the speed with which users come to certain data. One type of information system that can be used by the university's library is the information system ULIS presented in this paper. The proposed model for University's Library Information System (ULIS) integrates information in a simple way, and allows quick access to books, teaching materials (lectures, scripts, presentations, exercises), articles or research results from each member (unit) of the university. The added social element of the proposed ULIS expands over the traditional library use-case and increases the overall impact and usefulness of the system.

RTI3.3
GENERATING THEMATIC PEDOLOGIC MAPS BY USING DATA MINING AND INTERPOLATIONS

Elma Hot, Faculty of Electrical Engineering Podgorica, University of Montenegro, Montenegro
Vesna Popović-Bugarin, Faculty of Electrical Engineering Podgorica, University of Montenegro, Montenegro
Ana Topalović, Biotechnical Faculty Podgorica, University of Montenegro, Montenegro
Mirko Knežević, Biotechnical Faculty Podgorica, University of Montenegro, Montenegro

A problem of soil clustering and visualisation of the obtained results is analysed in the paper. K-means is adapted for the soil data clustering. Clustering is done based on chemical parameters of soil. Soil database of Montenegro, which contains values of physical and chemical parameters of soil, is used. Clusterized soil data has been presented on dynamic map and compared with existing pedologic map made by human experts. In addition, by using spatial interpolation distance weighting and results of K-means clustering, different types of thematic pedologic maps were made and integrated into WEB application.

RTI3.4
KNOWLEDGE SOURCES INNOVATION AT THE STANDARDIZATION PLATFORM: INFORMATION TECHNOLOGY AND ENGINEERING FIELDS

Marija Blagojević, Faculty of Technical Sciences Čačak, University of Kragujevac, Serbia
Živadin Micić, Faculty of Technical Sciences Čačak, University of Kragujevac, Serbia

The paper presents the multicriteria research and statistical analysis of knowledge trends in standardizes Engineering fields and Information Technology. The focus is on innovating sources of knowledge, at the beginning of the second decade of the XXI century. The goal is to provide resources and improving the quality of knowledge, on the platform of the international level (ISO) and local (national SRPS) standardization. The paper presents the significant details (results and analysis) comparing trends of knowledge sources, according to the analyzed fields / subfields classified according to the International Classification Standard (ICS) ICS1 = 35 (Information Technology - IT), where ICS1 = 01 to 99. Also, paper presents plans for further development of access to knowledge sources in the form of standards (as obligations), as well as comparisons of the index of innovation in IT with other standardized fields of creativity, especially the fields of engineering (eg = 29 Electrical Engineering, = 31 Electronics, = 33 Telecommunications, etc.).

RTI3.5
PYPMU – PYTHON SOFTWARE PACKAGE FOR SYNCHROPHASORS

Stevan Šandi, Faculty of Electrical Engineering, University of Montenegro, Montenegro
Božo Krstajić, Faculty of Electrical Engineering, University of Montenegro, Montenegro
Tomo Popović, Faculty of Electrical Engineering, University of Montenegro, Montenegro

pyPMU is an open-source Python software package that implements IEEE C37.118 standard protocol for synchrophasor data transfer. The pyPMU library offers various functions for supporting synchrophasor applications and it can be very useful in synchrophasor research and test bed implementations. The paper provides detailed overview of the pyPMU package, its installation, and usage examples. The most interesting use scenarios include PMU simulator and PMU data stream splitter, which have been described in the paper. The discussion illustrates initial benchmarking results and current issues. Finally, the paper outlines future work on the improvements and practical applications. The pyPMU project is published under 3-clause BSD license and made available at GitHub.

RTI3.6

SPARKLE – A FRAMEWORK FOR SPATIAL ANALYSIS ON APACHE SPARK PLATFORM

Aleksandra Stojnev, Faculty of Electronic Engineering, University of Nis, Serbia
Dragan Stojanović, Faculty of Electronic Engineering, University of Nis, Serbia

Due to the increasing volume and varying format of collected geospatial data, the growing need for specialized systems to handle spatial data exceeded the capability on the local level. As a result, different platforms for distributed processing, like Hadoop or Apache Spark are being used for this purpose. Although they support big data processing, they are internally unaware of spatial components of the data. This paper introduces Sparkle – a framework for spatial analysis based on Apache Spark platform that provides spatial functionalities to developers with aim to reduce development time and efforts for big spatial data analysis application. The main purpose of Sparkle framework is to inject spatial data awareness in Apache Spark platform on different abstraction levels: spatial data types (geospatial RDDs), big spatial datasets and spatial operations and queries. Sparkle also provides spatial index structures to form a two-level spatial index. Sparkle is tested with simulated data, and preliminary experiments show that, besides reducing development time, Sparkle based applications achieve better performances than applications that are not based on any spatial extension.

TELECOMMUNICATIONS – TEI

TEI1. Telecommunications
Chairs: Miroslav Popović, Faculty of Technical Sciences, University of Novi Sad, Milan Bjelica, School of Electrical Engineering, University of Belgrade
Tuesday, June 14, 8.00 h, Room 2

TEI1.1
Invited talk
SCRUTINIZING IXPS: INSIGHTS INTO THE WORLD'S LARGEST IXP

Sascha Bleidner, DE-CIX Management GmbH, Frankfurt, Germany

Over the past 20 years, Internet Exchange Points (IXPs) have become a essential part within the Internet interconnection system. While growing in both numbers and size, the largest IXPs carry over 5 Tbps of peak traffic. This enormous amount of traffic is backed by the popularity of *peering* relationships between two or more Autonomous Systems (ASes). IXPs ease the setup of multilateral peering sessions across their distributed switching fabrics. With just one physical connection a member AS is able to establish peering relationships to a rich number of other ASes connected to the same IXP.

While the business model for IXPs has been proven to be successful for the past years, IXP operators are thrilled to push the interconnection business even further with innovation at the core of the Internet. This presentation will give a brief history of the rise of IXPs while focusing on the technical challenges and solutions for successfully establishing an IXP. DE-CIX has experience in building and operating successful IXPs for more than 20 years.

Since IXPs are also an important building block for tomorrows Internet architecture, the presentation will highlight some innovative projects pursuit by DE-CIX to develop the next generation IXP based on Software Defined Networking (SDN). With its software centric design and increased programmability, the SDN paradigm introduces novel technologies to further drive innovation in the IXP market.

TEI1.2
EVALUATION OF NETMAP FRAMEWORK FOR MPLS PROTOCOL IMPLEMENTATION

Mihailo Vesović, School of Electrical Engineering, University of Belgrade
Hasan Redžović, Innovation Center, University of Belgrade - School of Electrical Engineering
Aleksandra Smiljanić, School of Electrical Engineering, University of Belgrade
Slavko Gajin, School of Electrical Engineering, University of Belgrade

Network protocol stack in Linux kernel is not optimized for fast I/O packet processing. Multiple packet replications are required, which degrade packet forwarding rates. Additionally, kernel is not suitable for network protocol development, and the implementation is not flexible. For these reasons, fast I/O packet processing frameworks, such as netmap, are becoming popular. These frameworks offer high I/O speed, which is able to saturate link with 10Gbit/s traffic. However, efficient network protocol implementation is required in user space. This additional layer may impose significant performance loss. In this work, we implement MPLS forwarding in user space, based on the netmap, and determine whether the implementation will affect forwarding rates significantly.

TEI1.3
AKOMUNIKATOR: A MOBILE APPLICATION FOR AUGMENTED COMMUNICATION OF AUTISTIC CHILDREN

Verica Milanović, Innovation Center, University of Belgrade - School of Electrical Engineering
Stanko Nikolić, Innovation Center, University of Belgrade - School of Electrical Engineering
Filip Rajičić, Innovation Center, University of Belgrade - School of Electrical Engineering
Vladislava Bobić, School of Electrical Engineering, University of Belgrade
Milica Djurić-Jovičić, Innovation Center, University of Belgrade - School of Electrical Engineering
Mirjana Đorđević, School for Special Education and Rehabilitation, University of Belgrade
Nataša Dragašević, School of Medicine, University of Belgrade
Miloš Cvetanović, School of Electrical Engineering, University of Belgrade
Boško Nikolić, School of Electrical Engineering, University of Belgrade

Autistic spectrum disorder is characterized with impaired human social behavior. Because of that, it is very important to create system that can help in communication establishment and development. In this paper we describe application in Serbian that can be used for such purpose, named "aKomunikator". Application is implemented on three platforms: Windows, Android, and iOS. The system represents interactive communicator which can be used to facilitate communication between autistic children and their parents/therapists. It initially contains 292 terms, which can be expanded or narrowed, according to child's needs. The designed application is simple to use, with great potential in therapy. All collected data is protected and saved, providing statistics of child's interests and progress. It is already implemented in 10 schools in Serbia, but also in some institutions that work with autistic children.

TEI1.4
ANALYSIS OF LINK UTILIZATIONS IN DATA CENTER NETWORKS WITH LOAD-BALANCED ROUTING

Nataša Maksić, School of Electrical Engineering, University of Belgrade

Data center networks are densely interconnected and provide multiple paths between endpoints. This paper analyzes the ability of two phase load balancing to improve the utilization of data center networks. We measure the flow density on data center links for worst-case and randomized traffic patterns to show that load-balanced routing can provide an advantage over the classical equal-cost multipath routing in terms of utilization of network resources.

TEI1.5
CHARACTERISTICS OF THE TRAFFIC ON SERBIAN OPEN EXCHANGE

Nenad Krajnović, School of Electrical Engineering, University of Belgrade

Internet is constantly changing and the same is true for its traffic. Because of that, it is important to constantly measure and analyses Internet traffic. The results of Internet traffic analysis is valuable source of information for network traffic modeling and defining network design strategies. This paper presents characteristics of Internet traffic measured at Serbian Open Exchange, which is the only Internet exchange in Serbia. Presented results shows change in Internet traffic structure, comparing with the Internet traffic in the past.

TEI1.6
PERFORMANCE EVALUATION OF OPEN-SOURCE VPN SOFTWARE IMPLEMENTATIONS

Hasan Redžović, Innovation Center, University of Belgrade - School of Electrical Engineering
Aleksandra Smiljanić, School of Electrical Engineering, University of Belgrade
Slavko Gajin, School of Electrical Engineering, University of Belgrade

VPN software implementations provide high flexibility and low cost of development. There are different approaches for VPN software implementations. One type of VPN software solution utilizes built-in kernel implementation of AH and ESP protocols. The second approach are software VPN solutions that use full user-space IPsec implementation. In this paper, we analyze these two approaches and compare their performances on 10Gbps links.

TEI1.7
SPEED OF ROUTING ALGORITHMS IN DIFFERENT PROCESSING ENVIRONMENTS

Mihailo Vesović, School of Electrical Engineering, University of Belgrade
Aleksandra Smiljanić, School of Electrical Engineering, University of Belgrade

As the Internet traffic is growing, path computation algorithms are becoming more critical. Path optimization is more effective if applied to larger domains. Data centers, for example, are flat networks with thousands of nodes. Also, path calculations should be performed more often to utilize network efficiently for varying traffic patterns. For these reasons, it is important to execute routing algorithms as fast as possible. In this paper, we compare speeds of promising shortest path algorithms on different computing platforms with varying system parameters.

TEI2. Telecommunications
Chair: Zorica Nikolić, School of Electronics, University of Niš
Monday, June 13, 16.30 h, Room 1

TEI2.1
INTEGRATION OF AIS DATA AND HF-OTHR TRACKS IN UNFAVORABLE ENVIRONMENT AT OTH DISTANCES

Dejan Nikolić, VLATACOM Institute, Belgrade, Serbia
Nikola Stojković, VLATACOM Institute, Belgrade, Serbia
Nikola Lekić, VLATACOM Institute, Belgrade, Serbia
Vladimir Orlić, VLATACOM Institute, Belgrade, Serbia
Branislav M. Todorović, VLATACOM Institute, Belgrade, Serbia

The complete picture of maritime situation at over the horizon (OTH) distances requires data fusion from following sensors: high frequency over-the-horizon-radar (HF OTHR), satellite automatic identification system (SatAIS) and land automatic identification system (LAIS). The proposed algorithm utilizes radar tracks obtained from network of HF OTHRs, which are already processed by multi-radar multi-target tracking algorithm. After the processing of OTHR data is done, SatAIS and LAIS data are associated to the corresponding radar tracks. During association process all OTHR targets in the vicinity of AIS data are evaluated and one which has highest matching factor is used for data association. During design and testing special attention is given to the latency of AIS data, which could be very high in some parts of the World. The software is designed, implemented, and tested in an environment consisting of a simulated network of six HF OTHRs (with significantly overlapping surveillance areas) and AIS data which are modeled according to data obtained from real vessels.

TEI2.2
OPTIMAL SOURCE LOCALIZATION PROBLEM BASED ON TOA MEASUREMENTS

Maja Rosić, School of Electrical Engineering, University of Belgrade
Mirjana Simić, School of Electrical Engineering, University of Belgrade

Predrag Pejović, School of Electrical Engineering, University of Belgrade
Milan Bjelica, School of Electrical Engineering, University of Belgrade

Finding of an optimal source location based on the time of arrival (TOA) measurements is an important problem in Wireless Sensor Networks (WSN). In determining the location of the source from TOA parameters, linear least-squares (LLS) and nonlinear least-squares (LS) estimation techniques can be employed. TOA source localization problem is formulated as an optimization problem with the sum of squared residuals as the objective function. Computer numerical simulation results illustrate the performance comparison of these different proposed optimization methods with different initial values and signal-to-noise ratio (SNR). The corresponding Cramer–Rao Lower Bound (CRLB) on the localization errors is derived, which gives a lower bound on the variance of any unbiased estimator. Finally, the performance of the proposed gradient-based optimization methods are evaluated and compared with the CRLB and the closed-form LLS method.

TEI2.3
ANALYSIS OF BASE STATION OUTPUT POWER IN GSM SYSTEMS

Mladen Mileusnić, IRITEL A.D, Belgrade
Dragan Mitić, IRITEL A.D, Belgrade
Aleksandar Lebl, IRITEL A.D, Belgrade
Žarko Markov, IRITEL A.D, Belgrade

This paper is the survey of different factors, which have influence on the base station output (emission) power in GSM systems. The survey is based on several already published papers in international journals and PhD thesis of the paper authors. The origin of factors, which influence base station output power, is manifold: the first one is connected with environmental conditions (signal propagation attenuation), the second one is connected with users' distance from the base station (users' distribution around the base station in the area of base station cell) and the third one is connected with users' behaviour (activity of users, i.e. traffic intensity, and part of calls realized between the users from the same cell – intra-cell traffic). The influences of all these factors can't be completely mutually separated, i.e. they have to be analyzed together. At the end common influence of mentioned factors is presented for real mobile systems with implemented power control.

TEI2.4
HYBRID POWER SUPPLY SYSTEM FOR TELECOMMUNICATION SITES

Radica Todorović, VLATACOM Institute, Belgrade, Serbia
Dejan Dašić, VLATACOM Institute, Belgrade, Serbia
Mirko Obradović, VLATACOM Institute, Belgrade, Serbia

A hybrid power supply system implemented on telecommunication sites in Angola is presented. Since many telecommunication sites in Angola have no access to power supply distribution grid, a solution based on renewable energy sources has been selected. The implemented hybrid power supply system consists of solar power supply subsystem and fossil fuel power supply subsystem. Primary power supply source is solar energy, while the generator using fossil fuel operates as auxiliary power supply. Generator is used only in the case when solar or stored energy is insufficient to supply the equipment on site after the planned 24 hours of battery backup. In this paper, the implemented technical solution is described, parameters for power supply design are calculated, and obtained results and savings are discussed.

ARTIFICIAL INTELLIGENCE – VII

VII1. Intelligent signal processing
Chair: Milan Milosavljevi, Faculty of Electrical Engineering, Belgrade University and also Faculty of Technical Science, Singidunum University, Belgrade, Serbia
Tuesday, June 14, 8.00 h, Room 4

VII1.1
ON THE RELATIONSHEEP BETWEEN RADICALY NEW AND ARTIFICIAL INTELLIGENCE

Milan Milosavljević, Faculty of Electrical Engineering, Belgrade University and also Faculty of Technical Science, Singidunum University, Belgrade, Serbia

Traditional knowledge as repetitive and transferable no longer make stable strategy that guarantees competitiveness and economic efficiency on the global market. Most valuable products and services belongs to category of so called radically new. Phenomenological deconstruction of radically new leads us in the vicinity of entirely new disciplines - Hermeticists, and new methodological approach near impossible as a starting point of the so-called con-creativity processes. In this paper we establish relationship between radical new and eventual goals of Human Level Artificial Intelligence (HLAI).

VII1.2
HSI BASED COLOUR IMAGE EQUALIZATION USING ITERATIVE NTH ROOT AND NTH POWER

Gholamreza Anbarjafari, iCV Research Group, Institute of Technology, University of Tartu, Tartu, Estonia
Marina Marjanović-Jakovljević, Faculty of Technical Science, Singidunum University, Belgrade, Serbia

In this paper, we present a new equalization technique for color images. The proposed method is based on nth root and nth power equalization, but with optimization of the mean of the image in different color channels such as RGB and HSI. In order to preserve the color information of image equalization in HIS, the color space is used. It is shown that proposed method has better performance in terms of Peak Signal-to-Noise Ratio (PSNR), comparing with a classical method, i.e. histogram equalization.

VII1.3
PERFORMANCE ANALYSIS OF VOCAL EMOTION RECOGNITION USING SELECTIVE SPEECH FEATURES

Angelina Njeguš, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia
Marina Marjanović-Jakovljević, Faculty of Technical Science, Singidunum University, Belgrade, Serbia
Gholamreza Anbarjafari, iCV Research Group, Institute of Technology, University of Tartu, Tartu, Estonia

Performance optimization in vocal emotion recognition has been a challenging task for many researchers. In this paper, we apply three different classifiers for automatic vocal recognition such as: Naïve Bayes, Support Vector Machine and Multilayer Perceptron. In order to show the influence of feature selection on the performance and computational complexity of the classification algorithms, different hybrid feature selection strategies are applied. With this approach, from 84 extracted state-of-the-art voice quality features, we come up with only 19 features resulting in better recognition rate performance. We use Serbian corpora as a case-study of this analysis.

VII1.4
ONE SOLUTION FOR MOBILE PHONE SCREEN UNLOCKING BY VOICE

Ivan Jokić, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia
Stevan Jokić, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia
Vlado Delić, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia
Zoran Perić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia

This paper gives one possible application of automatic speaker recognition in form of automatic speaker verification for mobile phone screen unlocking. Application has two working modes: training and listening. In the training mode mobile phone user forms one or more reference models. In the listening mode application is in active state, periodically records speech from the mobile phone microphone, estimates models for each recording and determines distinction between models estimated using speech recording from microphone and reference models. One of the main parameters for application of this type is allowed difference between reference model and current model formed in the listening phase. This allowed difference is a threshold value for which value application unlock mobile phone screen. Described application allows forming multiple reference models. On that way application has information about speaker speech in different acoustical environments and enable small threshold during speaker verification.

VII1.5
CLASSIFICATION PROBLEMS AND EVALUATION OF CLASSIFICATION MODELS

Jasmina Novaković, Belgrade Business School, Belgrade, Serbia

Alimpije Veljović, Techical Faculty Čačak, University of Kragujevac, Čačak, Serbia
Lidija Paunović, Techical Faculty Čačak, University of Kragujevac, Čačak, Serbia
Duško Tešanović, High Railway School, Belgrade, Serbia

In this paper we explore evaluation of classification models that are used in classification problems. Different theoretical and practical research in machine learning studied which classification model used in a specific situation. Assessment discovered knowledge is one of the essential components in the process of intelligent data analysis. Depending on the method of observing, there are different measures for evaluation the performance of the model. We discussed selection of the most appropriate measures depends on the characteristics of the problem and ways of its implementation.

VII1.6
SINGLE HOUSEHOLD ELECTRICITY POWER CONSUMPTION PREDICTION BASED ON KNN REGRESSION

Naser Farag Abed, Singidunum University, Belgrade, Serbia
Milan Milosavljević, Faculty of Electrical Engineering, Belgrade University and also Faculty of Technical Science, Singidunum University, Belgrade, Serbia

This work analyzes an electricity power consumption forecast for a single home using KNN regression. The performance of the predictor was evaluated using real data which represents power consumption per minute measured over almost 4 years for a single home near Paris, France (approximately 2 million data points). Experiments show that proposed system for predicting electricity power consumption one day ahead gave mean absolute value of relative percentage error (MARPE) lower more than 41% comparing to ordinary persistent prediction, without significant computational cost.

VI2. Algorithms and applications
Chair: Saša Adamović, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia
Tuesday, June 14, 10.00 h, Room 4

VII2.1
MATHEMATICAL MODEL AND SIMULATION OF JAK-STAT SIGNALING PATHWAY

Nataša Kablar, Lola Institute, Belgrade, Serbia

In this paper we give main biological mechanism of JAK STAT signaling pathway. We give set of biochemical reactions and mathematical model of JAK STAT signaling pathway. We look for the control elements and recognize SOCS1, SHP 2, and phosphatases PNP and PNX to be the main control elements. For the chosen parameter data from the literature we run simulations, and we give qualitative conclusions.

VII2.2
VIRTUALIZATION OF WORKSPACE AND ITS APPLICATION IN EDUCATION

Dušan Marković, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia
Marko Šarac, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia
Saša Adamović, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia
Dušan Stamenković, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia
Nikola Savanović, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia

From its beginning, virtualization of the physical space provided a way to present interactive content. Over time, the virtualization technology has advanced and its implementation in other areas began. The prospect of using virtualization technologies allows educational institutions to provide their students with a way to take a virtual walk through their halls and rooms from home or any other location with access to the Internet. When the student tours through the virtualized hallways, he or she can enter a virtual computer laboratory. There, the student can select any one of the computers that is currently available. This action creates a connection to the virtual machine with an operating system and application software installed. Via an integrated remote control and viewing interface, the student can use these applications to work on projects and to practice. These kinds of virtual systems allow for collecting processes information and students' behaviors and interests. Collected information can be analyzed and used for predicting behavior of students in physical spaces.

VII2.3
COMPUTER NETWORK SECURITY ON PHYSICAL LAYER

Nikola Savanović, Singidunum University, Belgrade, Serbia
Marko Šarac, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia
Dušan Marković, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia
Dalibor Radovanović, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia
Aleksandar Jevremović, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia

For development of modern information systems and computer networks, it is important to have safe data transfer. In previous years the protection of data was mostly secured on higher layer - Application layer. In this paper the authors will discuss about computer network security at the lowest layer - at the physical layer (PHY) where the signals and binary arrays are sent to the physical medium. In wireless networks authors will analyze the vulnerability of the communication link, and the points at which it is possible to perform secure communication. Authors will discuss about attack with random instructions and intercepting binary code at

physical medium. The aim of this paper is to show the potential improving of computer networks, as well as whether is possible to protect a communication link.

VII2.4
CONTINUOUS AUTHENTICATION OF WEB ACCOUNTS VIA BEHAVIORAL BIOMETRICS

Milomir Tatović, Singidunum University, Belgrade, Serbia
Saša Adamović, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia
Milan Milosavljević, Faculty of Electrical Engineering, Belgrade University and also Faculty of Technical Science, Singidunum University, Belgrade, Serbia
Vladisalav Miškovic, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia

This paper discusses the possibilities of behavioral biometrics in content authentication of web accounts. Starting from the well-known assumption that human movement could not be reproduced, by collecting data through the human-computer interface (mouse, keyboard or touch screen), we can reliably identify users. In this way, we have used unique user characteristics, "who you are", making it easier for today's needs for more web accounts. The advantage of this solution in comparison to other present solutions is its simple implementation and the fact that it does not require any additional software, it already works on all types of browsers.

VII2.5
POSSIBILITY OF DEVELOPMENT BIOMETRIC DIGITAL SIGNATURE

Saša Adamović, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia
Milan Milosavljević, Faculty of Electrical Engineering, Belgrade University and also Faculty of Technical Science, Singidunum University, Belgrade, Serbia
Mladen Veinović, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia
Marko Šarac, Faculty for Informatics and Computing, Singidunum University, Belgrade, Serbia
Milomir Tatović, Singidunum University, Belgrade, Serbia

In this paper, we analysis possibility of development biometric digital signature based on iris biometrics. Fuzzy commitment scheme's for the generation of cryptographic keys based on iris biometrics in the field of biometric cryptography are based on the development of a new class of PKI system's. Starting from the theoretical-information frame biometric information sources, security of the private key cannot be violated in accordance with the principles and processes that are required. In this way, there would be a strong link between an individual and private key, in order to ensure the security of business information systems.

VII2.6
COMPARISON OF METHODS FOR THE BACKGROUND EEG ASSESSMENT IN ASPHYXIATED INFANTS

Vladimir Matic[1,2,3], Perumpillichira J Cherian[4], Ninah Koolen[2,3], Gunnar Naulaers[5], Paul Govaert[6], Sabine Van Huffel[2,3] and Maarten De Vos[7]
[1]Faculty of Technical Science, Singidunum University, Belgrade, Serbia
[2]KU Leuven, Department of Electrical Engineering, STADIUS Centre for Dynamical Systems, Signal Processing and Data Analytics, Leuven, Belgium
[3] iMinds Medical IT Department, Leuven, Belgium
[4] Section of Clinical Neurophysiology, Department of Neurology, Erasmus MC, University Medical Center, Rotterdam, The Netherlands
[5] Neonatal Intensive Care Unit, University Hospital Gasthuisberg, Leuven, Belgium.
[6] Section of Neonatology, Department of Pediatrics, Erasmus MC-Sophia Children's Hospital, University Medical Center, Rotterdam, The Netherlands
[7] Institute of Biomedical Engineering, Department of Engineering, University of Oxford, Oxford, UK

Perinatal asphyxia represents a lack of oxygen and/or blood supply into the infants' brain during the delivery. In the Neonatal Intensive Care Units (NICUs), there is a need for a prompt assessment of the neonatal brain functioning. In this work, we propose a set of novel features to assist in an automated EEG classification of the degree of hypoxic brain injury. Subsequently, we propose how this set of features can be structured as a tensor and demonstrate high classification accuracy using higher order linear discriminative analysis (HODA).

Quick Reference Timetable

		MONA Congress Centre				TOLEDO Congress Centre		
		1	2	3	4			1
	10,30-11,00	TPC Meeting						
	11,00-13,00	NMI1+NM1	EKI1+EK1	API1	ELI1		RTI1	
	13,00-15,00	NTI1+NT1	EKI2+EK2	AP1	ELI2		RTI2	
Monday	15,00-16,30							
June 13	16,30-18,30	TEI1	EKI3+EK3	MTI1	EL1		RTI3	
	18,30-20,00					Opening		
	20,00-21,00					Cocktail		
	21,00-							Dean meeting
	08,00-10,00	AKI1	TEI2+TE2	MTI2	VII1		EEI1+EE1	
	10,00-11,30					Plenary x2		
	11,30-13,30					Round Table 1		
	13,30-14,30							
Tuesday	14,30-16,30	AK1	TEI Tutorial	MT1	VII2+VI1		RT1	
June 14	16,30-18,30	AK2	TE1	MTTS Assembly	MOI1+MO1		RT2	
	18,30-20,00					Assembly		
	20,30h-							Conference dinner
	08,00-10,00	ML1	AUI1+RT	MEI1	MOI2+MO2		RT3	
Wednesday	10,00-12,00	ML2	AUI2	MEI2		Round table2		
June 15	12.00-13,30					Plenary x2		
	13,30-14,30							
	14,30-19,30							Excursion
	08,00-10,00	MLI1	AUI3	MEI3+ME1	ROI1		RT4	
Thursday	10,00-12,00	MLI2	AUI4		ROI2		RT5	
June 16	12,00-14,00	ML3	AU1		RO1			
	14,00					Conference closing		