Electronics
Telecommunication
Computers
Automations
Nuclear Technique

Proceedings of Abstracts and Program

1st International Conference on Electrical, Electronic and Computing Engineering

IcETRAN 2014

Vrnjačka Banja, Serbia
June 2-5, 2014

Belgrade, June 2014

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

Organizers

ETRAN Society

Faculty of Electronics, University of Niš

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

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1. Rajko Tomović, honorary president of ETAN/ETRAN

Zadar, June 12,. 1978.

12 members

Beograd, 1999.

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Belgrade, May 15, 2006.

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Zlatibor, June 4, 2013.

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ETRAN

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General Information

Time and Venue

IcETRAN 2014 conference is held in Zvezda hotel, Vrnjačka Banja, Serbia from Monday, June 2 to Thursday, June 5, 2014.

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: 150 €
IEEE members: 120 €

Students of undergraduate studies (up to 35 years of age), master students (up to 27 years) and PhD students (up to 30 years) pay 50% of the normal registration fee (75 €). Proofs must be given for their status in order to enjoy discounted fee. The 50% discount is valid for a maximum of one paper per participant.

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, 2014.

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 2, 2014 in 9:00 h in the lobby of the Zvezda hotel, Vrnjačka Banja.

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

Conference Opening
Monday, June 2, 18:30
Room 1

a. Welcome address
b. Introductory speeches by ETRAN Society chair Bratislav Milovanović and ETRAN Soceity program chair Zoran Jakšić
c. Opening of 58th ETRAN Conference
d. Opening of IcETRAN 2014 conference

Welcome Cocktail
Monday, June 2, 19:30

After the conference opening the participants and guests are invited to WELCOME COCKTAIL.

Annual General Assembly of ETRAN Society
(in Serbian)
Tuesday, June 3, 18:00
Room 1

Round table: R&D projects in Serbia and their implementation
(in Serbian)
Tuesday, June 3, 10:30
Room 1

Forum: Mihajlo Pupin – 160 years
(in Serbian)
Tuesday, June 3, 14:00
Room 4

The forum will be dedicated to less-known details about the famous Serbian scientist and engineer Mihajlo Pupin – his patents that are built into the foundations of modern telecommunications, his influence to the establishment and development of the largest science institution in the first half of XX Century.

Tenth Annual Workshop nanoETRAN
(in English)
(within the section for Microelectronic and Optoelectronics)
Chair: Zoran Jakšić
Monday, June 2, 16:00
Room 5

The nanoETRAN workshop is dedicated to all aspects of nanoscience and nanotechnologz 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.

IEEE Serbia & Montenegro Section Annual Meeting
(in Serbian)
Tuesday, June 3, 16:00
Room 4

Chair: Nataša Nešković, IEEE Serbia & Montenegro Chair

Exhibition: Mihajlo Pupin

Conference Lobby, Throughout the conference

Exhibition: Academic Mind

Conference Lobby, Throughout the conference
An exhibition of science books published by Belgrade-based publisher Academic Mind will be held

Annoncing Best Paper Award recepients for 2014, Best Young Researcher Award recepients for 2014 and conference closing

Thursday, June 5, 13:30
Room 1

IcETRAN Sections

120 regular papers have been accepted for presentation at the IcETRAN 2014 International Conference within 24 sessions of 15 sections:

AKI	Acoustics (3)
API	Antennas and Propagation (4)
AUI	Automatic Control (16)
EEI	Power Engineering (3)
EKI	Electric Circuits and systems and signal processing (10)
ELI	Electronics (8)
MEI	Biomedicine (5)
MLI	Metrology (11)
MOI	Microelectronics and Optoelectronics (10)
MTI	Microwave and Submillimeter Technique (9)
NMI	New Materials (0)
NTI	Nuclear Engineering (2)
ROI	Robotics and Flexible Automation (16)
RTI	Computers (4)
TEI	Telecommunications (8)
VII	Artificial Intelligence (12)

Additionally, 17 keynote lectures are to be given at the IcETRAN conference.

Besides that, 152 regular papers have been accepted for 58th national conference ETRAN, to be presented within 28 sessions of 15 sections. A total of 274 regular papers and 16 keynote lectures will be presented at the both conferences of ETRAN Society.

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. As a rule, a contributed paper has an available time slot of 15 minutes (12 minutes talk + 3 minutes discussion). The available time for keynote presentations is 30 mintes.

Session Chairs

Keynote Sessions

KS1	**Branko Kolundžija**
KS2	**Zoran Prijić**
KS3	**Aleksandra Smiljanić**
KS4	**Ivan Milentijević**
KS5	**Dejan Popović**
KS6	**Aleksandar Rodić**
KS7	**Zoran Petrović**

Contributed Sessions

AKI1	**Dragana Šumarac Pavlović**
API1	**Branko Kolunžija**
AUI1	**Milorad Božić**
AUI2	**Branko Kovačević**
EEI1	**Dejan Reljić**
EKI1	**Vlastimir Pavlović**
EKI1	**Irini Reljin**
ELI1	**Tom Kazmierski, Miroslav Lazić**
MEI1	**Dejan Popović**
MLI1	**Platon Sovilj**
MLI2	**Dragan Denić**
MLI3	**Ivan Župunski**
MOI1	**Zoran Prijić**
MOI2	**Zoran Jakšić**
MOI3	**Ljubiša Tomić**
MTI1	**Bratislav Milovanović, Nebojša Dončov**
MTI1	**Vera Marković, Olivera Pronić-Rančić**
NTI1	**Selena Grujić**
ROI1	**Huosheng Hu**
ROI2	**Stevo Bozinovski**
ROI3	**Aleksandar Rodić**
RTI1	**Claudio Moraga, Ivan Milentijević**
TEI1	**Igor Radušinović**
VII1	**Aleksandar Perović**
VII2	**Aleksandar Jevremović**

Time schedule of IcETRAN and ETRAN conferences

	Time	Room 1	Room 2	Room 3	Room 4	Room 5
2. 6. 2014.	9:00	Registration – ETRAN desk, hotel "Zvezda" reception desk, Vrnjačka banja				
	10:00	**Keynotes: M. Krstic, L. Gavrilovska, M. Taguchi**				
	12:00	Joint Meeting of Steering Committee and Program Committee of ETRAN Society				
	12:30	Lunch break				
	14:00	RT-1	**AUI-1**	**MLI-1**+ML1	**API-1**	**Keynote: A. Nikiforov** **MOI-1**+MO-1
	16:00	RT-2	**AUI-2**	**MLI-2**+ML2	AP-1	**nanoETRAN** (**MOI-2**+MO-2)
	18:15	**Conference opening (ETRAN/IcETRAN)** • Welcome address • Introductory speeches (Bratislav Milovanović/Zoran Jakšić) • ETRAN/**IcETRAN** opening **Presenting awards for 2013:** • "Nikola Tesla" • "Aleksandar Marinčić" • Best ETRAN Paper Award • Best Young Researcher Paper Award				
	19:30	**Welcome cocktail**				
3. 6. 2014.	8:30	RT-3	AU-1	ML3	**MTI-1**	**MOI-3**+MO3
	10:30	**Round table: R&D projects in Serbia and their implementation**				
	12,30	**Keynote: K. R. Rao**				
	13:00	Lunch break				
	14:00	**Keynotes:** **C. Moraga** **R. Kounchev** **RTI-1**	**NTI-1**+NT1	NM1	**Forum**	**MEI-1** + ME1
	16:00	RT-4	AU-2	**Keynotes:** **J. Milanović** **S. Došen** **O. Fratu** **T. Kazmierski**	IEEE section of Serbia & Montenegro	EL1
	18:00	**Annual assembly of ETRAN Society**				
	20:30	**Conference Dinner**				
4. 6. 2014.	8:30	RT5	EE1	**ROI-1**	**MTI-2**	**ELI-1**
	10:30	RT6	**EEI-1**+EE2	**Keynotes:** **H. Hu** **S. Bozinovski** **K. Kpalma** **S. Avramov-Zamurovic**	• Annual assembly microw. soc. MTTS • Microwave Review presentation • A. Nešić Jubilee	EL2
	12:30	**Keynote: T. Makabe**				
	13:15	Lunch break				
	14:00	Excursion "Monasteries of Serbia": Žiča, Ljubostinja				
5. 6. 2014.	8:30	**TEI-1**	**AKI-1**+AK1	**ROI-2**	MT-1	**VII-1**
	10:30	**TEI-2**+TE1	AK-2	**ROI-3**	**EKI-1**	**VII-2**
	12:00	TE1 (cont'd)	AK-3		**EKI-2**+EK1	VI-1
	13:45	• Announcement of Best Paper Award and Best Young Researcher Award winners • Conference closing				

Underlined: IcETRAN

Keynote Sessions

KS1
June 2, Room 1, 10:00
Chair: Branko Kolundžija, School of Electrical Engineering, University of Belgrade, Serbia

10:00
EXTREMUM SEEKING FOR WIND AND SOLAR ENERGY APPLICATIONS

Miroslav Krstić, University of California San Diego, USA

Invented in 1922, extremum seeking (ES) is one of the oldest feedback methods. However, its purpose is not regulation but optimization. For this reason, applications of ES have often come from energy systems. The first noted publication in the West is Draper and Li's 1951 application to spark timing optimization in internal combustion engines, preceded by considerable popularity of ES in the Russian literature in the 1940s. ES has been applied to gas turbines and even nuclear fusion reactors. Renewable energy applications have brought a new focus on the capabilities of ES algorithms. We present applications of ES in two types of energy conversion systems for renewable energy sources: wind and solar energy. In both areas the goal is maximum power point tracking (MPPT), i.e., the extraction of the maximum feasible energy from the system under uncertainty and in the absence of a priori modeling knowledge. For the wind turbine system we perform MPPT by tuning the set point for the turbine speed using scalar extremum seeking. For the photovoltaic array system, we perform MPPT by tuning the duty cycles of the DC/DC converters employed in the system using multivariable ES. For the photovoltaic system we provide experimental results.

10:30
VISIONS OF A NEW COGNITIVE AND COOPERATIVE COMMUNICATIONS WORLD: THE ACROPOLIS VIEWPOINT

Liljana Gavrilovska, Vladimir Atanasovski, Faculty of Electrical Engineering and Information Technologies Skopje, Macedonia

The wireless communications systems introduce cognitive and cooperative mechanisms to support the advanced coexistence and to maximize the radio resource optimization. The cognition refers to the ability of the wireless networks to autonomously learn and reason upon certain context whereas the cooperation refers to the ability to extract increased performance by exchanging mutually relevant information among network nodes. This keynote speech will address the topics of cognition and cooperation from the ACROPOLIS viewpoint and will summarize and highlight the most relevant aspects, mechanisms and platforms to today and future cognitive systems. ACROPOLIS was a European initiative funded under the FP7 NoE program and gathered the most prominent European academic and research institutions in the corresponding field.

11:00
FUNCTIONAL ANTENNAS COMPOSED OF UNBALANCED FED ULTRA LOW PROFILE INVERTED L ANTENNA

Mitsuo Taguchi, Nagasaki University, Japan

The authors have proposed the unbalanced fed ultra low profile inverted L antenna on the rectangular conducting plane (ULPIL). This antenna is excited on the horizontal element. When the size of conducting plane is 0.245 l (l: wavelength) by 0.49 l and the antenna height is l/30, and the length of horizontal element is around l/4, the input impedance of this antenna is matched to 50 W and its directivity becomes more than 4 dBi. In this antenna, the inverted L element and the conducting plane are strongly coupled and the electromagnetic field concentrates within the inverted L element and the ground plane. By adjusting the antenna structure and adding the parasitic elements, the dual band antenna, the wideband antenna, and the high gain planar antenna have been proposed. The circular polarized antenna composed of ULPIL and L-shaped slot, the MIMO antenna composed of two ULPIL's and the antennas for the wireless power transmission (WPT) system have also been proposed. When the distance between transmitting and receiving antennas in WPT system is 10 mm, the power transfer efficiency of 99.2 % is obtained at the design frequency of 1 GHz. In this talk, these antennas will be presented.

KS2

June 2, Room 5, 14:00
Chair Zoran Prijić, Faculty of Electronic Engineering, University of Niš, Serbia

14:00
RADIATION EFFECTS AND TESTS IN MICROELECTRONICS: STATE-OF-THE-ART AND CHALLENGES

Aleksandr Nikiforov, Specialized Electronic Systems, Russia

Radiation is the inherent part of both natural space and artificial nuclear environments. Radiation induces IC's parameters degradation, logic upsets as well as functional failure. Usually high precious circuits (such as ADC, DAC, sensors and voltage regulators), functionally complex VLSI (such as microprocessors, memories, FPGA), high frequency and microwave devices are among the most radiation sensitive parts. In the keynote lecture it is stated that the wide variety of radiation environments leads to limited number of basic radiation effects in ICs which can be simulated, predicted, assured and characterized in radiation tests on each step of the devices living cycle. Typical radiation hardness levels for main microelectronic processes are discussed. The Russian state-of-art basic approach to microelectronics radiation hardness assurance and tests is introduced which seems to be more flexible, informative and cost effective as compared to other systems. Radiation and simulation installations have minimal signal cable lines specified for microelectronic tests in active mode of operation within -60…+125^{0}C temperature range. Radiation test basic procedure is fully automated and smart. It is also suggested to use obtained unique radiation response of each device as its identification mark similar to fingerprints. Future development trends and plans are discussed.

KS3
June 3, Room 1, 12:30
Chair: Aleksandra Smiljanić, School of Electrical Engineering, University of Belgrade, Serbia

12:30
VIDEO CODING STANDARDS: AVS CHINA, H.264/MPEG-4 PART 10, HEVC, VP6, DIRAC AND VC-1

K. R. Rao, University of Texas at Arlington, USA

In the family of video coding standard HEVC has the promise and potential to replace/supplement all the existing standards (MPEG and H.26x series including H.264/AVC). While the complexity of the HEVC encoder is several times that of the H.264/AVC , the decoder complexity is within the range of the latter. Researchers are exploring about reducing the HEVC encoder complexity. Motion estimation (ME) occupies 77-81% of HEVC encoder implementation. Hence the focus has been in reducing the ME complexity .Several researchers have implemented performance comparison of HEVC with other standards such as H.264/AVC , MPEG-4 Part 2 visual, H.262/PEG-2 Video, H.263, and VP9 and also with image coding standards such as JPEG2000, JPEG-LS, and JPEG-XR. However the payoff is several tests have shown that HEVC provides improved compression efficiency up to 50% bit rate reduction for the same subjective video quality compared to H.264/AVC. Besides addressing all current applications, HEVC is designed and developed to focus on two key issues: increased video resolution - up to 8kx4k – and increased use of parallel processing architecture. Brief description of the HEVC is provided. Multimedia Research Group Inc. predicts consumer devices with HEVC decoding capability to top 2 billion units by 2016 (www.mrg.com).

KS4
June 3, Room 1, 14:00
Chair: Ivan Milentijević, Faculty of Electronic Engineering, University of Niš, Serbia

14:00
REVERSIBLE COMPUTING

Claudio Moraga, European Centre for Soft Computing, Germany

Moore's Law, disclosed in 1975, predicted doubling the number of devices per Integrated Circuit, decreasing the size to 1/2, and doubling processor performance, every 18 months. This law was understood as "faster, smaller, better" (and "cheaper") by the semiconductor industry. Moore's Law is approaching the end of its validity, not actually on physical reasons (as it was expected), but on economic reasons. Each new step following Moore's Law is costing more than the previous ones. To avoid "stagnation" in the progress of computing, new technologies and new paradigms must be developed. Reversible Computing is one such paradigm, which comprises computing without information loss, i.e., without deleting -("erasing")- bits of information, and thus it alleviates the power dissipation in form of heat, which characterizes

today our computers. On the other hand, reversible computing is close to quantum computing, since quantum physics constraints quantum state transformations in such a way that all quantum gates and computing circuits must be reversible. Therefore, advances in (theoretical) reversible computing will be able to display all their power, when a quantum technology has been engineered.

14:30
PYRAMIDAL IMAGE REPRESENTATIONS: COMPARISON, EVALUATION AND APPLICATIONS

Roumen Kountchev, Technical University of Sofia, Bulgaria

In this work are presented the basic features of the well-known Laplasian/Gaussian Pyramid, the Wavelet pyramid, and the Inverse Difference Pyramid (IDP), used for still image representation. In the comparison is also included the IDP modification, called Branched Inverse Pyramid. The decompositions are analyzed in the spatial and spectrum domains. They are evaluated in respect of their computational complexity and the ability to be used in various contemporary applications. Here are also considered in detail the principles of the IDP based on linear (DFT, DCT, WHT, KLT, etc.) and non-linear transforms: deterministic, with oriented surfaces, and adaptive, based on pyramidal neural networks. Furthermore, the work introduces the non-recursive and recursive implementations of the IDP. Special attention is paid to the main application areas: the image compression (lossless, visually lossless and lossy), the multi-view and the multispectral images representation, etc. Besides, in this work is evaluated the ability of the pyramidal representations to offer additional facilities for image content protection through multiple resistant and fragile watermarking; for intelligent search-by-content in large image databases (big data management); for efficient compression of sequences of similar images (groups of multispectral images, and in medicine – sequences of CT images). Side achievements of the IDP are the specially developed methods for lossless data coding, histogram matching and adaptive image filtration, aimed at the compression efficiency enhancement.

KS5
June 3, Room 3, 16:00
Chair: Dejan Popović, School of Electrical Engineering, University of Belgrade, Serbia

16:00
FUTURE POWER SYSTEMS – EFFICIENT MANAGEMENT OF UNCERTAINTIES AND BIG DATA

Jovica Milanović, University of Manchester, United Kingdom

The future power systems will be characterised by blurred boundaries between transmission and distribution system, by mix of wide range of electricity generating technologies (conventional hydro, thermal, nuclear and power electronic interfaced stochastic and intermittent renewable generation), responsive and highly flexible, typically power electronics interfaced, demand and storage with significant temporal and spatial uncertainty, proliferation of power electronics (HVDC, FACTS devices and new types of load devices) and significantly higher reliance on the use of measurement data including global (Wide Area Monitoring) signals for system identification, characterization and control and Information and Communication Technology embedded within the power system network and its components. In order to successfully control such system and its parts and to ensure its stability and security the control strategies and modelling and simulation tools for future power networks need to cater for significantly increased uncertainties, both in terms of model uncertainties and operational uncertainties and influx of unprecedented amount of data from different types of local and wide area distributed data acquisition devices and monitors. This presentation identifies sources of uncertainties and big data in future power networks and gives examples of methodologies that can be used to successfully model, analyse and control these complex systems.

16:30
SENSORY FEEDBACK AND CLOSED-LOOP CONTROL IN PROSTHETICS

Strahinja Dosen, Georg-August University, Germany

A prosthesis should serve as a morphological and functional substitute of the missing limb and therefore restore both motor and sensory functions that are lost due to an amputation. Modern day upper limb prostheses are sophisticated mechanical systems with enough flexibility to restore various motor functions. However, the methods for effective and user friendly control of these devices are still missing, and there are yet no commercial prostheses providing any kind of somatosensory feedback to the user. This talk will present our research efforts towards understanding and designing manual and semi-automatic systems with integrated sensory feedback for closed-loop control of prosthetic devices. A framework for rapid prototyping and assessment of the closed-loop human manual control systems will be described, followed by experimental studies investigating the basic as well as applied aspects of sensory feedback in prosthetics. The solutions based on the

classic sensory substitution methods (electrotactile and vibrotactile) but also alternative, novel interfaces for feedback (augmented reality) and control (computer vision) will be presented. The overall aim of this research is to design an intuitively controlled closed-loop prosthesis, increasing the utility in the daily-life applications as well as facilitating the integration into the body scheme of the user.

17:00
SMALL CELLS IN NEW GENERATIONS OF MOBILE ACCESS NETWORKS

Octavian Fratu, Alexandru Vulpe, Razvan Craciunescu, Simona Halunga, University POLITEHNICA of Bucharest, Romania

Due to their low cost and easy deployment, small cells provide a viable and cost-effective way of improving the cellular coverage and capacity both for homes and enterprises, both in metropolitan and rural areas. Together with macro-cells, they form, what are called Heterogeneous Networks or HetNets. However, the successful rollout and operation of small cells are still facing significant technical challenges and issues. The new generations of mobile / cellular networks are trying to adapt the network capabilities to the traffic demands and, consequently, to optimize the network according the users' punctual and specific requirements. The development of small cells to cover these punctual demands and their deployment is seen in the recent years as a solution to cover these specific requirements and to optimize the network functionality. In this paper the need for, challenges and solutions of small cell deployments are analyzed. This analysis is conducted with respect to self-organizing features, interference coordination, energy efficiency and spectrum efficiency. The possibility to extend the small cells working frequency in milimiter waves domain is also investigated.

17:30
ENERGY EFFICIENT MANY-CORE PROCESSOR ARCHITECTURES

Tom Kazmierski, University of Southampton, United Kingdom

The traditional approach to boosting efficiency of microprocessors through architectural specialization and increasingly complex full custom design has led to ever increasing design and verification costs, increasing lead times, and increasing energy consumption. These issues have now become critical as they hinder further developments in the overall full-custom design approach to high-performance processing. A fundamentally different approach is needed, for example, to utilize clusters of small embedded processors that can successfully address the cost and energy issues. Approaches based on using many-core embedded processors promise substantial gains in energy efficiency by eliminating the complexity of a high-speed microprocessor and facilitating substantial reductions in wasted opcodes, wasted bandwidth, and wasted energy. Moreover, parallelization of time-demanding tasks can allow slower clock speeds which, coupled with reductions in the supply voltage to the near-threshold and sub-threshold levels, can lead to further energy savings. The many-core approach opens new possibilities of hardware-software trade-offs and tuning as it establishes a link between the application programmer and hardware design engineer. Such a link enables efficient simultaneous software optimization and semi-specialized processor hardware design. Powerful FPGA platforms, which appeared in recent years, make such software-hardware co-tuning fast and cost effective since the design is verified and tested before a full-custom many-core implementation is attempted. This keynote will give examples of very recent developments in energy-efficient multi-core processor design which demonstrate that the processor architecture development has taken a radically new direction. It will also address the trade-offs between energy consumption and performance and will give examples of different leading-edge many-core platforms optimised for energy consumption.

KS6
June 4, Room 3, 10:30
Chair: Aleksandar Rodić, Mihajlo Pupin Institute, University of Belgrade, Serbia

10:30
ADVANCED HUMAN-MACHINE INTERACTION IN ROBOTICS

Huosheng Hu, University of Essex, United Kingdom

Since recent advancement of computing and robotics technologies, intelligent robots are soon ready to serve us in our homes, hospitals, offices and everywhere. To be used by general public who has no special training, these robots should be able to speak, recognise facial expression, understand spoken and gesture instructions, navigate autonomously in human-centred environments, and therefore play an important role in our daily life. This seminar briefly overviews the recent development in advanced human-machine interaction, in particular focused on the various modalities of information exchanging between humans and robots. Several human-machine interaction mechanisms are discussed respectively, and many experimental implementation results are demonstrated via video.

11:00
KINESIS OF PHYSICAL OBJECTS CONTROLLED BY SIGNALS EMANATING FROM A HUMAN BRAIN: AN ENGINEERING AND COMPUTER SCIENCE APPROACH, SINCE 1988

Stevo Bozinovski, South Carolina State University, USA and Faculty of Information Science and Computer Engineering, Skopje, Macedonia

The lecture presents an overview and methodology on controlling movement of physical objects using signals emanating from a human brain. Until 1988 it was viewed in realm of science fiction, under the term of psychokinesis. In 1988 the first series of experiments were conducted showing how a physical object, a mobile robot, can be controlled by EEG signals emanating from a human brain. Before that, in 1973, a challenge was stated of controlling objects, virtual or physical, using biosignals, examples being EEG, EOG, and CNV, among others. The first movement of a virtual object, a graphical object on a computer screen, was carried out in 1977. In 1988 three results were achieved: the mentioned control of a physical object using EEG alpha rhythm, writing sequences of letter on a computer screen using P300 evoked potential, and controlling a buzzer using CNV anticipatory potential. In 1989 control of a physical object, a robot, was achieved using EOG signals. In 20th century, the mentioned 1988 result was the only one on controlling physical objects by a human brain; it was done with noninvasive recording of EEG signals, outside the brain, on the human scalp. Eleven years later, in 1999, a rat brain was used for showing movement of a physical object using invasive, inside the brain, recording of electrical signals. In 21st century, the field named as brain-robot interface, brain-computer interface, and brain-machine interface is a hot topic in engineering and computer science. This lecture will give some details on the mentioned pioneering results, as well as on current directions in the field.

11:30
RECENT TRENDS IN SATELLITE IMAGE PANSHARPENING TECHNIQUES

Kidiyo Kpalma, Institut National des Sciences Appliquées de Rennes, France

Nowadays, there are several satellites bearing sensors to provide images from different spectral bands at the same time, but with various resolutions and at different frequencies. In practice, there is an image captured over a wide spectral band which is known as panchromatic (PAN) image. Besides this image there are at least three multispectral (MS) images captured over narrower spectral bands including the visible red (R), green (G) and blue (B) bands. Commonly, multispectral images have lower spatial resolution than that of panchromatic image. Though, today's sensors can produce multispectral images with higher spatial resolution than before, it is still desirable to enhance their resolution in order to approach that of the PAN image. The process of generating high resolution color images from MS and PAN images is known as pan-sharpening. This process fuses the low-resolution MS images with the higher-resolution PAN image so that the resulting images corresponding to MS images are of the same resolution as the PAN image. This helps to obtain color images with higher spatial resolution for better visualization of remote sensing color images. This paper presents a review of pan-sharpening methods and then analyzes the trends of the algorithms. Through this review, we will analyze the impact of pan-sharpening on remote sensing images processing, and particularly, we will observe the income of pan-sharpening in vegetation detection. Based on our previous work, a strategy is implemented to evaluate the performance of pan-sharpened images.

12:00
MEASURING LASER BEAM PROPAGATION IN MARITIME ENVIRONMENT

Svetlana Avramov-Zamurovic, United States Naval Academy, USA

Laser light propagation in maritime environment is of importance to free space communications. Mitigating optical turbulence and scattering continue to be challenging issues from both theoretical and implementation aspects. The goal of the research is to minimize the laser light intensity variations at the reception. We approach laser beam propagation in complex random media using partially coherent beams. Those beams have prescribed spatial coherence statistics to best contest the atmosphere along the path. We create novel class of beams and measure their scintillation in various scenarios in the field. The talk will cover theoretical background that defines the several types of beams, including Multi Gaussian Schell model beams that create flat top profile and Bessel-Gaussian model beams that make ring shape. Methods used to produce partially coherent beams and to measure their performance in maritime environment will be discussed in detail. The results that demonstrate significant reduction in variations of laser light intensity will be presented and future research directions will be provided.

KS7
June 4, Room 1, 12:30
Chair: Zoran Petrović, Institute of Physics, University of Belgrade, Serbia

12:30
ATMOSPHERIC PRESSURE MICROPLASMA, ITS BASIS AND APPLICATION TO DEVICE FABRICATIONS

Toshiaki Makabe, Keio University, Japan

During these last three decades, low temperature collisional plasmas at low pressure have become the main technological tool for the fabrication of large-scale-integrated-circuits, based on a high efficiency over a large area of Si and SiO2. In particular plasma etching has been extended to both smaller and larger sizes of the pattern. For the MEMS fabrication, one of the issues of the low pressure dry processing is the process efficiency and the cost. Under these circumstances, a microplasma at atmospheric pressure is expected to be an inexpensive tool. In this talk low pressure plasma etching will be first reviewed, and the overview of the low temperature, atmospheric pressure plasma will be discussed. In particular, at atmospheric pressure, attention to a local gas heating and a transition from a low temperature plasma to high temperature discharge will be also discussed by using a predictive modeling.

Contributed Papers

ACOUSTICS – AKI

AKI1 Audio signals, Electroacoustics, Psychological acoustics
Chair: Dragana Šumarac Pavlović, School of Electrical Engineering, Belgrade, Serbia
Thursday, June 5, Room 2, 8:30

AKI1.1
THE LPCC-DTW ANALYSIS FOR WHISPERED SPEECH RECOGNITION

Branko R. Marković, Technical College, Computing and Information Technology Department, Čačak, Serbia
Đorđe T. Grozdić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia

In this paper we explained the results of recognition for whisper and normal speech using the LPCC analysis and DTW method. The isolated words used for this experiment are from the Whi-Spe database. Two subsets of this database which contains words of colours and words of numbers are taken in consideration. The speakers are 5 males and 5 females. The vectors for comparison are based on LPCC, delta and delta-delta coefficients. For a local constraint Type I is applied at DTW method without constraints on the global path. The results are presented in the form of tables and a diagram.

AKI1.2
AUDIO SIGNAL DE-NOISING USING WAVELETS ALGORITHM IN MATLAB AND LABVIEW

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

This paper describes usage of wavelet algorithms in process of de-noising of audio signals. Usage of wavelets nowadays is widespread and wavelet algorithms are very interesting for solving some engineering problems, such as noise cancellation in audio and image signals. Applications which are using the Fourier transform algorithms can be formulated using wavelets to provide more accurately localized temporal and frequency information. Matlab and LabVIEW program packages are very useful in these areas, first of all for analysis these signals, and later for some further processing such as de-noising. Both packages have built-in functions that can be easily used for solving these problems.

AKI1.3
ANALYSIS OF DIRECT SOUND AND FIRST REFLECTIONS USING SPHERICAL MICROPHONE ARRAY

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

Room impulse response represents a main characteristic for analysis of rooms as acoustic systems. However, it provides very limited information about spatial properties of the sound field, when measurements are performed with a single measurement microphone. Recently developed spherical microphone arrays have been used for analyzing the spatial properties of sound field. When such a device is applied for a room impulse response measurement, it is able to provide additional (spatial) information. This paper presents an investigation of direct sound and first reflections of the impulse responses using 20 sample points spherical microphone array. Here, floor reflection is considered, but also 90 and 180 degrees reflections from a wooden panel in an anechoic chamber. These results are compared with the impulse responses measured by the recently built 32 sample points spherical microphone array in a non-anechoic environment.

ANTENNAS AND PROPAGATION – API

API1. Antennas and Propagation
Chair: Branko Kolunžija, School of Electrical Engineering, Belgrade, Serbia
Monday, June 2, Room 4, 14:00

API1.1
CONVERGENCE OF THE HIGHER ORDER TIME-DOMAIN FINITE ELEMENT METHOD IN MODELING OF 1-D ELECTROMAGNETIC PROBLEMS

S. V. Savić, University of Belgrade, School of Electrical Engineering, Belgrade, Serbia
M. M. Ilić, University of Belgrade, School of Electrical Engineering, Belgrade, Serbia and Colorado State University, Department of Electrical and Computer Engineering, Fort Collins, USA

We investigate the convergence of a higher order and large-domain finite element method (FEM) in direct electromagnetic modeling of 1-D electromagnetic problem in the time domain (TD). In the process, we vary the parameters of the time-domain discretizations within the numerical models and the number of time-stepping samples in the time marching schemes. The numerical results are verified by comparison with analytical solutions and by accurate frequency-domain FEM solutions, providing valuable insight into accuracy and convergence properties of the higher order TDFEM for different time marching schemes.

API1.2
EDDY CURRENT POWER LOSS IN THE SHIELD OF AN *N*-CONDUCTOR TRANSMISSION LINE

Dragan Filipović, Faculty of Electrical Engineering, University of Montenegro, Bul. Dzordza Vasingtona bb, 81000 Podgorica, Montenegro
Tatijana Dlabač, Maritime Faculty, University of Montenegro, Dobrota 36, 85330 Kotor, Montenegro

In this paper a simple formula for the eddy current power loss in the shield of an *N*-conductor transimission line is derived under the assumption that the shield and the conductors are thin. The general theory is illustrated by a particular case of a shielded symmetrical three-phase line.

API1.3
CIRCULARLY POLARIZED PRINTED ANTENNA WITH TUNABLE ELEVATION ANGLE

Ivana Radnović, IMTEL Communications a.d, Bulevar Mihajla Pupina 165b, 11070 Belgrade, Serbia
Aleksandar Nešić, IMTEL Komunikacije a.d, Bulevar Mihajla Pupina 165b, 11070 Belgrade, Serbia
Dušan Nešić, ICTM-CMT, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia

The paper presents the antenna structure with circular polarization and possibility of tuning the elevation angle i.e. obtaining maximum radiation at angles declined from the broadside direction, which is particularly interesting in communications between mobile objects and satellites. The antenna consists of two printed crossed dipoles, feed line and a mechanism for adjusting the height of the antenna in regard to vehicle roof. Simulation and optimizations have been carried out using program package WIPL-D and analysis of obtained results proves the validity of presented concept. Simulated gain is between 4.3 dBi and 7.3 dBi, depending on the antenna position; axial ratio (AR) is less than 3 dB in the operational range of frequencies (2%); reflection coefficient S11 is less than -19 dB. Antenna is designed for INMARSAT frequency range.

API1.4
COMPARATIVE PERFORMANCE ANALYSIS OF NLMS AND VSS LMS ALGORITHM FOR PLANAR ANTENNA

Luka Lazović, Student, Faculty of Electrical Engineering, University of Montenegro, Podgorica, Montenegro
Ana Jovanović, Faculty of Electrical Engineering, University of Montenegro, Podgorica, Montenegro
Vesna Rubežić, Faculty of Electrical Engineering, University of Montenegro, Podgorica, Montenegro

This paper presents a comparative performance study of NLMS (Normalized Least Mean Square Algorithm) and VSS LMS (Variable Step Size LMS) adaptive algorithm. A smart antenna system with innovative signal processing can enhance the resolution of a beamformer. Super resolution algorithms take advantage of array antenna structures to better process the incoming signals and they also have the ability to identify multiple interferer signals and attenuate them. Adaptive beamforming is achieved using the LMS algorithm and its variation for directing the main beam towards the desired source signals and generating deep nulls in the directions of interfering signals. We studied the effect of antenna array parameters in terms of its size and element spacing. In simulations we study the influence of angle of arrival on algorithm behavior and MSE (Mean Square Error).

AUTOMATIC CONTROL – AUI

AUI1. Systems parameter and state estimation
Chair: Milorad Božić, University of Banja Luka
Monday, June 2, Room 2, 14:00

AUI1.1
ROBUST ADAPTIVE PARAMETER ESTIMATION OF THE THERMAL POWER PLANT COMBUSTION PROCESS

Aleksandra Marjanović, School of Electrical Engineering, University of Belgrade, Serbia
Sanja Vujnović, School of Electrical Engineering, University of Belgrade, Serbia
Veljko Papić, School of Electrical Engineering, University of Belgrade, Serbia
Predrag Todorov, School of Electrical Engineering, University of Belgrade, Serbia

Optimization of the combustion process control, as one highly complex system, represents a great challenge for the engineering scientific community. Proper regulation of the overall combustion process can significantly increase safety and energy efficiency, while decreasing the pollution in the system. In order to propose an adequate control algorithm, it is necessary to conduct a proper analysis and to obtain a reliable model of the system. The paper describes modeling of a firing system using the measurements obtained from the temperature visualization system, which is installed in the 350MW boiler of the Nikola Tesla Power Plant, in Obrenovac, Serbia. We propose an application of a robust adaptive parameter estimation method, based on a variable forgetting factor onto such a system and provide evaluation of this identification procedure.

AUI1.2
A NEW ADAPTIVE ROBUSTIFIED PREDICTION ALGORITHM WITH UNKNOWN NOISE STATISTICS

Dunja Đurović, Faculty of Informatics and Computing, Singidunum University, Serbia
Jelena Gavrilović, Faculty of Technical Sciences, Singidunum University, Serbia
Ivana Kostić Kovačević, Faculty of Informatics and Computing, Singidunum University, Serbia
Branko Kovačević, School of Electrical Engineering, University of Belgrade, Serbia

A new robust adaptive predictor for situations where noise statistics are not fully known is presented in the paper. First an optimized predictor is developed, based on the minimization of a generalized mean square prediction error. It determines the structure of the robust adaptive predictor, which is synthesized through minimization of a modified criterion in which a quadratic function is introduced instead of an arbitrary non-linear function of the prediction error. The non-linear function is determined by applying Huber's min-max approach, which assumes a priori knowledge of the distribution class to which the actual unknown noise distribution belongs. The resulting non-linearity is a maximum likelihood criterion function, and is determined by the least favorable probability density function within the given class, which carries minimal information about the estimated parameters. Unknown parameters of the predictor are estimated at each step by applying a recursive algorithm of the stochastic gradient type.

AUI1.3
FEATURE EXTRACTION FOR EMOTION CLASSIFICATION FROM SPEECH SIGNAL

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

Emotional speech recognition is one aspect of behavioral human analysis as a part of Social Signal Processing as a new multidisciplinary area for which there is an increasing interest of scientist. This paper is a review of basic elements of emotion analysis in speech signal which are used in previous researches: which characteristics are most commonly used, which databases are used and in a which way test sequences are prepared and recorded, and which classificators are used and in a which way. Successful emotion recognition is on the level of human recognition which is about 75%, but under special conditions can reach over 90%.

AUI1.4
MULTIVARIATE MEDIANS AND HALFSPACE DEPTH: ALGORITHMS AND IMPLEMENTATION

Milica Bogićević, School of Electrical Engineering, University of Belgrade, Serbia
Milan Merkle, School of Electrical Engineering, University of Belgrade, Serbia

We are considering the notions, properties and algorithms' implementations of data depth which represents the median of higher dimensional data. Our main objective is to present the snapshot of the data depth with respect to half-space depth, also known as location depth or Tukey depth. Although the problem is NP-hard, there are ways to compute nontrivial lower and upper bounds of the depth. Computation of Tukey depth is very demanding and even for low dimension dataset, it requires all one dimensional projections to be considered. This is the reason why implementations of particular algorithms represent a challenge, not only in order to calculate deepest data location, but also in order to visualize initial data set and its calculated results.

AUI1.5
SENSOR FAULT DIAGNOSIS IN NONLINEAR PLANTS: A MARGINALISED PARTICLE FILTER APPROACH

Predrag Tadić, School of Electrical Engineering, University of Belgrade, Serbia
Goran Kvaščev, School of Electrical Engineering, University of Belgrade, Serbia
Željko Đurović, School of Electrical Engineering, University of Belgrade, Serbia
Branko Kovačević, School of Electrical Engineering, University of Belgrade, Serbia

We consider the problem of detecting, isolating and reconstructing sensor faults in plants described by general, nonlinear, non-Gaussian state space models. The faults are modelled as additive time-varying terms in the measurement equation. The model is augmented by including the faults in the state vector. Particle filtering is then employed to simultaneously estimate both the original states and the faults in real time. We take advantage of the partial conditional linearity of the augmented model through Rao-Blackwellisation, thus significantly reducing the otherwise high computational cost. Computer simulations on the benchmark three tank process testify to the effectiveness of the proposed algorithm.

AUI1.6
A NEW APPROACH TO ADAPTIVE NON-STATIONARY SIGNALS PARAMETER IDENTIFICATION

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

Modeling of non-stationary signals can be achieved through autoregressive models using adaptive recursive least squares technique with variable forgetting factor. In this paper, a new method for adaptation of the forgetting factor based on absolute finite differences is presented. The method has good tracking ability of the non-stationary parts of the signal, and satisfactory low bias and variance in stationary ones. The validation of the approach is presented with simulations.

AUI1.7
MOVING HORIZON STATE ESTIMATION: MULTI-STEP CONSENSUS SCHEME

Vukašin B. Ćirović, School of Electrical Engineering, University of Belgrade, Serbia
Srđan S. Stanković, School of Electrical Engineering, University of Belgrade, Serbia

Moving horizon state estimation (MHE) is becoming an important tool for state estimation. Recent papers focus on distributed state estimation over sensor networks. In this case the system state could be estimated by two or more sensors, thus, a consensus algorithm may be used to define a common state estimate. In this paper, a review on the basics of MHE algorithms is presented. Attention is focused on distributed moving horizon estimation and current problems. An improvement of the existing MHE algorithm for distributed systems based on a multi-step consensus scheme is proposed and the obtained results are discussed. Finally, open problems are listed with the aim to prepare a basis for future research.

AUI1.8
BLIND MACRO CALIBRATION FOR SENSOR NETWORKS IN STOCHASTIC ENVIRONMENT

Miloš Stanković, Innovation Center, School of Electrical Engineering, University of Belgrade, Serbia
Srđan Stanković, School of Electrical Engineering, University of Belgrade, Serbia
Karl Henrik Johansson, ACCESS Linnaeus Center, School of Electrical Engineering, KTH Royal Institute of Technology, Stockholm, Sweden

In this paper a novel distributed algorithm forblind macro-calibration in sensor networks based on outputsynchronization is proposed. The algorithm is formulated asa set of gradient-type recursions for estimating parametersof sensor calibration functions. It is proved, on the basis ofan originally developed methodology for treating higher-orderconsensus schemes, that the algorithm achieves asymptoticagreement for sensor gains and offsets in the mean square senseand with probability one in the case of additive measurementnoise, either using the a priori knowledge of noise covariance ora modification of the original algorithm based on instrumentalvariables. Special attention is paid to the situation when a subsetof sensors remain with fixed characteristics. An illustrativesimulation example is provided.

AUI2. Control of complex systems
Chair: Branko Kovačević, University of Belgrade, Serbia
Monday, June 2, Room 2, 16:00

AUI2.1
FLEXIBLE CASCADE CONTROL FOR TRAJECTORY TRACKING OF A QUADROTOR

Ivan Petruševski, School of Electrical Engineering, University of Belgrade, Serbia
Aleksandar Rakić, School of Electrical Engineering, University of Belgrade, Serbia

This paper presents a cascade control approach for trajectory tracking of a four rotor helicopter called Quadrotor. Inner attitude control is proposed in the form of separate PD controllers, while the backstepping approach is utilized to obtain appropriate outer trajectory tracking control. Dynamic quadrotor model is presented and used in the design of control algorithm. Various simulations were performed implying the proposed control strategy can be implemented as control algorithm of fully autonomous quadrotor.

AUI2.2
AN APPROXIMATE INTERNAL MODEL-BASED NEURAL CONTROL FOR NONMINIMUM PHASE SYSTEMS

Jasmin Igić, mtel a.d., Banja Luka, Bosnia and Herzegovina
Milorad Božić, Faculty of Electrical Engineering, University of Banja Luka, Bosnia and Herzegovina

An Approximate Internal Model-based Neural Control (AIMNC), using Multi Layer Perceptron (MLP) neural networks is proposed for nonminimum phase systems. In the proposed control strategy only one neural network, which is the neural model of the plant, should be trained off-line. An inverse neural controller can be directly obtained from the neural model. Simulations demonstrate the satisfactory performance of the proposed AIMNC strategy and confirms that the system provides zero steady-state error in case of the constant reference and constant disturbances.

AUI2.3
ITERATIVE LEARNING FEEBACK CONTROL FOR SINGULAR FRACTIONAL ORDER SYSTEM- PDA TYPE

Mihailo Lazarević, Faculty of Mechanical Engineering, University of Belgrade, Serbia
Panagiotis Tzekis, Electronic Engineering Department, School of Technological Applications, A.T.E.I Thessaloniki, Greece

In this paper an closed-loop PDalpha type iterative learning control (ILC) of fractional order singular system. Particularly, we discuss fractional order linear singular systems in state space form. Sufficient conditions for the convergence of a proposed PDalpha type of learning control algorithm for a class of fractional order singular system are given in time domain. Finally, a simulation example shows the feasibility and effectiveness of the approach.

AUI2.4
IMPLEMENTATION OF ACTIVE DISTURBANCE REJECTION CONTROL ON FPGA

Momir Stanković, Military Academy, University of Defence, Belgrade, Serbia
Stojadin Manojlović, Military Academy, University of Defence, Belgrade, Serbia
Slobodan Simić, Military Academy, University of Defence, Belgrade, Serbia
Zoran Jovanović, Faculty of Electronic Engineering, University of Niš, Serbia

Implementation of Active Disturbance Rejection Control (ADRC) on Field Programmable Gate Array (FPGA) was presented in this paper. Discrete ADRC for speed servo system with predictive and current extended state observer (ESO) was derived and compared by simulation. A hardware design of ADRC using high-level blocks and system-level hardware design tools, actually Xilinx's System Generator™ is presented. The experimental results largely agree with simulation and maintain good system's performance regardless different working conditions with external disturbance.

AUI2.5
OPTIMAL CONTROL OF SINGULAR SYSTEMS: CONTINUOUS TIME CASE

Nataša A. Kablar, Faculty of Computer Science and Lola Institute, Belgrade, Serbia
Vladimir Kvrgić, Lola Institute, Belgrade, Serbia
Dragutin Debeljković, Faculty of Mechanical Engineering, University of Belgrade, Serbia

In this paper for the class of singular dynamical systems we present optimal control results. We develop unified framework for feedback optimal and inverse optimal control involving a nonlinear-nonquadratic performance functional. It is shown that the cost functional can be evaluated in closedform as long as the cost functional considered is related in a specific way to an underlying Lyapunov function that guarantees asymptotic stability of the nonlinear closed-loop singular system. Furthermore, the Lyapunov function is shown to be a solution of a steady-state, Hamilton-Jacobi-Bellman equation.

AUI2.6
OPTIMAL CONTROL OF SINGULAR SYSTEMS: DISCRETE TIME CASE

Nataša A. Kablar, Faculty of Computer Science and Lola Institute, Belgrade, Serbia
Vladimir Kvrgić, Lola Institute, Belgrade, Serbia
Dragutin Debeljković, Faculty of Mechanical Engineering, University of Belgrade, Serbia

In this paper for the class of discrete time singular dynamical systems we present optimal control results. We develop unified framework for feedback optimal and inverse optimal control involving a nonlinear-nonquadratic performance functional. It is shown that the cost functional can be evaluated in closed-form as long as the cost functional considered is related in a specific way to an underlying Lyapunov function that guarantees asymptotic stability of the nonlinear closedloop discrete time singular system. Furthermore, the Lyapunov function is shown to be a solution of a steady-state, Hamilton-Jacobi-Bellman equation.

AUI2.7
PERMANENT MAGNET DC MOTOR ADDITIVE FAULTS DETECTION AND ISOLATION

Sanja Antić, Faculty of Technical Sciences Čačak, University of Kragujevac, Serbia
Željko Đurović, School of Electrical Engineering, University of Belgrade, Serbia

This paper presents methods for detection and isolation of four selected additive faults of DC (direct current) motor. The motor model is nonlinear due to temperature-dependent coefficient of viscous friction. Nevertheless, it is shown that linearized set of residuals provides adequate detection and fault isolation. Residuals were designed using two fundamental residual enhancement approaches: structural residuals and directional residuals. It has been shown that the structural residuals can be efficiency designed for all of the four faults using alternative interpretations with series of eliminations. On the other hand, the number of faults for which independent directional responses can be design is limited to the number of system outputs that is two. So in order to detect and isolate all of the four faults it is necessary to design directional residuals in two steps: firstly with assigned independent response directions for the first two faults, secondly with assigned independent response directions for the last two faults. Experiments have been performed on a PM DC motor with Compact RIO 9074 real-time processor and its NI C Series I/O modules.

AUI2.8
A MISSILE GUIDANCE METHOD BASED ON A SLIDING MODE CONTROLLER

Ali AmerAl_Rawi, School of Electrical Engineering, University of Belgrade
Stevica Graovac, School of Electrical Engineering, University of Belgrade
Badlisha Ahmad, AbidYahya, School of Electrical Engineering, University of Belgrade

In this paper, a modified guidance and control sliding mode controller (MGCSMC) method is proposed in a guided missile system. The modified sliding mode controller (MSMC) algorithm is adopted to enable the missile to reach the desired target within a short period of time. The target always makes high manoeuvres when the missile is close it. This issue has been treatment in Guidance and control (G&C) by using a MSMC instead of the traditional method such proportional navigation method (PN).Theoretical analysis is conducted to reduce the miss-distance and chattering phenomenon in SMC. Simulation of MGCSMC compared with PN method show an improvement of about 80%, 47% and 20%for the chattering, miss-distance and finite time, respectively. Furthermore, for the high-altitude target, the MGCSMC improves the acceleration and flight angle of the missile by approximately 65%., and achieve100% accuracy, whereas in PN method achieves only 60% accuracy under the same conditions.

POWER ENGINEERING – EEI

Session EEI1. Power Engineering
Chair: Dejan Reljić, Faculty of Technical Sciences, University of Novi Sad, Serbia
Wednesday, June 4, Room 2, 8:30

EEI1.1
ON-LINE AIRGAP ECCENTRICITY FAULT DETECTION IN A THREE-PHASE INDUCTION MOTOR

Dejan Reljić, Faculty of Technical Sciences, University of Novi Sad, Serbia
Josif Tomić, Faculty of Technical Sciences, University of Novi Sad, Serbia
Željko Kanović, Faculty of Technical Sciences, University of Novi Sad, Serbia

In this paper, a method for the on-line detection of the airgap eccentricity fault in a three-phase cage induction motor has been proposed. The method is based on a Motor Current Signature Analysis (MCSA) approach, a technique that is often used for induction machine condition monitoring and fault diagnosis. It is based on the spectral analysis of the stator line current signal and the frequency identification of specific harmonic components, which are created as a result of motor faults. However, in this paper MSCA has been proposed as a tool for the on-line detection of abnormal levels of airgap eccentricity. The most commonly used method for current signal spectral analysis is based on the Fast Fourier transform (FFT). However, due to the complexity and memory demands, the FFT algorithm is not always suitable for real-time systems. Instead of the whole spectrum analysis, this paper suggests only the spectral analysis on the expected airgap fault frequencies employing the Goertzel's algorithm. The proposed MCSA method with the Goertzel's algorithm allows continuous the real-time monitoring of airgap eccentricity in a three-phase cage induction motor under the steady-state condition. In this way airgap eccentricity can be detected at an early stage, before serious failures occur, and costly secondary deterioration can be avoided. The proposed technique has been conducted on both the line-connected and the inverter-fed three-phase four-pole cage induction motor operated under various load torques. An experimental low-cost data acquisition card, which runs under LabView software, has been used to validate the algorithm.

EEI1.2
DYNAMIC MODEL OF SURFACE MOUNTED PERMANENT MAGNET SYNCHRONOUS MACHINE

Gojko Joksimović, Faculty of Electrical Engineering in Podgorica, University of Montenegro, Montenegro
Thomas M. Wolbank, Institut für Energiesysteme und Elektrische Antriebe, Technische Universität Wien, Austria
Goran Stojčić, Institut für Energiesysteme und Elektrische Antriebe, Technische Universität Wien, Austria
Ana Zogović, Faculty of Electrical Engineering in Podgorica, University of Montenegro, Montenegro

In this paper, an approach to modeling of surface mounted permanent magnet synchronous machine using winding function approach is given. The specific machine with radial magnetized NdFeB permanent magnets is modeled. Slotting effect from stator side and core saturation is neglected. Complete set of equations that describes the machine is derived in detail. Manner of self and mutual inductance between stator phase windings is presented, too. Manner of calculation of magnetic flux linkages of stator phase windings due to the rotating permanent magnets from rotor side as well as electromagnetic torque calculation is also presented. The model was verified in a manner that some transient regimes of the machine are modeled. The changes in rotor speed, developed electromagnetic torque, stator currents as well as back emf in stator phase windings are in line with expectations for this type of machine.

EEI1.3
HARMONIC POWER FLOW STUDIES FOR RADIAL ELECTRIC DISTRIBUTION SYSTEMS

Hani M. Baniodeh, Electrical & Electronics Department, Faculty of Engineering, University of Sirte, Libia
Abdaslam Eajal, Electrical & Electronics Department, Faculty of Engineering, University of Sirte, Libia
Saad Muftah Zeid, Electrical & Electronics Department, Faculty of Engineering, University of Sirte, Libia

The Power flow studies are the backbone of the power system analysis and design. These studies are normally carried out at the fundamental frequency. However, due to the proliferation of electronic devices in distribution systems, the power flow studies at harmonic frequencies need to be conducted and that's is for several reasons, First, the system real power loss in a harmonic-rich environment consists of two components, the fundamental component, the real power loss obtained at the fundamental frequency, and the harmonic component, the real power loss obtained at the harmonic frequencies. Second, the harmonic distortion level at each bus needs to be determined in order to identify the harmonic sources in the system. Thus, a harmonic power flow algorithm (HPF) for radial distribution systems (RDSs) is developed in this project. The HPF algorithm is based on a well known technique called a backward-forward sweep technique. The backward sweep is employed to calculate the harmonic line section currents, while the forward sweep is utilized to obtain magnitudes and phase angles of the harmonic bus voltages. The HPF algorithm is fast

compared with the conventional power flow programs since there is no need to build up and find the inverse of the bus admittance matrix or the Jacobian matrix which is a time-consuming procedure. The HPF algorithm is tested on a 10-bus radial distribution test system. The results obtained demonstrate the accuracy and efficiency of the proposed HPF technique in carrying out on- and off-line power system studies.

ELECTRIC CIRCUITS AND SYSTEMS AND SIGNAL PROCESSING – EKI

EKI1. Filter Analysis and Design and Advanced Data Processing
Chair: Vlastimir Pavlović, Faculty of Electronic Engineering, University of Niš, Serbia
Thursday, June 5, Room 4, 10:30

EKI1.1
ANALYSIS OF ATYPICAL FILTER STRUCTURES IN MATLAB

Aleksandar Radonjić, Crnogorski Telekom A.D., Podgorica, Montenegro
Jelena D. Ćertić, School of Electrical Engineering, University of Belgrade, Serbia

In this paper, we present a method of analysis of specific/atypical filter structures in commercially available software packages. As an example, we use an approximately linear phase half-band IIR filter and MATLAB FDA Tool. We consider this as a good example because current version of FDA Tool does not support directly design and analysis of proposed structure. We present developed MATLAB script that creates filter objects for the specific filter implementations and test those objects in FDA Tool performing analysis of the quantization effects. We show that FDA Tool can be used for the analysis of the filters even in the case when specific design is not supported directly.

EKI1.2
CHARACTERISTICS OF NOVEL DESIGNED CLASS OF CIC FIR FILTER FUNCTIONS OVER CLASSICAL CIC FILTERS

Vlastimir D. Pavlović, University of Niš, Faculty of Electronic Engineering, Department of Electronics, Niš, Serbia
Dejan N. Milić, and Biljana P. Stošić, University of Niš, Faculty of Electronic Engineering, Department of Telecommunications, Niš, Serbia

Novel class of selective multiplierless Cascaded-Integrator-Comb (CIC) finite impulse response (FIR) filter functions with improved frequency response characteristics is designed by use of CIC sections of different lengths and presented here. The superiority of the novel class of CIC filter functions is verified by comparing their characteristics with those of the classical CIC filters under fair conditions: the same number of cascaded sections and the same group delays.

EKI1.3
QUASIELLIPTIC TRANSFER FUNCTIONS WITH DOUBLE POLES

Maja M. Lutovac, Lola Institute, Belgrade, Serbia
Miroslav D. Lutovac, Singidunum University, Belgrade, Serbia

The largest pole Q factor of the second order transfer functions determines the filter properties. With the larger Q factor we can expect more deviations to component imperfections and more problems with the dynamic range of active filters. There are a large number of methods for reduction of Q factors, but the double critical poles are the most efficient method. In this paper we provide systematic procedure for the design of active filters with double poles that is based on elliptic rational functions. The number of transfer function zeros is maximal with equiripple stop-band attenuation, and with the half of the ripples in the pass-band with respect to the stop-band.

EKI1.4
COMBINED TV FILTERING METHOD AND CS SIGNAL RECONSTRUCTION

Marijana Šćekić,
Radomir Mihajlović,
Andjela Draganić,
Irena Orović,

The procedure that combines Total Variation filtering method and Compressive Sensing signal reconstruction is proposed in this paper. Recently, Compressive Sensing has been intensively studied as a method for signals acquisition. It has been shown that signals can be reconstructed by using just a small set of random samples. However, the signal reconstruction may not be efficient in the presence of noise. Therefore, we considered a combined approach that performs Total Variation filtering prior to Compressive Sensing reconstruction, in order to provide high accuracy of reconstruction results. The procedure is tested on signals that appear in wireless communications. The experiments demonstrate that the Total Variation procedure successfully eliminates the Gaussian noise, while the filtered signal can be successfully recovered using only 30% of signal samples..

EKI1.5
PROGRAMMING OF VICKERY AUCTION USING COMPUTER ALGEBRA SYSTEM

Miroslav D. Lutovac, Singidunum University, Belgrade, Serbia
Aleksandra M. Lutovac, Faculty of Economic, University of Belgrade, Belgrade, Serbia

The market for information and communication networks and mobile services is constantly growing. Technological progress creates new challenges and new operators and service providers, with largely independency of choosing the business models. It is important immediately to

recognize the most efficient business model, which is more based on the one step e-auction process with unknown number of auctioneers. One of the most popular auction models is Vickery auction, in which the highest bidder wins but pays the second-highest bid. This variation over the normal bidding procedure is supposed to encourage bidders to bid the largest amount they are willing to pay, but the payoff can be very low if the bidding prices is too high. In this paper, the efficient programming procedure based on game theory and computer algebra systems is presented.

EKI1.6
AUTOMATIC LICENSE PLATE RECOGNITION USING CROSS CORELATION

Ivan Božić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Ivan Lazić, ICT College, Belgrade, Serbia
Stefan Đinđić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Maksim Đurđevac, Faculty of Mathematics, University of Belgrade, Belgrade, Serbia
Marko Dragoslavić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia

Automatic License Plate Recognition system is a real time embedded system which automatically recognizes the license plate of vehicles. There are many applications ranging from complex security systems to common areas and from parking admission to urban traffic control. Automatic license plate recognition has complex characteristics due to diverse effects such as of light and speed. Proposed method is based on Hough transform, and artificial neural networks.

EKI1.7
COMPARATIVE ANALYSIS OF MULTIFRACTAL PROPERTIES OF H.264 AND MULTIVIEW VIDEO

Amela Zeković, School of Electrical and Computer Engineering of Applied Studies, Belgrade, Serbia
Irini Reljin, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia

In this paper, a comparative analysis of multifractal properties of a H.264 video and a multiview video is presented. Analyses of the different views of the multiview video are performed, as well as analyses of different streaming approaches of the multiview video, and results are compared with those for the H.264 video. Calculation of the multifractal properties is performed by the histogram method. For the analysis, publicly available long frame size traces are used.

EKI2. Systems for data processing
Chair: Irini Reljin, School of Electrical Engineering, University of Belgrade, Serbia
Thursday, June 5, Room 4, 12:00

EKI2.1
AN EXAMPLE OF COMPUTER MODELING OF MATCHED CRYSTAL FILTERS

Milorad Paskaš, Inovation Center, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Marijeta Savković Ilić, Inovation Center, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Ana Gavrovska, Inovation Center, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Milan Milivojević, Inovation Center, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Dubravka Jevtić, Inovation Center, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Dragi Dujković, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Irini Reljin, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia.

In this paper matched filters with crystal units are simulated on computer. The transfer function is further analyzed and the influence of the filter parameters on its transfer function in pass-band is investigated. Simulation of crystal filters enables filter design corrections before the manufacturing process.

EKI2.2
TOWARDS OPTIMAL CLASSIFIER OF SPECTROSCOPY DATA

David D. Pokrajac, The Optical Science Center for Applied Research, Delaware State University, Dover, DE, USA,
Poopalasingam Sivakumar, The Optical Science Center for Applied Research, Delaware State University, Dover, DE, USA,
Yuri Markushin, The Optical Science Center for Applied Research, Delaware State University, Dover, DE, USA,
Daniela Milovic, Electrical Engineering, University of Nis, Nis, Serbia,
Mukti Rana, The Optical Science Center for Applied Research, Delaware State University, Dover, DE, USA
Gary Holness, The Optical Science Center for Applied Research, Delaware State University, Dover, DE, USA
Jinjie Liu, The Optical Science Center for Applied Research, Delaware State University, Dover, DE, USA
Noureddine Melikechi, The Optical Science Center for Applied Research, Delaware State University, Dover, DE, USA

Towards Laser spectroscopy can produce vast amounts of data, anticipating needs for automatization of tasks such as classification and discrimination of spectra. Using the apparatus of statistical theory of detection, we develop the optimal classifier for spectroscopy data for a linear model of an echelle spectrograph system. We validate model assumptions through statistical analysis of “dark signal” and laser-breakdown induced spectra of standardized NIST glass. The experimental results suggest that the quadratic classifier may provide optimal performance if the spectroscopy signal and noise can be considered Gaussian.

EKI2.3

AN EFFICIENT MATLAB IMPLEMENTATION OF OFDM/OQAM MODULATOR

Selena Vukotić, Faculty of Computer Science, Belgrade, Serbia
Desimir Vučić, Faculty of Computer Science, Belgrade, Serbia

In this paper we made a theoretical overview considering OFDM/OQAM signals in continuous and discrete time and presented several implementation schemes, which were obtained by introducing the filterbank theory and polyphase decomposition of a prototype filter. Based on the most efficient scheme, among those presented here, we gave our implementations of OFDM/OQAM modulator in MATLAB. Based on the simulations results, power spectrums for different number of subcarriers and pulse shaping parameters are shown.

ELECTRONICS – ELI

ELI1 Electronics Circuits and Systems
Chairs: Tom Kazmierski, University of Southampton, UK
Miroslav Lazić, Iritel a.d. Belgrade, Serbia
Tuesday, June 3, Room 5, 16:00

ELI1.1
OPTIMIZING USE OF THE ALTERNATIVE ENERGY SOURCES - DC DISTRIBUTION

Invited paper

Miroslav Lazić, Iritel a.d. Belgrade, Serbia
Dragana Petrović, Iritel a.d. Belgrade, Serbia
Zoran Cvejić, Iritel a.d. Belgrade, Serbia
Bojana Jovanović, Iritel a.d. Belgrade, Serbia

Fossil fuels are the basis for electricity production. However, the amount of fossil fuel is limited. In order to reduce the consumption of fossil fuels, different solutions of using alternative energy sources such as solar, wind, water and fuel cells have been realized. Usually, in this solutions, alternative sources are used separately, or as part of a hybrid system linked to the power distribution network. In practice, alternative sources are becoming the elements of distribution system, contributing to the overall production of electricity. That solution is simple, but has a low benefit. Problem with this approach is how to count and rely on the unstable, limited, time variant and unpredictable alternative energy resources. The electricity distribution network with significant alternative energy share will strongly depend of the unmanageable natural environment conditions. Another approach is distributed production, transfer and consumption of the alternative energy sources. Only a certain part of the energy, under contract agreement, could be delivered to the power grid network. The concept proposed here allows more efficient using of alternative energy sources. It opens many new different possibilities. One of them is DC electrical power distribution, what will build completely new foundation for the electrical power system organization. Here we are presenting a set of devices developed and manufactured as a components for the integrated electrical system build, combining alternative and traditional energy sources in parallel working.

ELI1.2
HARDWARE-EFFICIENT DIGITAL SYSTEM SYNTHESIS USING A VARIABLE-ARCHITECTURE APPLICATION-SPECIFIC PROCESSOR

Tom J Kazmierski, Charles Leech and Dominic Murphy, University of Southampton, United Kingdom

A key design challenge in embedded and mobile systems is to reduce energy consumption while delivering high performance. Application-driven specification of a variable-architecture processor is a promising approach that can produce significant energy saving whilst maintain or even increase performance. The paper presents a methodology to create an energy-efficient variable-architecture processor that is tailored to the specific requirements of an application. As an example, an implementation of the JPEG decompression algorithm is demonstrated where the hardware size is reduced four times compared with an equivalent dedicated hardware synthesis approach.

ELI1.3
ENERGY EFFICIENT CMOS DIGITAL MULTIPLAYERS

Branko L. Dokić, Faculty of Electrical Engineering, University of Banja Luka, Bosnia and Herzegovina
Velibor Škobić, Faculty of Electrical Engineering, University of Banja Luka, Bosnia and Herzegovina
Aleksandar Pajkanović, Faculty of Technical Sciences, University of Novi Sad, Serbia

In this paper the characteristics of CMOS digital array multipliers in three operating regimes (weak, strong and mixed inversion) are given. Two topologies characterized by series transmission – dual and symmetric transistor networks – are used. It is shown that the mixed CMOS regime is the optimum choice in the context of low consumption and high speed. The characteristics compared are obtained using PSPICE 16.3 and the parameters of a 180 nm technology.

ELI1.4
HIGH ACCURANCY SELF-CONFIGURABLE DLL BY FREQUENCY RANGE

Vazgen Melikyan, Synopsys Armenia Educational Department, Yerevan, Armenia
Arthur Sahakyan, Synopsys Armenia Educational Department, Yerevan, Armenia
Mikayel Piloyan, Synopsys Armenia Educational Department, Yerevan, Armenia
Armen Sahakyan, State Engineering University of Armenia, Yerevan, Armenia
Borisav Jovanović, Faculty of Electronic Engineering, University of Niš, Serbia

An architecture of Self-configurable Delay-Locked Loop (SCDLL) by frequency range presented in this paper. The proposed architecture produces different phases of clock signal for the different frequencies in the output of DLL over PVT, which is needed to avoid clock skew and setup/hold time margins violations between the different synchronized blocks inputs. The presented architecture is self-configurable depended on input clock signal frequencies and operates by the negative feedback system. DLL is widely used in such circuits where is the actual issue to get clock signals with different phases. For example in special input/output circuits of several

standards such as Universal Serial Bus (USB), Double Data Rate (DDR) and etc.

ELI1.5
NEW BLOOD LEVEL DETECTION SYSTEM IN BLOOD SEPARATING MACHINE

Miloš Petković, Faculty of Electronic Engineering, University of Niš, Serbia
Miroslav Božić, Faculty of Electronic Engineering, University of Niš, Serbia
Dragiša Krstić, 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

Standard version of a blood separators typically use medium-price color sensors for detection of boundary level between red blood cells and plasma, at the last gate – at hose clamps. Discrete number of sensors are related to a number of significant levels to be detected thus making blood separation potentially faulty and unreliable. Our target was to make flexible, low cost replacement for level detection system that can be easily integrated into the existing product. We came up with an image processing solution that uses USB web-camera, ARM based off-the-shelf board – BeagleBone black and free OpenCV library. Flexibility is held in much higher, selectable number of levels, freely positioned USB camera and brand-free independent processing platform, as well as semi-automatic calibration system. By adding minimum additional electronics, we managed to integrate our solution into existing Blood processing machine. In conclusion, we added new value to the machine at lower cost in production, increasing measurement frequency and resolution needed for improvement of blood separation process. Next step is to try to use two USB cameras on a custom-made board, for simultaneous level detection on two channel blood separator, bringing the system integration to the higher level.

ELI1.6
RACPBERY PI AS INTERNET OF THINGS HARDWARE: PERFORMANCES AND CONSTRAINTS

Mirjana Maksimović, Faculty of Electrical Engineering, University of East Sarajevo, Bosnia and Herzegovina
Vladimir Vujović, Faculty of Electrical Engineering, University of East Sarajevo, Bosnia and Herzegovina
Nikola Davidović, Faculty of Electrical Engineering, University of East Sarajevo, Bosnia and Herzegovina
Vladimir Milošević, Faculty of Technical Sciences, University of Novi Sad, Serbia
Branko Perišić, Faculty of Technical Sciences, University of Novi Sad, Serbia

The Internet of Things (IoT) ideology can be looked as a highly dynamic and radically distributed networked system composed of a very large number of identifiable smart objects. These objects are able to communicate and to interact among themselves, with end-users or other entities in the network. Entering the era of Internet of Things, the use of small, cheap and flexible computer hardware that allow end-user programming become present. One of them, considered in this paper, is the Raspberry Pi, fully customizable and programmable small computer board. Comparative analysis of its key elements and performances with some of current existing IoT prototype platforms have shown that despite few disadvantages, the Raspberry Pi remains an inexpensive computer with its very successfully usage in diverse range of research applications in IoT vision

ELI1.7
ON THE METHOD DEVELOPMENT FOR ELECTRICITY LOAD FORECASTING

Jelena Milojković, Innovation centre of advanced technologies, Niš, Serbia
Vančo Litovski, Faculty of Electronic Engineering, University of Niš, Serbia

The way of development a method for systematic prediction of electricity load at suburban level is described. Steps that were passed are described and the evolution of the method is illustrated by proper examples. Prediction of electricity load at annual, monthly, daily and hourly level as well as peak consumption is considered. Comparisons with some other's results are given, too.

ELI1.8
EXPERIENCE IN USING OPEN COMMAND ENVIRONMENT FOR ANALYSIS IN EDUCATION

Dejan Mirković, Faculty of Electronic Engineering, University of Niš, Serbia
Predrag Petković, Faculty of Electronic Engineering, University of Niš, Serbia

This paper sublimates experiences in using Open Command Environment for Analysis (OCEAN) for teaching IC design at University of Niš. IC design requires a lot of repetitive analysis needed to get better insight into possibilities of a new or unknown process. Since design automation implies usage of appropriate software environment, one such environment known as OCEAN will be considered. Basic guidelines and techniques for exploiting it will be given. Concrete example will demonstrate usefulness of the platform.

BIOMEDICINE – MEI

MEI.1 Biomedicine
Chair: Dejan Popović, School of Electrical Engineering, University of Belgrade, Serbia
Tuesday, June 3, Room 5, 14:00

MEI1.1
ASSESMENT OF VIGILANCE BASED ON EEG SIGNALS FOR PREDICTION OF THE SPEAKER/LISTENER INTERACTION

Milena Okošanović (Student) mBrainTrain d.o.o., Faculty of Electrical Engineering, University of Belgrade, Serbia
Ivan Gligorijević, mBrainTrain d.o.o., Faculty of Engineering, University of Kragujevac, Serbia

The objective of the present work in progress is to set up a novel approach for on-line tracking of psychophysiological markers for detection of slips in attention and vigilance decrement in an educational environment. We present here the recordings and processing method that allows the estimation of the level of vigilance from the cortical signals measured at the scull and when using the Smarting® device (24 channels digital amplifier with wireless communication with a Windows/Android platform). Wireless electroencephalographic measurements (EEG) were used for the assessment of subject's concentration during a lecture and estimation of the optimum duration of the lecture. The optimum is defined as the longest time during which the vigilance decrement raises over the predefined threshold. The state when the vigilance drops below the specific level can be considered as the state of drowsiness. This method allows also the training of the teacher since the feedback from the listener can be brought to the teacher on-line.

MEI1.2
HEURISTIC SYNTHESIS OF JOINT ANGLES BASED ON DATA FROM INERTIAL SENSORS DURING GAIT

Marija Petrović (Student), University of Belgrade, School of Electrical Engineering, Serbia
Dejan Popović, University of Belgrade, School of Electrical Engineering, Serbia

The gait performance is of interest for the diagnostics and the assessment of the efficacy of a therapy in rehabilitation. The availability, prices, accuracy, reproducibility and ease of calibration of body worn inertial sensors make the excellent candidates for the clinical assessment of the gait performance. The output data from inertial sensors needs to be processed in order to generate joint angles and other data in a form suitable for clinicians. We suggest the application of principal component analysis (PCA) for the recognition of gait modality, and a heuristic fitting of predefined joint angle patterns between the automatically recognized gait events. The heuristic fitting aims to generate the angle joint data that is matching the data recorded with joint angle sensors. We tested this method for normal and artificially made abnormal gait (walking on toes, walking on heels, etc.) in healthy subjects. The application of this method and instrumentation is envisoned in the rehabilitation of humans with impaired gait after stroke, surgery, or other disease affecting bipedal progression.

MEI1.3
BIOFEEDBACK: SOFTWARE FOR PROCESSING OF MULTIPLE ELECTROPHYSIOLOGICAL SIGNALS

Ilija Jovanov (Student), University of Belgrade, School of Electrical Engineering, Serbia
Dejan Popović, University of Belgrade, School of Electrical Engineering, Serbia

Biofeedback is the process of gaining greater awareness of a physiological function with the aim of improving the performance. This improvement is due to cortical plasticity; thus, biofeedback could be considered as a "training of the brain". We show here the software that was developed for the Smarting® device, developed by the Serbian company "mBrainTrain". Smarting is a light body-worn 24-channel recording interface of small signals (>1 μV) and Bluetooth transmission of digital outputs to Windows/Android platform. Communication, processing, and control, are handled by software developed in C++, while LabVIEW software is used for graphical representation of signals to the user (biofeedback). This system can be used for assessing muscle activity by surface electrodes (sEMG), brain activity with the appropriate electrode sets (EEG, evoked potentials), or other information coming from the body worn sensors (e.g., ECG, arousal - GSR, EOG). The use is primarily envisioned in the domain of neurorehabilitation of humans with brain injury or disease.

MEI1.4
EEG SIGNAL PROCESSING AND CLASSIFICATION USING ANN

Damir J. Đozić (Student), University of Novi Sad, Faculty of Technical Sciences, Serbia
Goran Krajoski (Student), University of Novi Sad, Faculty of Technical Sciences, Serbia
Nikola Popov (Student), University of Novi Sad, Faculty of Technical Sciences, Serbia
Darko Stanišić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Slađana Lazarević (Student), University of Novi Sad, Faculty of Technical Sciences, Serbia

There is a wide area of application for good interpretation of Electroencephalogram (EEG) signals, from medicine to computer games. In order to be used for control, EEG signals must be acquired and classified in the right way. This research includes extraction of 15 new features from EEG signals in frequency domain (not yet seen in literature), and classification of signals using those features. Classification is done with Artificial Neural Network method, and the results are found to be promising.

MEI1.5
LABORATORY SYSTEM FOR PHYSIOLOGICAL MEASUREMENTS

Nikola Jorgovanović, University of Novi Sad, Faculty of Technical Sciences, Serbia
Mišo Stanković (Student), University of Novi Sad, Faculty of Technical Sciences, Serbia
Željko Tepić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Vojin Ilić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Dubravka Bojanić, University of Novi Sad, Faculty of Technical Sciences, Serbia

This paper presents the design of a physiological measurements system, which allows recording of electrophysiological signals (electrocardiography ECG, electromyography EMG and electroencephalography EEG). The system also has the ability to monitor the concentration of oxygen in arterial blood using the method of pulse oximetry. Its main purpose is the use for educational purposes, but can also be used as a development system for the devices that are based on some of the applied integrated circuits.

METROLOGY – MLI

MLI1. MEASUREMENT METHODS
Chair: Platon Sovilj, Faculty of Technical Sciences, University of Novi Sad, Serbia
Monday, June 2, Room 3, 14:00

MLI1.1
DENSITY MEASUREMENT USING THE OSCILLATORY TYPE DEVICES

Emil Peić Tukuljac, School of Professional Higher Education, Subotica, Serbia
Zoran Mitrović, University of Novi Sad, Faculty of Technical Sciences, Serbia
Nemanja Gazivoda, University of Novi Sad, Faculty of Technical Sciences, Serbia
Božidar Vujičić, University of Novi Sad, Faculty of Sciences, Serbia
Jovan Mitrović (Student), University of Novi Sad, Faculty of Technical Sciences, Serbia

Density of fluids may be determined using different measuring devices. Recently, a wide variety of oscillatory devices are used to measure the density. Their application allows sophisticated analysis of fluids in biotechnology, pharmaceutics, saturation processes, concentration or crystallization procedures. Unique design allows temperature compensation and obtaining the correct measurements in various measurement processes. In the paper, the mathematical model and the potential uncertainty in the calibration of the aforementioned devices will be described.

MLI1.2
IDENTIFICATION OF THE MODEL OF FREQUENCY VARIATIONS IN POWER GRID

Željko Beljić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Duško Davidović, University of Novi Sad, Faculty of Technical Sciences, Serbia
Bojan Vujičić, 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 the analysis of the model of frequency variations in Serbia, as well as in the European interconnection. Multiple measurements have shown that the distribution of frequencies in Serbia, to the greatest extent, is normal - Gaussian. It is known that the frequency variations affect the measurement of the power grid parameters, and on example of the mains voltage THD factor measurement the impact of frequency variations to measurement error is shown. Results obtained from a series of simulations are presented in the paper. Those results represent a significant contribution to a better understanding of the power grid behavior, as well as to the further development of measurement methods for measurement of the power grid parameters.

MLI1.3
STOCHASTIC MEASUREMENT IN FOURIER AND WAVELET DOMAIN: A COMPARATIVE STUDY

Aleksandar Radonjić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Platon Sovilj, University of Novi Sad, Faculty of Technical Sciences, Serbia
Vladimir Vujičić, University of Novi Sad, Faculty of Technical Sciences, Serbia

In this paper we compare two strategies for measuring in frequency domain using digital stochastic measurement (DSM) method. One of them, based on Fourier series expansion, was already analyzed in theory and applied in practice. The second strategy, based on Wavelet series expansion, has never been discussed in literature.

MLI1.4
STOCHASTIC MEASUREMENT OF THE SPECTRAL POWER DENSITY OF LOW-FREQUENCY NOISE GENERATED BY GRAPHENE-BASED CHEMICAL AND BIOLOGICAL SENSORS – CASE STUDY

Vladimir Vujičić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Aleksandar Radonjić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Bojan Vujčić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Željko Beljić, University of Novi Sad, Faculty of Technical Sciences, Serbia

This paper proposes a new method for measuring the spectral power density of low-frequency noise generated by graphene-based chemical and sensors. The proposed solution is based on two-bit digital stochastic measurements (DSMs). In addition, we criticize the common measurement method based on application of Fast Fourier Transform (FFT) and digital signal processors (DSPs). It is shown that this method requires large hardware resources and great power supply.

MLI1.5
APROXIMATION OF THE NTC RESISTOR CURVE BY NEURAL NETWORK USING MICROCONTROLLERS

Marko Dragoslavić, School of Electrical Engineering, University of Belgrade, Serbia
Ivan Božić, School of Electrical Engineering, University of Belgrade, Serbia
Marija Cvijanović, Faculty of Agriculture, University of Belgrade, Serbia

Marko Cvijanović, School of Electrical Engineering, University of Belgrade, Serbia

The objective of this paper is to demonstrate the approximation of NTC resistor R/T curve using neural networks. Special attention is focused on the efficiency of the approximating algorithm considering that microcontrollers have limited memory and processing ability. Dedicated systems often use battery power to periodically measure temperature and therefore it is important to carry out approximation of the algorithm in the least possible number of beats. We compared the algorithm based on neural network with interpolation of temperature. The paper will show that the algorithm which uses data from previously trained neural network can be more efficient than the conventional method of approximation using temperature polynomial. For the needs of this paper the temperature range between 0^0C and 120^0C was selected, which was tested on three generations of microcontrollers.

MLI2. Measurement instruments and systems
Chair: Dragan Denić, Faculty of Electronics Engineering, University of Niš
Monday, June 2, Room 3, 16:00

MLI2.1
TEMPERATURE AND PRESSURE MEASUREMENT IN VALIDATION PROCEDURE FOR FOOD PRODUCT PASTEURISATION

Emil Peić Tukuljac, School of Professional Higher Education, Subotica, Serbia
Nemanja Gazivoda, University of Novi Sad, Faculty of Technical Sciences, Serbia
Zoran Mitrović, University of Novi Sad, Faculty of Technical Sciences, Serbia
Ivan Župunski, University of Novi Sad, Faculty of Technical Sciences, Serbia
Nemanja Čabrilo, University of Novi Sad, Faculty of Technical Sciences, Serbia

The process of thermal treatment of food products provides long shelf life while preserving the quality without the use of chemical additives. Regardless of whether it is a short-term process under heating for a few seconds, or an ultra high temperature (up to 140 °C) or the heating method which requires a longer thermal treatment, but at lower temperature (88-90 °C) it is important to monitor the critical process parameters. Getting a quality product involves not only thermal treatment of the contents of the packaging, but also all surfaces that have contact with the product.

MLI2.2
MONITORING OF THE SEISMIC ACTIVITY USING HIGH SENSITIVITY MEMS ACCELEROMETER

Djordje Klisić, School of Electrical Engineering, University of Belgrade, Serbia
Ilija Radovanović, School of Electrical Engineering, University of Belgrade, Serbia
Nikola Bežanić, School of Electrical Engineering, University of Belgrade, Serbia
Ljubisav Stamenić, Vinča Institute of Nuclear Sciences, University of Belgrade, Serbia
Ivan Popović, School of Electrical Engineering, University of Belgrade, Serbia

MEMS sensors are widely used type of sensors that can be found in many modern gadgets. Affordable price and small dimensions in combination with high sensitivity and precision made them interesting candidates for the wide range applications in various fields. In case of seismology, application of MEMS accelerometer is still in the shadow of the classical accelerometers with the inertial element, although the characteristics of the today MEMS accelerometers can easily match the classical ones. In this paper group of authors decided to test characteristics of the high sensitivity accelerometer and to determine if it is suitable for the applications in seismology. The requirements that sensor had to meet are high sensitivity and noise level below the threshold of human detectable vibrations which is around four degrees of the Mercalli scale or the ground acceleration between 0.015g and 0.04g.

MLI2.3
IMPLEMENTATION OF INDUSTRIAL NETWORKS AND PROTOCOLS IN THE LabVIEW PROGRAM

Josif Tomić, University of Novi Sad, Faculty of Technical Sciences, Serbia
Miodrag Kušljević, Termoelektro Enel AD, Belgrade, Serbia
Milan Vidaković, University of Novi Sad, Faculty of Technical Sciences, Serbia
Miloš Živanov, University of Novi Sad, Faculty of Technical Sciences, Serbia

Modern industry can no longer be imagined without the application of information technologies and complex network systems. Industrial processes are becoming increasingly complex and require the integration and synchronization of a great number of the most various measurement sensors, PLC devices, microprocessors, actuators, IO devices, motors and other equipment. Networking of this equipment is carried out on several hierarchical levels where the lowest level usually has requirements for operation in real time, while the higher levels are not as time-critical and have lately been relying on Internet protocols. There are several dozens of different industrial networks and protocols currently functioning on the market, and knowledge of them represents a very complex task for engineers that deal with the automation of industrial processes. This paper presents one management solution that uses Modbus protocol that is based on the LabVIEW program. The LabVIEW program significantly simplifies this task as a result of its exceptional flexibility and a large number of pre-written subroutines for a large number of industrial networks and protocols. Furthermore, the LabVIEW program also contains some original solutions that significantly simplify the implementation of complex

SCADA systems, at the same time allowing them to operate in real time.

MLI2.4
STOCHASTIC CONTROL OF PARALLEL CONNECTED DC/DC CONVERTERS

Velibor Pjevalica, JP Srbijagas Novi Sad, Serbia
Nebojša Pjevalica, University of Novi Sad, Faculty of Technical Sciences, Serbia
Vladimir Vujičić, University of Novi Sad, Faculty of Technical Sciences, Serbia

In order to process higher and higher power, DC-DC converters should be operating in parallel. Parallel processing of power means higher efficiency and better reliability. In this paper, stochastic control for parallel DC-DC converters structures is presented.

MLI2.5
THE THEOREM ABOUT THE EXCITATION TRANSFORMER CURRENT MAPPING INTO THE DYNAMIC HYSTERESIS LOOP BRANCH FOR THE SINE WAVE MAGNETIC FLUX IN THE STATIONARY REGIME

Nenad Petrović, Electrotechnical school Stari grad, Belgrade, Serbia
Velibor Pjevalica, JP Srbijagas Novi Sad, Serbia
Vladimir Vujičić, University of Novi Sad, Faculty of Technical Sciences, Serbia

The paper analyses aspects of the approximation theory usage on the certain subsets of the measured samples of the excitation transformer current and the sinusoidal magnetic flux in the single-phase transformer, Epstein frame and toroidal core specimen. In the paper is given the theorem of direct mapping the excitation transformer current in the stationary regime to the dynamic hysteresis loop branch (in further text DHLB). This theorem provides the necessary and satisfactory conditions for above mentioned mapping. The theorem highlights that the excitation transformer current under the sinusoidal magnetic flux has qualitatively equivalent information about magnetic core properties as the DHLB. Furthermore, the theorem establishes direct relationship between the number of the excitation transformer current harmonics and their coefficients with the degree and the coefficients of the DHLB interpolation polynomial for the subsets of the measured samples that represent the Chebyshev nodes of the first and the second kind. These nonequidistant Chebyshev fi-i0 nodes provides the uniform convergence of the interpolation polynomial to the experimentally obtained DHLB with an excellent approximation accuracy and are applicable on the approximation of the static hysteresis loop branches and the DC magnetization curves as well.

MLI2.6
STUDY OF A ROOM TEMPERATURE AND LIGHT DYNAMIC

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Andreea Garliceanu, Telecommunication Department, Faculty of Electronics, Telecommunications and Information Tehnology, Bd. Iuliu Maniu, 1-3, 061071, Bucharest, Romania
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ZigBee wireless technology makes the control network applications and the wireless sensors more practical. The usage of this technology can offer security, light control, access control to your home. Building Automation is a very wide market nowadays. Smart Energy is a big part of Building Automation. Some of the features included in the Smart Energy profile are: basic metering, pricing, support for water and gas, security to allow consumer only, text messaging in case of incidents. In this paper we use a ZigBee based wireless sensor network in order to study the dynamic of light and temperature in a room. The measurement were done in different environment conditions.

MICROELECTRONICS AND OPTOELECTRONICS – MOI

MOI1. Microelectronics and MEMS
Chair: Zoran Prijić, University of Niš, Serbia
Monday, June 2, Room 5, 14:30

MOI1.1
WET ISOTROPIC CHEMICAL ETCHING OF PYREX GLASS WITH Cr/Au MASKING LAYERS

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Milče M. Smiljanić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia
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Milija Sarajlić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia
Dana Vasiljević-Radović, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia

In this paper we developed various techniques of wet isotropic chemical etching of Pyrex glass in an aqueous solution of 49% HF. The techniques are based on the processes of sputtering and photolithography. The various thin films of Cr/Au were sputtered. Layers of Cr/Au and photoresist serve as a masking material during etching of Pyrex glass in aqueous HF.

MOI1.2
IMPLEMENTATION OF IEEE 1451.4 TRANSDUCER ELECTRONIC DATA SHEET (TEDS) USING AN 'MBED' MICROCONTROLLER MODULE: THE CASE OF MEMS PIEZORESISTIVE PRESSURE SENSORS

Branko Vukelić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia
Miloš Frantlović, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia

In this paper we describe an implementation of the IEEE 1451.4 standard, based on the "mbed" hardware and software platform which enables simple and efficient development of microcontroller-based solutions. The Class 2 Mixed Mode Interface (MMI), defined by the standard, was chosen for IHTM silicon piezoresistive MEMS pressure sensors used in intelligent pressure transmitters. A program for the microcontroller is written, enabling communication with the EEPROM memory containing the Transducer Electronic Data Sheet (TEDS), as well as with a personal computer via the USB virtual serial port. A user application is also created for communication with the "mbed" module, enabling user-friendly management of the TEDS contents.

MOI2. nanoETRAN
Chair: Zoran Jakšić, ICTM, University of Belgrade, Serbia
Monday, June 2, Room 5, 16:00

MOI2.1
PAULI PARAMAGNETISM AND SPIN-VALLEY FILTERING IN GRAPHENE VAN DER WAALS HETEROSTRUCTURES

M. Grujić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia and Department of Physics, University of Antwerp, Antwerp, Belgium
M. Ž. Tadić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
F. M. Peeters, Department of Physics, University of Antwerp, Antwerp, Belgium

The most recent trend in 2D materials research is reflected in the idea of stacking different material layers on top of each other, forming the so called van der Waals heterostructures, in order to custom tailor the device properties according to specific needs. In the light of this paradigm shift, and for the particular case of graphene, tantalizing new experiments reveal that carrier mass and spin-orbit interaction, properties that are vanishing in intrinsic graphene, can be artificially engineered. The interplay of the two parameters is especially interesting given that they open topologically distinct gaps. Given that the additional valley degree of freedom arises in graphene due to its honeycomb structure, the aforementioned interplay will also result in a spin and valley dependent gap in bulk graphene. Here we show that this will influence the transmission through a 1D barrier made of this two parameters in the presence of a magnetic field significantly. Specifically, the two parameters induce Pauli paramagnetic moments which manifest in the transmission of the electron through the

barrier. We find that these magnetic moments couple with spin-orbit interaction and with mass through spin and valley degrees of freedom, which is reflected in the Landau level spectrum. Additionally, we show that only opposite spins from opposite valleys can be transmitted given a proper set of parameters. On the basis of these findings we demonstrate that in the presence of a strain-induced pseudomagnetic field, and due to the finite mass and spin-orbit interaction, a spin-valley filtering device can be obtained. We also show that the filtering behavior is controllable by electrical gating as well as by strain.

MOI2.2
CONDUCTION-BAND NONPARABOLICITY AND GAIN CALCULATIONS FOR THz QUANTUM CASCADE LASER IN STRONG MAGNETIC FIELD

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Aleksandar Daničić, Vinca Institute of Nuclear Sciences, University of Belgrade, 11001 Belgrade, Serbia
Jelena Radovanović, School of Electrical Engineering, University of Belgrade, 73 Bulevar kralja Aleksandra, 11020 Belgrade, Serbia
Vitomir Milanović, School of Electrical Engineering, University of Belgrade, 73 Bulevar kralja Aleksandra, 11020 Belgrade, Serbia

Simulation results for the optical gain and scattering rates of relevant transitions in the THz quantum cascade laser (QCL) structures subjected to strong magnetic field are presented. Starting from a comprehensive nonparabolic model of III-V semiconductor conduction-band we first obtain bound states energies of a QCL without the presence of magnetic field. A strong magnetic field applied along the growth direction of the structure provides discretization of the energy spectrum into Landau levels (LLs). Once familiar with the electronic structure, we are able to evaluate longitudinal optical (LO) phonon and interface roughness (IR) scattering rates and use them as input data for the system of rate equations. After we calculate the population inversion from this system, we can estimate the optical gain at desired wavelength.

MOI2.3
TAILORABLE PLASMONIC RESPONSE OF FREESTANDING METAL-COMPOSITE NANOMEMBRANES WITH 2D ARRAYS OF SUBWAVELENGTH CIRCULAR APERTURES

Zoran Jakšić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia
Jovan Matović, Department for Energetics, Electronics and Telecommunications, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia
Alois Lugstein, Institut für Festkörperelektronik, Technische Universität Wien, Floragasse 7, 1040 Wien, Österreich
Marko Obradov, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia

We report *ab initio* electromagnetic modeling and nanofabrication of 7 nm thick metal-containing freestanding nanomembranes with square lattice of circular apertures (single fishnet structure) 100 nm in diameter, intended for plasmonic applications. We used finite element modeling to determine the scattering parameters of our nanomembranes for different plasmonic materials (silver, chromium). The nanomembrane samples were fabricated using radiofrequent sputtering of chromium to single crystalline silicon wafer, while bulk micromachining in KOH was used to etch away silicon support (sacrificial structure). The nanoaperture arrays (square lattice with a 300 nm lattice constant) were fabricated directly in the freestanding metal-composite nanomembrane using the focused ion beam technique. Large absorption in visible has been observed both theoretically and experimentally that can be contributed to impedance matching between the nanomembrane and free space. The final result is a perfectly symmetrical platform for long range surface plasmon polaritons with a possibility to tailor its response utilizing designer plasmons. The choice of geometrical and material parameters allows for tuning of frequency dispersion and effective parameters of the structure and results in rich spectral behavior in spite of the apparent simplicity of the structure.

MOI2.4
INFRARED PHOTODETECTOR ENHANCEMENT UTILIZING TRANSPARENT CONDUCTIVE OXIDE SUBMICROMETER PARTICLES EMBEDDED IN GRADIENT INDEX ANTIREFLECTION LAYER

Marko Obradov, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia
Zoran Jakšić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia
Dana Vasiljević-Radović, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia

We consider the enhancement of the specific detectivity of semiconductor infrared photodetectors for mid-infrared range utilizing localized surface plasmons resonance (LSPR) of spherical submicrometer plasmonic particles. A plasmonic particle localizes electromagnetic field within the detector active area, but conventional plasmonic materials, like noble metals, have their resonant frequencies in the ultraviolet or visible part of the spectrum. In this work we investigate a redshifting strategy based on simultaneous use of doped spherical submicrometer transparent conductive oxide (TCO) plasmonic particles and an embedding high-permittivity

dielectric that further redshifts the spectral characteristics. In order to avoid large reflection losses at the surface of embedding dielectric, we apply on the top of it an antireflective layer with a linear increase of refractive index. We perform an *ab initio* simulation of the whole system starting from Maxwell equations and utilizing the finite element method. We determine the scattering properties of the system including scattering cross sections and spatial electromagnetic field distribution. We confirm a resonant response of TCO particles in mid-infrared, tailorable by adjusting the surrounding medium permittivity. The use of the antireflective layer is crucial for achieving scattering cross-sections more than 20 times larger than the geometric cross-section.

MOI2.5
SELECTIVITY ISSUES IN AFFINITY-BASED BIOCHEMICAL SENSORS: DETERMINING THE RATIO OF SIMILAR BIOMOLECULES IN BINARY MIXTURES

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Olga Jakšić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia
Zoran Jakšić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia
Katarina Radulović, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia
Miloš Frantlović, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia

We consider selectivity of affinity-based nanosensors utilizing resonance shift due to the presence of adsorbed analyte. Among such devices we analyze mass-based sensors utilizing mechanical resonance in e.g. micro or nanocantilevers and all-optical refractometric sensors utilizing surface plasmon polariton resonance. The sensitivity of such devices can be extremely high, reaching single-molecule level, however their selectivity is limited by the differences in mass in the first case or in refractive index values between different analytes in the second. The typical approach is to use some kind of receptors on the sensor surface with highly specific binding of a targeted analyte. The properties of a given biomolecule, for instance protein, will vary between its different conformations due to different arrangements of their atoms in space. Since the conformation of a molecule is critically important for its function, it is of interest to determine the ratio between different conformational isomeres in a given sample. In general, different conformations of a biomolecule may have different affinity toward binding sites on the surface of an affinity-based nanosensor, as well as different surface-volume ratios. We argue that the analysis of adsorption kinetics ensures sufficient data to discriminate between different conformations in a mixture.

MOI2.6
UNIT-CELL LEVEL SUPERSTRUCTURES FOR THE EXTENSION OF SPECTRAL RANGE OF DOUBLE FISHNET METAMATERIAL PARAMETERS AND FINE TUNING OF THEIR EFFECTIVE OPTICAL PROPERTIES

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Zoran Jakšić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia
Marko Obradov, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia
Olga Jakšić, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia
Ivana Mladenović, Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, 11000 Belgrade, Serbia

We considered a possible generalization of aperture-based metamaterial structures for the optical range like single and double fishnets where a single aperture is a compound object formed by superposition of two or more primitives (rectangles, circles, ellipses). Thus obtained "super unit cell" reflects the properties of all subobjects that comprise it. The newly introduced features may be utilized to fine tune the effective optical parameters of the structure like its scattering parameters and thus the effective permittivity, permeability and refractive index. They can also be used to extend and modify in other ways the spectral characteristics of the structure, thus resulting in enhanced modes of operation. In our investigation we applied finite element modeling and analytical calculation to the case of 2D array of square apertures where an aditional smaller square aperture was placed in each corner of the fundamental aperture. It is our conclusion that the obtained compound super unit cells can find application in different fields like waveguiding and sensing.

MOI3. Optoelectronics
Chair: Ljubiša Tomić, Technical Test Center, Serbia
Tuesday, June 3, Room 5, 8:30

MOI3.1
NUMERICAL ESTIMATION OF THE NOISE EQUIVALENT TEMPERATURE DIFFERENCE OF THE THIRD GENERATION THERMAL IMAGERS

Anis Redjimi, Military Academy, University of Defense, Belgrade, Serbia
Nikola Jovanović, Military Technical Institute, Ratka Resanovića 1, 11000 Belgrade, Serbia
Dragan Knežević, Military Technical Institute, Ratka Resanovića 1, 11000 Belgrade, Serbia
Ljubiša Tomić, Technical Test Center, Vojvode Stepe 445, 11020 Beograd, Serbia

This paper proposes a software tool for numerical estimation of noise equivalent temperature difference (NETD) which allows the user to see and check the effect of each thermal imager parameter. The developed software is based on a mathematical model designed to estimate the NETD for 1st and 2nd generation thermal imagers which is modified to estimate the NETD for 3rd generation thermal imagers. As a demonstration, two models of thermal imagers of the third generation are tested. The obtained results are compared with the declared values given by the producers. Moreover, the developed software tool could be used as an educational tool for examination and demonstration of thermal imager properties.

MOI3.2
NUMERICAL SIMULATION OF THE BLACK BODY RADIATION LAWS

Katarina Savić, Military Technical Institute, Ratka Resanovića 1, 11000 Belgrade, Serbia
Anis Redjimi, Military Academy, University of Defense, Belgrade, Serbia
Nikola Jovanović, Military Technical Institute, Ratka Resanovića 1, 11000 Belgrade, Serbia
Dragan Knežević, Military Technical Institute, Ratka Resanovića 1, 11000 Belgrade, Serbia

This paper proposes a software tool for numerical simulation of black body radiation laws which allows the user to see and check the effect of each parameter that influences the global curve of radiation. It can also be used to calculate each parameter separately knowing the other necessary parameters. The developed software could be used as an educational tool for examination and demonstration of basic principles of thermography and infrared radiation.

MICROWAVE TECHNIQUE, TECHNOLOGIES AND SYSTEMS – MTI

Session MTI1
Chairs: Bratislav Milovanović, University of Niš, Serbia
Vera Marković, University of Niš, Serbia
Tuesday, June 3, Room 4, 8:30

MTI1.1
PRINTED ANTENNA ARRAY WITH TAPERED DIPOLES IMPEDANCES

Marija Milijić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Aleksandar Nešić, IMTEL Komunikacije, Novi Beograd, Serbia
Bratislav Milovanović, Faculty of Electronic Engineering, University of Niš, Niš, Serbia

This paper presents printed antenna array which consists of symmetrical dipoles and symmetrical in-phase feeding line. Dolph-Chebyshev distribution has been used enabling side lobe suppression around 30 dB in E-plane in the range of approximately 10 GHz. Dipoles, operating at a second resonance, have different impedances that are calculated in order to their powers match specified distribution enabling great side lobe suppression. The antenna array and feeding line are placed on the same dielectric substrate. The parallel reflector is at distance λ0/4 from antenna array.

MTI1.2
ANTENNA STRUCTURE ON CYLINDRICAL OBJECT WITH A QUASI-ISOTROPIC RADIATION PATTERN

Aleksandar Nešić, IMTEL Komunikacije, Belgrade, Serbia
Dušan Nešić, ICTM-CMT, University of Belgrade, Belgrade, Serbia

Introduced .innovation is an antenna system on a cylindrical object with a spherical (isotropic) radiation pattern. In that way, radio communication and detection from all directions between cylindrical object and corresponding stations are obtained without any switching. The highest deep deviation from the spherical shape (0 dBi) is around 4 dB.

MTI1.3
WIDEBAND PRINTED ANTENNA FOR K BAND INTEGRATED WITH A LOW NOISE AMPLIFIER

Siniša Jovanović, IMTEL Komunikacije, Belgrade, Serbia
Zoran Živanović, IMTEL Komunikacije, Belgrade, Serbia

This paper features the design, practical realization and measured results of an active receiving antenna developed for field testing of microwave links operating at K frequency range. The proposed solution combines a printed antenna array with a low noise amplifier to obtain a convenient small size, low power-consuming device with an overall gain of more than 43 dBi. Since the required frequency range was more than 10% wide a pentagonal dipole was used instead of a standard patch antenna as the radiating element of a printed antenna array. Also, to enable integration with a low noise amplifier the pentagonal antenna array is for the first time realized on a hydrocarbon ceramic substrate instead of a previously used teflon-fiberglass substrate. Excellent matching in a very wide frequency range is achieved by employing wideband Klopfenstein-type impedance transformers as major building parts of the antenna array feeding network. Finally, a thick antenna cover in addition to robust protective case is used to ensure the sturdiness of the device for everyday usage for field testing. The final measurements of the overall antenna characteristics showed very good results that are in very good accordance with the theoretical predictions.

MTI1.4
EXPERIMENTAL VERIFICATION OF THE INTEGRAL CYLINDRICAL TLM MODEL OF A PROBE-FED MICROSTRIP CIRCULAR ANTENNA

Tijana Dimitrijević, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Jugoslav Joković, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Nebojša Dončov, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Bratislav Milovanović, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Kurt Blau, Technical University of Ilmenau, Ilmenau, Germany

In this paper, an accuracy of the integral cylindrical TLM method has been experimentally verified on an example of a coax-fed circular patch antenna fabricated on the FR4 substrate. Obtained results are also compared with corresponding results reached by the rectangular grid based TLM method as well as with analytical results based on the cavity model.

MTI1.5
UNMITERED BEND STRUCTURE – MODELING AND ANALYSIS BASED ON A COMBINED WAVE DIGITAL/ FULL-WAVE ELECTROMAGNETIC APPROACH

Biljana Stošić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Nebojša Dončov, Faculty of Electronic Engineering, University of Niš, Niš, Serbia

An efficient technique for modeling of microstrip unmitered bend structure is reported in this paper. The described technique uses a full wave electromagnetic approach to generate a transmission line model of bend

discontinuity from its *S*- parameters. The model is then incorporated into an equivalent wave digital network representing the complete microstrip bend structure. Two single right-angled microstrip bend structures, with 90^0 and 45^0 bend discontinuities are considered here in order to validate the presented combined wave digital/EM approach technique.

Session MTI2
Chairs: Vera Marković, University of Niš, Serbia
Vera Marković, University of Niš, Serbia
Wednesday, June 4, Room 4, 8:30

MTI2.1
ANN APPROACH FOR THE ANALYSIS OF THE RESONANT FREQUENCY BEHAVIOR OF RF MEMS CAPACITIVE SWITCHES

Zlatica Marinković, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Tomislav Ćirić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Olivera Pronić-Rančić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Taeyoung Kim, TU München, Lehrstuhl für Hochfrequenztechnik, Arcisstr. München, Germany
Marija Milijić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Vera Marković, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Larissa Vietzorreck, TU München, Lehrstuhl für Hochfrequenztechnik, Arcisstr. München, Germany

RF MEMS switches are widely applied in modern communication systems. For the design of circuits and systems containing these switches it is necessary to have their accurate and reliable models. In this paper it is illustrated how RF MEMS switch models based on artificial neural networks can be used for the analysis of the RF MEMS capacitive switch resonant frequency behavior. The resonance frequency is controlled by changing the switch bridge dimensions, to have a scalable model relating geometry and switch performance parameters turns out to be very useful during the design of a system or circuit containing RF MEMS switches. The change of resonant frequency with the tolerances in the bridge dimension fabrication is studied as well. The proposed approach allows the designers to analyze the switch behavior in a significantly shorter time compared to the same analysis performed with standard electromagnetic full-wave simulators.

MTI2.2
EXTRACTION OF INTRINSIC NOISE PARAMETERS OF MICROWAVE FETS BASED ON ANN

Vladica Đorđević, Innovation centre of advanced technology, Niš, Serbia
Zlatica Marinković, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Olivera Pronić-Rančić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Vera Marković, Faculty of Electronic Engineering, University of Niš, Niš, Serbia

A procedure of extraction of intrinsic noise parameters of microwave FETs based on artificial neural networks is presented in this paper. The reason why the extraction of these parameters is carried out, is to make simplified the entire procedure for determining the noise model parameters. A neural network is trained to predict noise parameters of intrinsic circuit for given equivalent circuit parameters, transistor total noise parameters, frequency and ambient temperature. The detailed validation of the trained artificial neural network was done by comparison of the transistor total noise parameters obtained using extracted noise parameters of intrinsic circuit and measured transistor total noise parameters.

MTI2.3
BEHAVIORAL MODELING OF LOW NOISE AMPLIFIER FOR LTE SYSTEMS BASED ON RECURRENT NEURAL NETWORKS

Jelena Mišić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Vera Marković, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Zlatica Marinković, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Djuradj Budimir, the Wireless Communications Research Group,University of Westminster, London, UK

In this paper, the behavior model of a low-noise amplifier for LTE receiver, based on a recurrent artificial neural network, is presented. The development of the model has been performed in MATLAB software environment. For the modeling purpose, the measured data of the device Mini Circuit ZFL-500 has been employed. The input signal is an LTE signal with 3MHz channel bandwidth and carrier frequency of 1960MHz. The output characteristics obtained by the proposed model agree very well with measured ones.

MTI2.4
ANALYSIS OF LINEARIZATION CIRCUIT IMPACT ON BROADBAND DOHERTY AMPLIFIER PERFORMANCES

Aleksandra Đorić, Innovation centre of advanced technology, 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

The impact of linearization circuit on broadband two-way Doherty amplifier for application in the frequency range 0.95-1.05 GHz is considered in this paper. The carrier and peaking amplifiers in Doherty configuration comprise Freescale's transistor MRF281S LDMOSFET characterized by the maximum output power 4W and the broadband combined matching circuits with lumped elements and transmission lines. The linearization of the

amplifier is carried out by the second- and fourth-order nonlinear signals that are extracted at the output of the peaking cell, adjusted in amplitude and phase and fed at the input and output of the carrier cell in Doherty amplifier. Since the extraction and injection of the signals for linearization are carried out through the band-pass filters, the influence of different types of filters on broadband Doherty amplifier performances is analyzed. Additionally, the effects of linearization are considered for WCDMA digitally modulated signal.

NUCLEAR ENGINEERING – NTI

NTI1 Use of Nuclear Radiation
Chair: Selena Grujić, Faculty of Technical Sciences, Novi Sad, Serbia
Tuesday, June 3, Room 2, 14:00

NTI1.1
QUASI-MINIMAL RESIDUAL METHOD FOR X-RAY SPECTRUM UNFOLDING

Jelena Stanković, Institute for Nuclear Sciences Vinča, Lab for protection against radiation and environmental protection, P.O. Box 522 Vinča, 11001 Belgrade, Serbia
Predrag Marinković, School of Electrical Engineering, University of Belgrade, Bulevar kralja Aleksandra 73, 11020 Belgrade, Serbia

Spectrum unfolding is crucial to characterize primary X-ray spectrum i.e. spectrum before any interactions in spectrometer material. This paper is presenting results obtained when Quasi-minimal Residual Method (QMR) is used for X-ray spectrum unfolding. Pulse amplitude spectrum was first acquired with CdTe spectrometer and after that unfolded. Energy response of CdTe spectrometer was simulated using Monte Carlo program MCNP5. Unfolded spectrum agreed well with reference spectra calculated via semi-empirical method, still results showed that correction due to carrier trapping must be incorporated in Monte Carlo calculation.

NTI1.2
OCCUPATIONAL DOSES IN INTERVENTIONAL CARDIOLOGY

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Jelena Stanković, School of Electrical Engineering, University of Belgrade, 73 Bulevar kralja Aleksandra, 11020 Belgrade, Serbia
Danijela Arandić, School of Electrical Engineering, University of Belgrade, 73 Bulevar kralja Aleksandra, 11020 Belgrade, Serbia
Predrag Božović, School of Electrical Engineering, University of Belgrade, 73 Bulevar kralja Aleksandra, 11020 Belgrade, Serbia
Vojislav Antić, School of Electrical Engineering, University of Belgrade, 73 Bulevar kralja Aleksandra, 11020 Belgrade, Serbia

Occupational doses from interventional procedures are the highest among medical staff using x-rays. The aim of the study was to evaluate the level of the occupational doses in modern international cardiology procedures in Serbia. Effective dose levels were analyzed by means of two methods. One method consisted of measuring ambient doses in terms of H*(10), and the another one of measuring personal dose equivalent, Hp(10). For measuring H*(10) ionization chamber was used. Thermoluminescent dosimeters (TLD) were used for Hp(10) assessment. Method for measuring H*(10) gave higher results than TLD method, but both results showed values that are in accordance with annual dose limits for the occupational exposure. The efficiency of personal protective tools was also assessed. The presented results showed that one third of monitored persons are not wearing TLDs correctly and that additional training of the medical staff should be conducted.

ROBOTICS AND FLEXIBLE AUTOMATION – ROI

ROI1 Design, kinematics, dynamics
Chair: Huosheng Hu, University of Essex, UK
Wednesday, June 4, Room 3, 8:30

ROI-1.1
DEVELOPMENT OF EXPERIMENTAL PLATFORM FOR RESEARCH IN ROBOTS HAVING COMPLIANT JOINTS

Veljko Potkonjak, School of Electrical Engineering, University of Belgrade, Bulevar Kralja Aleksandra 73, 11020 Belgrade, Serbia
Branko Lukić, School of Electrical Engineering, University of Belgrade, Bulevar Kralja Aleksandra 73, 11020 Belgrade, Serbia
Zaviša Gordić, School of Electrical Engineering, University of Belgrade, Bulevar Kralja Aleksandra 73, 11020 Belgrade, Serbia
Predrag Milosavljević, Automatic Control Laboratory, Swiss Federal Institute of Technology Lausanne (EPFL), Lausanne, Switzerland

This paper describes the development and testing of the experimental platform for the control of robots having compliant joints. Testing consists of the three smaller tasks. The tasks were designed to test whether the realized platform meets all the necessary requirements to properly control the robot. Each task represents a segment required for the implementation of robot control software (communication with the hardware, the exchange of data between the HOST PC and the controller, the processing of data in real time). In particular, attention has been paid to the rational use of resources on the controller. We used a FPGA Spartan 3 of the NI cRIO 9074 chassis. We controlled position of 5 DC drives. Reference is given by turning the potentiometer, entered from the keyboard, or loaded from a text file. The problems for each method of assigning references and adopted solutions are presented.

ROI-1.2
COMPLIANT BEHAVIOR OF REDUNDANT ROBOT ARM – EXPERIMENTS WITH NULL-SPACE COMPLIANCE

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Ivan Danilov, Faculty of Mechanical Enginering, Belgrade University, Kraljice Marije 16, 11120 Belgrade, Serbia
Petar B. Petrović, Faculty of Mechanical Enginering, Belgrade University, Kraljice Marije 16, 11120 Belgrade, Serbia

In this paper we present recent research activities related to impedance control of redundant robot arms. Redundancy is widely studied for decades theoretically and very seldom, achieved theoretical results are proved by experiments. Therefore, deep understanding the principles of accurate motor coordination with redundant degrees of freedom still remains a challenging problem. This is particularly true for new research in highly complex robotic systems such as humanoid robots, and especially a new generation of industrial robots, i.e., industrial humanoids, which possesses humanoid properties found in service robotics, but with one very important additional requirement – high precision and accuracy. High precision and accuracy are indispensable property for application of humanoid robots in industrial environment, performing various tasks on manufacturing (mostly assembly) lines. Redundancy resolution is typically based on use of the Jacobian pseudoinverse techniques, with local null-space optimization in order to determine the inverse kinematics transformation. In a number of research studies, kinematic redundancy is resolved at the velocity, acceleration or torque levels in order to achieve desired TCP velocity, acceleration, and force profiles. Achieved theoretical results are proved typically by simulation studies, using simple TCP movements, limited to geometrical primitives only. Moreover, stability of derived algorithms is incompletely studied as well as influence of inevitable modeling errors of the robot dynamics. For that reason we have developed a dedicated platform for experimentation based on 7 d.o.f. SIA 10F Yaskawa robot arm and appropriate sensory system for displacement and force measurement and acquisition. The robot controller YASKAWA FS100 is of newest generation, with very fast servo loops, down to 1 ms for all of controlled degrees of freedom. In addition, a special development environment for Yaskawa FS100 controller, named MotoPlus, is used to create application programs which can be executed as a tasks for the main CPU of the robot controller, with ability to access very basic control functions and variables / data in real-time. API (Application Program Interface) routines which are included in the MotoPlus environment allows access to fast data transmission (via Ethernet or RS232C serial) and control of all robot functionalities. Such open control system enables extensive experimentation with fully controllable redundant robot arm and evaluation of various theoretically developed redundancy resolution schemes / theories, including those one which are focused to the generalized / extended impedance control and redundancy resolution algorithms (modifying / control of the null-space is incorporated) which is robust against modeling errors and unforeseen disturbances arising from contact forces. This paper is particularly focused on our ongoing research activities related to the compliant motion / behavior issues in the robot null-space and some of the aspects related to overall performances of the redundant robot arm when the dynamics of task space and null motions are coupled together.

ROI-1.3
DUAL-ARM ROBOT TRACKING OF THE MOVING TARGET USING THE ALGORITHM OF INVERSE KINEMATICS

Marija Tomić, Robotics Laboratory, Mihailo Pupin Institute, University of Belgrade, Volgina 15, 11000 Belgrade, Serbia and School of Electrical Engineering in Belgrade, Buleva kralja Aleksandra 73, 11000 Belgrade, Serbia
Duško Katić, Robotics Laboratory, Mihailo Pupin Institute, University of Belgrade, Volgina 15, 11000 Belgrade, Serbia

The tendency of scientists to integrate robots into human environments has led to a boom in the development of more sophisticated robotic system inspired by the human skills like dual-arm robotics manipulation. In this paper a conventional algorithm of inverse kinematics (IK algorithm) is proposed for natural imitation of human upper body motion. Using the model of dual arm robot and IK algorithm inverse kinematics, the two tasks are analyzed: following the moving target by predefined trajectory and tracking stochastic moving points. For designing optimization algorithms of monitoring, it is necessary to add some more criteria in inverse kinematics algorithm. Proportional navigation algorithm is chosen as possible solution for monitoring the moving point, which has shown good tracking performance of moving point.

ROI-1.4
D-DECOMPOSITION METHOD FOR STABILIZATION OF INVERTED PENDULUM USING FRACTIONAL ORDER PD CONTROLLER

Petar D. Mandić, Faculty of Mechanical Engineering, University of Belgrade, 16 Kraljice Marije, 11120 Belgrade, Serbia
Mihailo P. Lazarević, Faculty of Mechanical Engineering, University of Belgrade, 16 Kraljice Marije, 11120 Belgrade, Serbia
Tomislav B. Šekara, Faculty of Electrical Engineering, University of Belgrade, 73 Bulevar kralja Aleksandra, 11120 Belgrade, Serbia

This paper deals with stability problem of inverted pendulum controlled by a fractional order PD controller. D-decomposition method for determining stability region in controller parameters space is hereby presented. The D-decomposition problem for linear systems is extended for linear fractional systems and for the case of linear parameters dependence. Knowledge of stability regions enables tuning of the fractional order PD controller.

ROI-1.5
THE CONCEPT OF RECONFIGURABLE ROBOTIC PLATFORM

Ilija Stevanović, Robotics Laboratory, Mihailo Pupin Institute, University of Belgrade, Volgina 15, 11000 Belgrade, Serbia

Improvement in robotics and in movement of robot platforms is a continuing pursuit. Over the past years there is a noticeable progress in development of existing mobile robot platforms designed to move over uneven terrains. Reason for this trend is increased demand for this systems is application in different critical situations such as: (search and rescue of earthquake survivals, firefight situation assessment and search and rescue injured people, situation assessment and decontamination of nuclear power plants after incidents and in different environmental accidents where direct human access is too dangerous or impossible). The robotic platform should be able to move between areas of interest quickly and safely. Wheeled transportation can be characterized by greater speed and efficiency, while (biologically inspired) articulated leg transportation can be characterized by greater flexibility for movement over complex terrain. Wheeled robot platforms can move quickly, but can have difficulty on uneven terrain, while articulated legs or other different types of motion can negotiate the uneven terrain, but can have difficulty with speed. Such wheeled transport can have limited mobility and behavior due to complex environment and lack of adaptability to unpredictable terrain. The solution is a new type of vehicles which inherits both advantages of legged and wheeled vehicles, namely the high adaptive capabilities of legs and the high velocity and payload of the wheels. In order to deal with the rough terrains of planetary surfaces, researchers put most of the efforts in designing new structure of rover body, but give less attention to new types of reconfigurable mechanism for wheels and or easy changeable motion systems that depends of type of terrain that the robotics platform need to move across.

ROI2. Bio-Inspired Systems & Humanoid Robotics
Chair: Stevo Bozinovski, South Carolian State University, USA
Thursday, June 5, Room 3, 8:30

ROI-2.1
SVM REGRESSION-BASED COMPUTED TORQUE CONTROL OF HUMANOID ROBOT REACHING TASK

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Mirko Raković, Faculty of Technical Sciences, University of Novi Sad, 6 Trg Dositeja Obradovića, 21000 Novi Sad, Serbia
Milutin Nikolić, Faculty of Technical Sciences, University of Novi Sad, 6 Trg Dositeja Obradovića, 21000 Novi Sad, Serbia
Branislav Borovac, Faculty of Technical Sciences, University of Novi Sad, 6 Trg Dositeja Obradovića, 21000 Novi Sad, Serbia

This paper presents the application of Support Vec- tor Machine regression (SVR) for realization of the robot arm reaching task. Robot arm with 4 DOFs (Degrees Of Freedom) was used in simulation for solving trajectory tracking problem. Only position of the target point was defined, not the orientation, so the system had one redundant DOF for the considered task. Inverse

kinematics was solved at the velocity level and redundancy was exploited to keep the joints away from their mechani- cal limits. The advantage of the proposed approach over the well- established control techniques like computed torque control and inverse dynamics control lies in the fact that with SVR it is not necessary to know exact dynamic model which is actually never realizable in practice, due to complex friction models, actuator dynamics and unmodeled nonlinearities. In this paper ε-SVR was used to estimate nonlinear dynamic model of the robot arm. Outputs from the SVR are learned driving torques which are used as nonlinear feedforward control in conjunction with PD feedback regulator to achieve positioning task in presence of external disturbance.

ROI-2.2
3D BIPED GAIT REALIZATION USING INVERTED PENDULUM ANALOGY

Miloš D. Jovanović, Mihailo Pupin Institute, University of Belgrade, Volgina 15, Belgrade Serbia
Veljko Potkonjak, Faculty of Electrical engineering, University of Belgrade, Bulevar kralja Aleksandra 73, Belgrade, Serbia

One common interpretation of bipedal walking is equivalence with inverse pendulum. In a number of attempts, the biped is represented by a simple system with only one to complex with the pendulum of the pendulum, in the general case by one extremity by a pendulum. The solid is suitable for describing the pendulum course, are not suitable for other modes describe bipedal motion such as, for example, scoring. For purposes of describing the runs are used which in addition to the mass of the pendulum and a spring, which provides a variable longitudinal dimension. The simplest solution is the equivalence of a single pendulum with a concentrated mass at the top, a constant length of the pendulum and the connection at the point of support which has two degrees of freedom. If for such a three-dimensional pendulum set of dynamic equations, the globbing trajectory of the pendulum's center of mass, we can determine the motion along the axis of the system set out in the rest point.

ROI-2.3
ONE OF THE SOLUTIONS FOR CONVERSION HUMAN TO HUMANOID MOTION

Marija Tomić, Mihailo Pupin Institute, University of Belgrade, Volgina 15, Belgrade, Serbia
Christine Chevallereau, Institut de Recherche en Communications et Cybernetique de Nantes, Nantes, France

In the recent years, the focus of research in the field of humanoid robotics is an imitation of human movement. The development of technology has led to various systems for the capture of human motion. One of the systems for recording 3D human motion and marker-based motion capture system. This paper presents an algorithm of conversion the recorded human movements to the robot's movements. The basic ideas for the human to humanoid motion conversion are to scale the robot segment dimensions to the human limbs size, attach the model of robot Virtual Markers such that during the movements their position and orientation evolution match the Real Markers evolution attached to the actor and following the position of actor's joints obtained from capture motion systems. Based on these principles the optimization algorithm gives the humanoid imitation of motion in joint space. As a model of humanoid the ROMEO robot is used. The algorithm was tested on measurements from several experiments and comparative analysis of the results was performed.

ROI-2.4
MUSCLE MODELS FOR ACCURATE SIMULATION OF HUMAN MOVEMENTS

Kosta Jovanović, Faculty of Electrical engineering, University of Belgrade, Bulevar kralja Aleksandra 73, Belgrade, Serbia
Jovana Vranić, Faculty of Electrical engineering, University of Belgrade, Bulevar kralja Aleksandra 73, Belgrade, Serbia

Safe human-robot interaction is one of the key issues in future service robotics. Numerous researchers have already invested a lot of effort to design passively compliant robots and to investigate active compliance through control algorithms. On the top of that, human-like robots are expected to move, act and fit into fully human adapted environment. To exploit human movement patterns and design human like actuators we firstly need to understand how humans move. This paper presents different muscle models (Hill's and Huxley's model), elaborates their features and demonstrates the trade-off between their accuracy and efficiency of computer simulations. Comparative analysis of the models is done, and comparison of simulation results to experimentally measured human movement is carried out.

ROI-2.5
LIGHT WEIGHT ARMS - AN OVERVIEW

Svemir Popić, Institute Mihailo Pupin, Robotics laboratory, Volgina 15, 11060 Belgrade, Serbia

Industrial robots - manipulators are indispensable devices in carrying out the tasks of accurate and repeatable of his end effectors positioning. For this reason it is extremely important to have a system with high rigidity and power capacity, able to quickly and reliably manipulate with his body weight and payloads. On the other hand, the Light weight arms have a new complex task. The own thought mass in relation to the payload must be approximately equal, with limitation in installed power and with sufficient system dynamic. This is achieved by a new constructive solutions as well as implementation of new algorithms and control systems.

ROI-2.6
TOWARDS BUILDING OF LIGHTWEIGHT ROBOT ARM OF ANTHROPOMORPHIC CHARACTERISTICS

Aleksandar Rodić, Institute Mihailo Pupin, Robotics laboratory, Volgina 15, 11060 Belgrade, Serbia
Branko Miloradović, Institute Mihailo Pupin, Robotics laboratory, Volgina 15, 11060 Belgrade, Serbia
Đorđe Urukalo, Institute Mihailo Pupin, Robotics laboratory, Volgina 15, 11060 Belgrade, Serbia

The subject of research in this paper does not concern with development of new lightweight robot arm of better technical characteristics than the existing industrial robots available at the market. The aim is setting of the new design concept of a bionic robot arm, based on the priciples known from human bio-mechanics, that leads towards achieving better antropomorphic characteristics of the robot. The novelties to be presented in this paper regard to decresing of the overall robot weight, increasing the payload fraction (the mass and payload ratio) and introducing of the spherical joint in the shoulder instead of commonly used cylindric joints in sequence. Also, the new proposed robot-arm structure represnets a redundant, over-actuated robot mechanism such as human arm with muscles that are more numerous than the number of degrees of freedoom. We expect that one such approach will lead to decresing of the robot mass as well as saving energy making system more reliable and efficient. In parallel, we will take care to keep the required high precision and reapitibility of the robot mechanism as well as to enable robot to be enough speed in order to be implemented with service robots (e.g. dual arms robotic system).

ROI3. Control, Technology and Applications
Chair: Aleksandar Rodić, Mihailo Pupin Institute, Belgrade, Serbia
Thursday, June 5, Room 3, 10:30

ROI3.1
SURVEY OF VIRTUAL LABORATORIES AND VIRTUAL ENVIRONMENTS WITH EMPHASIS ON APPLICATIONS IN ROBOTICS

Veljko Potkonjak, School of Electrical Engineering, University of Belgrade, 73 Bulevar kralja Aleksandra, 11020 Belgrade, Serbia
Vladimir M. Petrović, School of Electrical Engineering, University of Belgrade, 73 Bulevar kralja Aleksandra, 11020 Belgrade, Serbia

Due to the high expenses that modern laboratories and learning facilities require, in recent years much attention has been paid to various forms of virtual education. This paper deals with virtual laboratories and virtual environments in education. We will first give an overview of existing virtual laboratories in STEM (Science, Technology, Engineering, Mathematics) fields. Since our focus is on robotics, special attention is given to virtual laboratories developed in this field. Also, an analysis of the exisiting VE (virtual environment) technologies is provided. Finally, Virtual Laboratory for Robotics, developed at ETF is fully described, illustrating our viewpoint on the entire idea of virtual laboratories.

ROI3.2
THE COMPARISON BETWEEN THE REAL AND THE SCALED MODEL OF THE CPR SYSTEM

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Mirjana Filipović, Mihajlo Pupin Institute, University of Belgrade, Volgina 15, 11060 Belgrade, Serbia
Ana Djuric, Wayne State University , 4855 Fourth St. Detroit, MI 48202, USA

In this paper, we present one configuration of the Cable-suspended parallel system, ie. CPR system, for the workspace surveillance. We have designed two versions of this system and we have compared these systems. First, we have designed a real version of this system, ie. “the big system”, which presents a starting idea. Then, we have designed a smaller (scaled) replica of this system, ie. “the small system”. Afterwards, we have tested the both systems for similar conditions and for adequate motors; and then we have compared results acquired from both systems. From these results we have made adequate concluding remarks and plans for future development.

ROI3.3
COMPLEXITY OF THE ELASTIC S-TYPE CABLE-SUSPENDED PARALLEL ROBOT

Mirjana Filipović, Mihajlo Pupin Institute, University of Belgrade, Volgina 15, 11060 Belgrade, Serbia
Ana Djuric, Wayne State University , 4855 Fourth St. Detroit, MI 48202, USA
Ljubinko Kevac, School of Electrical Engineering, The University of Belgrade, Bulevar Kralja Aleksandra 73, 11000 Belgrade, Serbia; Innovation center, School of Electrical Engineering, The University of Belgrade, Bulevar Kralja Aleksandra 73, 11000 Belgrade, Serbia

The presence of the elastic property in the ropes significantly increases the complexity of the eSCPR system (elastic S-type Cable-suspended Parallel Robot). The significance of the eSCPR system modeling is the relation between the motor angular position and the elastic deformation of the corresponding rope which is defined by the fictitious coordinates. This novel procedure is named ED+M method, which means Elastic Deformations plus Motor motion. The Jacobian matrix of the eSCPR system relates the velocities of the external coordinates with the velocities of the fictitious coordinates. The relation between the fictitious elastic load moment and the external force, which is calculated using the Lagrange principle of virtual work, is expressed with the Jacobian matrix. The motors loads are expressed from the same calculation. Three different case studies of the eSCPR were analyzed and presented.

ROI3.4

MODELING AND CONTROL OF CAR HANDLING BOX SYSTEM

Zaviša Gordić, PhD student, School of Electrical Engineering, University of Belgrade, Bulevar Kralja Aleksandra 73, 11020 Beograd, Serbia
Kosta Jovanović, PhD student, School of Electrical Engineering, University of Belgrade, Bulevar Kralja Aleksandra 73, 11020 Beograd, Serbia

This paper presents two approaches to Car Handling Box system modeling and design of a controller. With a goal of obtaining adequate model of a process, Newton and Lagrange based methods were used separately. Both models were tested under same conditions and more comprehensive model was chosen for further work. Controller was designed in a form of cascade consisting of two real PD regulators in conjunction with low-pass filters. Performances of closed loop system were tested for robustness to disturbances, measurement noise and parameter uncertainty.

COMPUTERS – RTI

RTI1. Computers
Chair: Claudio Moraga, Ivan Milentijević
Tuesday, June 3, Room 1, 15:00

RTI.1.1
PERFORMANCE COMPARISON OF RAID-1, RAID-0 AND SINGLE DISK ON OPERATING SYSTEM MS WINDOWS 7

Borislav Djordjević, Institute Mihajlo Pupin, University of Belgrade, Serbia
Valentina Timčenko, Institute Mihajlo Pupin, University of Belgrade, Serbia
Nikola Davidović, Faculty of Electrical Engineering at University of East Sarajevo, East Sarajevo, RS BiH

This paper presents results of performance comparison for two different RAID configuration disks, RAID-0 and RAID-1, using CrystalMark software and HD Tune Pro tool. Special accent is on the analysis of results and on comparison to performances of a single disk. Result analysis is based on mathematical model of write and read operations for chosen RAID configuration and for every single disk. In order to gain validity and comparability of the results, all tests are conducted under the same conditions, i.e. in same environment and partition.

RTI.1.2
EXPLORATORY SPATIO-TEMPORAL ANALYSIS TOOL FOR LINKED DATA

Dejan Paunović, Institute Mihajlo Pupin, University of Belgrade, Serbia
Valentina Janev, Institute Mihajlo Pupin, University of Belgrade, Serbia
Vuk Mijović, Institute Mihajlo Pupin, University of Belgrade, Serbia

Linked Data provides a publishing paradigm in which not only documents, but also data, can be a first class citizen of the Web, thereby enabling the extension of the Web with a global data space based on open standards - the Web of Data. This paradigm has been used in an increasing number of data stores in recent years, including data stores with spatio-temporal data. Analysis of spatio-temporal data is not a straightforward task due to the complexity of the data structures, together with the representation and manipulation of the data involved. This paper considers challenges and directions for modelling spatio-temporal data and describes the first prototype of the Exploratory Spatio-Temporal Analysis tool for Linked Data.

RTI.1.3
CONCERN-ORIENTED API DESIGN FOR IMPROVED USABILITY AND MAINTAINABILITY

Žarko Mijailović, Faculty of Electrical Engineering, University of Belgrade, Serbia
Dragan Milićev, Faculty of Electrical Engineering, University of Belgrade, Serbia

Inheritance hierarchies of mainstream application programming interfaces (API) are too often developed in contrast with usability experience of their users. Very often, inheritance hierarchies are too deep, too complex, and hard to explore. Although many design guidelines exist, popular APIs provide diverse design configurations of their inheritance trees. Moreover, it seems that there is no agreement in terms of how exactly to use interfaces in API design. We propose a novel approach to API design with improved API usability and maintainability of the client code. The goal is to adjust API design to fit programmers' needs. More precisely, our approach is oriented towards high-level concerns of the API users. It adopts benefits of interface-based programming style, while at the same time avoids its common pitfalls.

RTI.1.4
EFFICIENT COMPUTATION OF THE OPTIMAL REED-MULLER SPECTRUM ON GRAPHICS PROCESSORS

Miloš Radmanović, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Dušan B. Gajić, Faculty of Electronic Engineering, University of Niš, Niš, Serbia
Radomir S. Stanković, Faculty of Electronic Engineering, University of Niš, Niš, Serbia

The Reed-Muller transform is a useful mathematical tool for the analysis, synthesis, and optimization of Boolean functions. The number of spectral coefficients can be reduced by selecting either positive or negative literals for variables, which leads to the fixed-polarity Reed-Muller (FPRM) spectra. For practical applications, it is often useful to be able to efficiently compute these spectra in order to select the spectrum with the minimum number of non-zero coefficients (the optimal spectrum). This paper proposes techniques for the efficient computation of optimal FPRM Reed-Muller spectrum for the given function, by using graphics processing units (GPUs). We present the mappings of computation algorithms based on exhaustive search and dual polarity route to the GPU. The algorithm is implemented both as sequential C++ code and using the CUDA (Compute Unified Device Architecture) framework for the development of parallel GPU applications. These approaches are experimentally verified and compared. It is found that the computations of the optimal spectrum on a GPU are quite efficient in terms of the computation time.

TELECOMMUNICATIONS – TEI

TEI1 Telecommunications
Chair: Igor Radušinović, Faculty of Electrical Engineering in Podgorica, Montenegro
Thursday, June 5, Room 1, 8:30

TEI1.1
UPDATING OF PARALLELIZED IPv6 LOOKUP ALGORITHMS

Nataša Maksić, Innovation Center of the School of Electrical Engineering, Belgrade, Serbia
Zoran Čiča, School of Electrical Engineering, Belgrade, Serbia
Aleksandra Smiljanić, School of Electrical Engineering, Belgrade, Serbia

The transition from IPv4 to IPv6 is inevitable since the IPv4 address space is becoming depleted, while the number of Internet users is growing. Memory requirements of IP lookup algorithms increase with the address length, and, thus limit the scalability and speed of these algorithms. We proposed earlier the BPFL algorithm which has reduced memory requirements. In this paper, we examine updating of BPFL IPv6 lookup tables, and compare it with the benchmark lookup algorithm, POLP, which is based on a conventional trie lookup algorithm sped up using parallelization and pipelining. First, we derive expressions of the worst-case memory requirements for POLP and BPFL, and confirm the superiority of BPFL in terms of scalability. Then, we examine updating complexities of these two lookup algorithms. It will be shown that updating is faster in POLP, and, therefore, less intrusive. For large lookup tables, updating speed in BPFL remains acceptable.

TEI1.2
INTEGRATION OF QUAGGA ROUTING SOFTWARE AND NetFPGA-10G PLATFORMS

Saša Takov, Inovation Center, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Jelena Seović, Inovation Center, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Jelena Veličković, Inovation Center, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Aleksandra Smiljanić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia

Modern Internet services require link and routers providing high bandwidths. In order to help promote education and competition in the area of high-capacity routers, several routing platforms have been developed, most prominent ones being the NetFPGA-10G platform and the Quagga open-source routing software. In this paper we will describe integration of these two platforms, and its validation. Our test will show that the IP lookup table calculated by the central processor using the Quagga software can be successfully transported to the QDR-II memory on the NetFPGA board. This integration is an important step for the Internet router design since it has not been presented in the literature before, while the code provided by the NetFPGA was closed and inflexible. We used the proposed design to implement a high-speed routing environment that deploys a novel lookup algorithm which was developed in our lab.

TEI1.3
EVALUATION OF THE OPEN-SOURCE IMPLEMENTATION OF PIM-SM

Jelena Veličković, Inovation Center, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Jelena Seović, Inovation Center, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Aleksandra Smiljanić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia

PIM-SM is the routing protocol which describes the exchange of the network topology information in order to construct logical multicast trees. Multicast traffic is routed along these multicast trees in order to more efficiently utilize the network resources. In this paper, we evaluate capabilities of the open-source implementations which allow routing of multicast traffic: Quagga and Pimd.

TEI1.4
EVALUATION OF IS-IS IMPLEMENTED IN QUAGGA

Saša Takov, Inovation Center, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
Aleksandra Smiljanić, School of Electrical Engineering, University of Belgrade, Belgrade, Serbia

Routing protocols define rules according to which routers exchange the network topology information. Based on this topology information and a packet address, routers decide where to send incoming packets. IS-IS routing protocol is the most scalable intradomain routing protocol. In this paper, we will evaluate the IS-IS functionalities implemented in the Quagga open-source software.

TEI1.5
ANALYSIS OF SOME ROUTING AND WAVELENGTH SELECTION TECHNIQUES IN OPTICAL NETWORKS WITH DYNAMIC TRAFFIC DEMANDS

Suzana Miladić (Ph.D student), Faculty of Transport and Traffic Engineering, University of East Sarajevo, Doboj, Bosnia and Herzegovina
Goran Marković, Faculty of Transport and Traffic Engineering, University of Belgrade, Belgrade, Serbia

Fixed-alternate routing and some wavelength selection techniques as two different parts of routing and wavelength assignment (RWA) problem in wavelength-routed optical networks (WRON) with dynamic traffic demands are focused in this paper. Such networks operate under the wavelength-continuity constraint in which lightpaths are established for connection requests between a source and a destination node pairs. For each of these pairs several possible routes are determined in advance. We compared first-fit and random-fit wavelength assignment algorithm for a given optical network topology on the basis of blocking probability. The results are analyzed by varying the values of network load per fiber link and the number of alternate routes.

TEI1.6
POLICY BASED PERFORMANCE MANAGEMENT IN MOBILE AD HOC NETWORKS

Valentina Timčenko, Institute Mihailo Pupin, University of Belgrade, Belgrade, Serbia
Slavica Boštjančič Rakas, Institute Mihailo Pupin,University of Belgrade, Belgrade, Serbia

This paper addresses issue of automation in network management for mobile ad hoc network (MANET). We have proposed a framework for overall policy based management (PBM) solution applicable in MANET environment. Proposed framework relies on the overlay management network concept with two-layer architecture and it is independent of the underlying network size, routing protocols, mobility models and mobile nodes speed. Functional model of the proposed PBM solution consists of five entities regarding management policies, quality of service, resources, security and configuration

TEI1.7
LEVEL CROSSING RATE OF WIRELESS SYSTEM OVER GAMMA SHADOWED A-MMULTIPATH FADING CHANNEL

Časlav Stefanović, Faculty of Electrical Engineering at University of Niš, Niš, Serbia
Dejan Milić, Faculty of Electrical Engineering at University of Niš, Niš, Serbia
Danijel Đošić, Faculty of Electrical Engineering at University of Niš, Niš, Serbia
Dragan Radenković, Faculty of Electrical Engineering at University of Niš, Niš, Serbia
Petar Spalević, Faculty of Technical Sciences, University of Priština, Kosovska Mitrovica, Serbia

Random α-μ signal envelope with Gamma distributed power is considered. Received signal experiences α-μ multipath fading resulting signal envelope variation and Gamma shadowing resulting in signal envelope power variation. Closed form expression for average level crossing rate of signal envelope is derived. Obtained results can be used for evaluation of closed form expression for average fade duration of wireless communication system operating over Gamma shadowed α-μ multipath fading environment. Numerical results are plotted graphically to show influence α-μ fading severity parameter and Gamma shadowing several parameter on average level crossing rate.

TEI1.8
A SCALABLE LOAD BALANCING SOLUTION FOR A DIGITAL MULTIMEDIA CONTENT DISTRIBUTION PLATFORM

Ognjen Joldžić, Faculty of Electrical Engineering Banja Luka, Bosnia and Herzegovina
Zoran Djurić, Faculty of Electrical Engineering Banja Luka, Bosnia and Herzegovina

The process of network convergence and the constant advancement in the area of network performance have resulted in an increase in availability of different types of digital multimedia content to network subscribers. A modern, converged network presents a unified infrastructure for content distribution, regardless of its type or other characteristics. In this context, any implementation of digital video delivery networks has to resolve several important issues in order to provide its users a satisfactory level of service quality. One of the most important problems in this category is the implementation of a responsive and scalable platform that would be able to withstand high server loads caused by a large number of simultaneous requests. This paper presents an overview of a load balancing solution which is able to dynamically distribute the load across any number of nodes configured within the distribution cluster. As a proof of concept, the solution presented in this paper has been successfully implemented in a Digital Multimedia Content Distribution System called GSTV.

TEI2 Telecommunications 2
Chair: Goran T. Đorđević, Elektronski fakultet, Niš
Thursday, June 5, Room 1, 10:30

TEI2.1
FLEXIBLE FUTURE OF THE INTERNET: CHALLENGES AND RESEARCH TRENDS

Invited Paper

K. R. Rao, Department of Electrical Engineering, University of Texas of Arlington, USA
Zoran Bojković, University of Belgrade, Studentski trg 1, Serbia
Bojan Bakmaz, Faculty of Transport and Traffic Engineering, University of Belgrade, Belgrade, Serbia

The Internet has been successfully deployed for several decades due to its flexibility in operating using different physical media and supporting various higher layer protocols and applications. However, rapidly emerging applications with different requirements and implications for future Internet design pose a significant set of challenges and research problems. This work focuses on future Internet emphasizing current challenges and research trends. We start with the comprehensive survey of future Internet architecture, together with the

information-centric principles. Then, the new concept of video delivery is briefly presented. Finally, self-management scenarios including adaptive resource management, energy aware network management and cache management are described. The analysis will enable the research community to focus on the key technologies to enable the flexible future of the Internet.

TEI2.2
BER PERFORMANCE ANALYSIS OF A MULTICHANNEL SATELLITE LINK EMPLOYING FDMA

Hana Stefanović, High School of Electrical Engineering and Computer Science, Vojvode Stepe 283, 11000 Belgrade, Serbia
Dejan Milić, Faculty of Electronic Engineering, University of Nis, Aleksandra Medvedeva 14, 18000 Nis, Serbia
Daniela Milović, Faculty of Electronic Engineering, University of Nis, Aleksandra Medvedeva 14, 18000 Nis

This paper proposes some simulation models of a satellite based transponder communication link, employing frequency division multiple access (FDMA). A nonlinear power amplifier is assumed, while its impact on intermodulation (IM) products is analyzed. Bit-Error-Rate (BER) performance in the downlink is given, including the effect of Gaussian noise, IM distortion, intersymbol interference (ISI) which is mainly due to the input and output multiplexing filters, and adjacent channel interference (ACI) caused by increasing the number of carriers and also varying the power amplifier back-off level.

ARTIFICIAL INTELLIGENCE – VII

VII1. Mathematical models of artificial intelligence
Predsedavajući: Aleksandar Perović
Thursday, June 5, Room 5, 8:30

VII1.1
FUZZY LOGIC AND FUZZY SET THEORY BASED EDGE DETECTION ALGORITHM

Nebojša T. Perić, Group for Intelligent Systems, Faculty of Mathematics, University of Belgrade, Serbia

In this paper we will introduce a new way how to detect edges in digital images. Edge detection is a fundamental part of many algorithms, both in image processing and in video processing. Therefore it is important that the algorithm is efficient and, if possible, fast to carry out. The fuzzy set theory based approach on edge detection is good for use when we need to make some kind of image segmentation, or when there is a need for edge classification (primary, secondary...). One example that motivated us is region labeling; this is a process by which the digital image is divided in units and each unit is given a unique label (sky, house, grass … etc). To accomplish that, we need to have an intelligent system that will precisely determine the edges of the region. In this paper we will describe tools from image processing and fuzzy logic that we use for edge detection as well as the proposed algorithm.

VII1.2
HEURISTIC APPROACHES FOR SOLVING THE PROBLEM OF INFRASTRUCTURE EXPANSION OF A WIRELESS NETWORK

Miloš Šošić, Faculty of Mathematics, University of Belgrade, Serbia
Zorica Stanimirović, Faculty of Mathematics, University of Belgrade, Serbia
Marko Šošić, Faculty of Mathematics, University of Belgrade, Serbia

In this paper, the problem of expansion of a wireless network infrastructure is considered, which is of great importance in telecommunications. The set of existing locations of base stations and switching centers in a network is given, as well as the set of demand points to be served. The problem is to expand the network by adding new locations for base stations and switching centers, with respect to the location of the demand points and given capacities of both base stations and switching centers. The objective is to minimize the sum of cost of establishing new base stations and switching centers and the costs of their inter-connections and allocations to user nodes. Two heuristic methods - Iterated Local Search and Ant Colony Optimization are proposed for solving the considered problem, especially the cases of larger problem dimensions.

VII1.3
A NOTE ON WEIGHTED LOGICS

Obrad Kasum, Group for Intelligent Systems, Faculty of Mathematics, University of Belgrade, Serbia
Aleksandar Perović, Group for Intelligent Systems, Faculty of Mathematics, University of Belgrade, Serbia
Aleksandar Jovanović, Group for Intelligent Systems, Faculty of Mathematics, University of Belgrade, Serbia

In this talk we will give a short survey of weighted logics and their application in artificial intelligence. The emphasis will be on propositional real-valued fuzzy logics and probability logics, the main axiomatization issues, their relation with classical, modal logics and theoretical computer science, as well as their application in various expert systems.

VII1.4
SECURITY RISKS IN SYNCHRONIZATION ON-PREMISES ACTIVE DIRECTORY WITH OFFICE 365 CLOUD PLATFORM

Dušan Stamenković, Singidunum University, Belgrade, Serbia
Saša Adamović, Singidunum University, Belgrade, Serbia
Goran Šimić, Singidunum University, Belgrade, Serbia
Marko Šarac, Singidunum University, Belgrade, Serbia

Over the years, mail servers were moved a long way in accordance with the development of new technologies. Microsoft's started with basic mail server integrated into the Windows Server operating system via the Exchange Server until the Office 365 Cloud platform. Classic datacenter is comprised almost inevitable with the local domain controller's and mail or Exchange Server with a high level of security. In recent years, with the development of Cloud technology and more affordable prices, there's a new resource type - Hybrid Cloud. Hybrid Cloud is a combination of classical and modern (virtual) datacenter, where the local datacenter kept on-premises active directory while the Exchange server and Office365 is in Cloud on Azure platform far away from your datacenter. Authors of this paper reviewed safeguards and security mechanisms used in this synchronization and data transfer as well, and the possible impact of Heartbleed bug in implementation of TLS / SSL in Microsoft Azure platform.

VII1.5
AN OPEN-SOURCE SOLUTION FOR PROTECTING PHP SOURCE CODE

Nenad Ristić, Singidunum University, Belgrade, Serbia
Aleksandar Jevremović, Singidunum University, Belgrade, Serbia
Mladen Veinović, Singidunum University, Belgrade, Serbia
Goran Shimic, Univerzitet Sinergija, Biljeljina, Bosnia and Herzegovina

Protecting software code unwanted using, copying and modifications is a pressing issue to many software developers. Current mechanisms for protecting program source code are mostly working as obfuscators, they are free, and are not providing any serious level of protection. Solutions that are based on encrypting opcode are more secure, nevertheless they are commercial and require closed-source proprietary PHP interpreter's extension. Additionally, encrypted opcode is not compatible with upcoming versions of interpreters which include re-buying encoders from authors. Lastly, if extension source-code is compromised, all script encoded by that solution are compromised too. In this paper we present a novel model for free and open-source PHP script protection solution.

VII2 Learning techniques in artificial intelligence
Predsedavajući: Aleksandar Jevremović, Singidunum University, Belgrade, Serbia
Thursday, June 5, Room 5, 10:30

VII2.1
ANALYZING BEHAVIOR OF WEB APPLICATIONS USERS AS A COMPONENT OF AUTHENTICATION

Aleksandar Jevremović, Singidunum University, Belgrade, Serbia
Marko Šarac, Singidunum University, Belgrade, Serbia
Milan Milosavljević, Singidunum University, Belgrade, Serbia
Mladen Veinović, Singidunum University, Belgrade, Serbia

Authentication of Web applications users is generally based on what user knows, and rarely by what user has, or what user is. Enabling authentication based on what user has or is requires additional hardware (smart card readers, fingerprint scanners, cameras, etc.) and therefore is very difficult to implement. In this paper we are analyzing effectiveness of using user's behavior as a component of authentication procedure. User behavior is analyzed during the use of Web application for electronic testing.

VII2.2
ON THE EVALUATION OF EMAIL SPAM FILTERS IN ADVERSARY ENVIRONMENT

Lutfia Ramadan Milod, Singidunum University, Belgrade, Serbia
Milan Milosavljević, Singidunum University, Belgrade, Serbia

This paper proposes a new approach to estimating the robustness of e-mail spam filters in relation to possible attacker strategies. The lower limit of filters vulnerability are obtained based on the modification of learning and/or test sets by the attacker, so as to maximize performance drop measured by AUC criterion in the range of high sensitivity values of the ROC curve. Experimental results show that, email spam filters based on Random Forest machine learning technique, possesses superior robustness property, which is a novelty compared to the results known so far.

VII2.3
APPLICATION OF HYBRID INCREMENTAL MACHINE LEARNING METHODS TO ANOMALY BASED INTRUSION DETECTION

Vladislav Miškovic, Singidunum University, Belgrade, Serbia
Milan Milosavljević, Singidunum University, Belgrade, Serbia
Saša Adamović, Singidunum University, Belgrade, Serbia
Aleksandar Jevremović, Singidunum University, Belgrade, Serbia

Anomaly based intrusion detection systems can detect computer systems misuse based on network and system behaviour where the type of misuse isn't previously known. Different machine learning methods explore different hypothesis spaces, use different search strategies, different sets of features, and are appropriate for different types of problems. Their combination or integration usually gives better performance than using each individual machine learning method on its own. Hybrid models can reduce individual limitations of basic models and can exploit their different generalization mechanisms. In this paper we compare performances of explicit, implicit, and hybrid machine learning models in several publicly available intrusion detection problems. Their applicability to mobile and cloud computing is briefly analyzed. Machine learning methods in use areprovided by the Weka/MOA and R/Revolution environments.

VII2.4
THE EFFECTIVNESS OF GABOR FILTER, PRINCIPLE COMPONENT ANALYSIS AND HIGHER MOMENT ON FACE RECOGNITION SYSTEM

Salem Muftah Abdusalam, Al-Mergeb University, Al-Khums, Libya

This paper shows the effectiveness of features on the performance of face recognition systems. The general idea is that the features based on PCA have the greatest discriminatory value. Experiments showed that applying Gabor Filter on ORL database and then extracting PCA and calculating higher order moments (HiMo) combing them together improves the performance of face recognition system. It was experimentally determined profile of number of higher order moments in relation to the number of PCA features for fixed dimensionality of feature vectors. Key words, PCA, Gabor filter, Support Vector Machine.

VII2.5
MATHEMATICAL MODEL AND SIMULATION OF JAK-STAT SIGNALLING PATHWAY

Nataša A. Kablar, Faculty of Computer Science and Lola Institute, Belgrade, Serbia
Vladimir Kvrgić, Lola Institute, Belgrade, Serbia

In this paper we give main biological mechanism of JAK STAT signalling pathway. We give set of biochemical reactions and mathematical model of JAK STAT signalling pathway. We look for the control elements and recognize SOCS1, SHP 2, and phospahatases 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.

VII2.6
THE APPLICATION OF THE BAYESIAN NETWORKS TO THE UNCERTAINTY DURING THE PROJECT MANAGEMENT

Nataša Glišović, State University of Novi Pazar, Department of Mathematical Sciences, Novi Pazar, Serbia

Risk is unavoidable in the project. The risk management has become an important part of the project management. Although in the literature there are a number of techniques, the risk management is rapidly developing and managing uncertainties in complex projects is still a challenge. There is great interest in the application of the Bayesian networks as a tool for modeling uncertainties in project management. The Bayesian networks provide a method for representing the relations between the variables (Bayesian nodes in the network) even when these relations contain uncertainty. This paper considers the problem of including uncertainties in the project management. The proposed approach is based on the application of the concept of Bayesian networks while modeling the uncertainty of some activities in terms of time and cost. Validity of proposed approach is tested on a project of franchising implementation in PE of PTT Communications "Srbija".

VII2.7
AN ALGORITHM FOR THE GENERATION AND EXCHANGE OF CRYPTOGRAPHIC SECRET KEYS OVER PUBLIC CHANNELS

Sasha Adamovic, Singidunum University, Belgrade, Serbia
Milan Milosavljević, Singidunum University, Belgrade, Serbia

This paper proposes a new algorithm to generate high-quality cryptolographic secret keys based on shared randomness and public discussion over public channels. The key subsystem is correlated multivariate source of randomness, which is based on data received from the public service monitoring globall flight data of civilian air transport. Experimental verification of the proposed protocol confirms its theoretical expected performance.