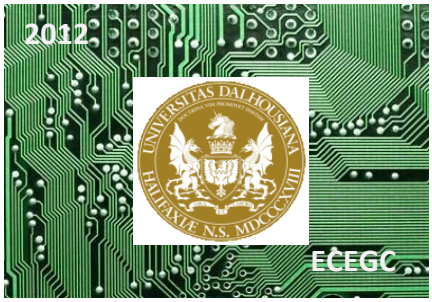


DALHOUSIE UNIVERSITY
Inspiring Minds

Proceedings of

ECEGC - 2012

Electrical and Computer Engineering Graduate Conference

May 8, 2012
Scotia Bank Auditorium
McCain Arts and Social Sciences Building
Halifax, N.S. Canada

NSERC CRSNG
ASPIRE

partially sponsored by CREATE training program in
Applied Science in Photonics and Innovative Research in Engineering

Committee members

Michael Cada
Graduate Advisor and Chair

Hamed Aly
Ph.D. Student

Shadi Shehadeh
Ph.D. Student

Yousef Alattar
M.A.Sc. Student

Rahul Singh
M.A.Sc. Student

Session Chairs

Scott Melvin
Ph.D. Student

Franklin Che
Ph.D. Student

Farid Jolani
Ph.D. Student

Organization volunteers

Amal Devasia, Mayank Jain, Ava Rahman Kashfi, Chen Miao
First-year master-students

Message from the Chair

It is my pleasure to introduce our first formal annual graduate student conference, ECEGC-2012. All eighty six graduate students registered in our department participate in the conference this year, either actively or passively.

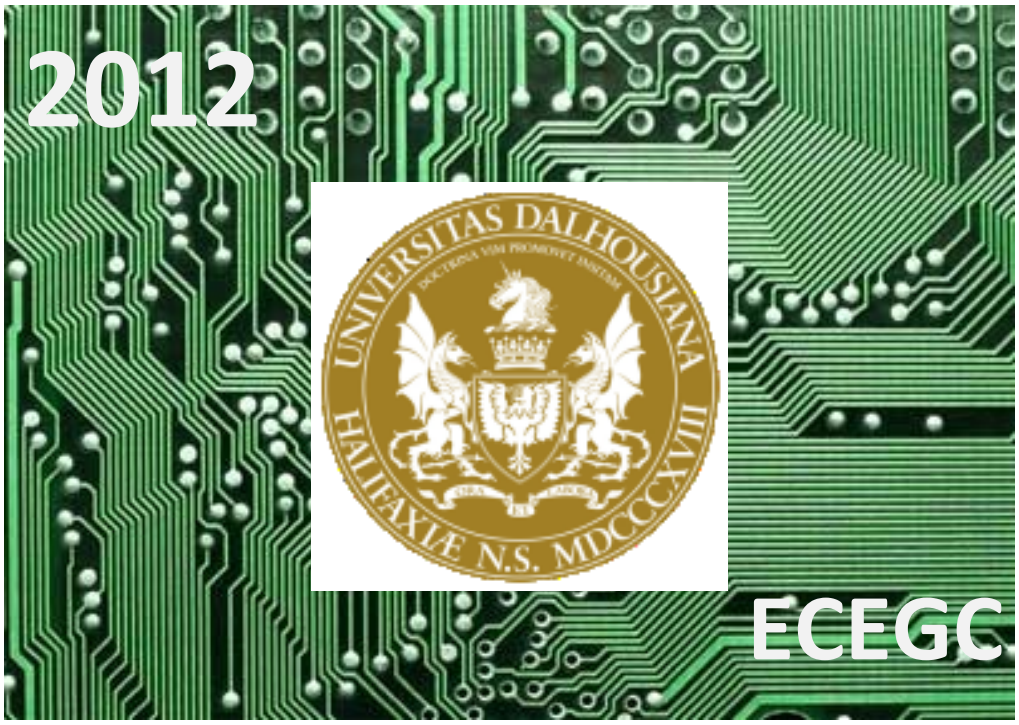
Sixteen Ph.D. students present their research results orally. Forty four master students report their results on posters. The remaining twenty six first-year students attend all sessions to learn and see what is expected of them next year.

I feel proud of and look forward to see all the talented and hard-working students putting forward their achievements in research and professionally presenting them. Admittedly, we professors would not be able to reach our goals in research and teaching without significant and consistent contributions from our graduate students.

The work produced by the cohort of our graduate students is very impressive, indeed, as it covers a wide range of subjects in both depth and breadth. Only when I reviewed all the students' submissions I realized the sheer volume of their research work; it is quite amazing.

I would like to thank all students for submitting their high-quality work to this conference. Special thanks belong to the students who agreed to serve on the Conference Committee and as Session Chairs, and to those who volunteered to help during the conference day with all aspects of its organization.

My appreciation goes to the Department Head, Dr. Zhizhang Chen, for his continuous support of our efforts throughout the entire conference preparation stage, and to the administrative secretary, Selina Cajolais, for her invaluable and truly irreplaceable support to all tasks related to the conference and beyond.



ABSTRACTS

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Student		Supervisor	Program
MacNeill	Aaron	El-Hawary	MASc
Nasr	Abdulhakim	El-Hawary	MASc
Alarabi	Abdulrazig	El-Hawary	PhD
Abobkr	Abobkr	El-Hawary	MASc
Ranjan	Ashish	Hughes	MASc
Vishwanathan Rajendran	Atheindhar	Chen	MASc
Alluhaidah	Bader	El-Sankary	MEng
Mutwali	Bandar	El-Hawary	MASc
Almarghani	Abdelbaset	Little	PhD
Che	Franklin	Ponomarenko/Cada	PhD
O'Flynn	Colin	Chen	MASc
Singh	Daljeet	Chen	MASc
Simili	Deepak	Cada	MASc
Gujjari	Durgesh	Cada	MASc
Abdelhadi	Elssodani	El-Hawary	MASc
Jolani	Farid	Chen	PhD
Aly	Hamed	El-Hawary	PhD
Yu	Haoran	El-Masry/El-Sankary	PhD
Imam	Hasan Tareq	Ma	PhD
Mosbah	Hossam	El-Hawary	MASc
Ketout	Hussin	Gu	PhD
Hoseyni	Sayyed Mohammad Javad	Ilow	PhD
Mehta	Jeet Kumar	Chen	MEng
Hamed	Khald	Gu	MASc
Aldubaikhy	Khalid	Chen	MASc
Mokhtarpour	Laleh	Ponomarenko	PhD
Wang	Luyu	Chen	MASc
Rastmanesh	Maziar	El-Masry/El-Sankary	MASc
Esmet	Medhat	El-Hawary	MASc
Ceekala	Mithun	El-Sankary/El-Masry	MASc
Bregraw	Mohamed	El-Hawary	MASc
Darfoun	Mohamed	El-Hawary	MASc
Eldlio	Mohamed	Cada	PhD
Mohamed	Meftah	Gu	PhD
Thulukkameetheen	Mohideen Raiz Ahamed	El-Sankary/El-Masry	MASc
Khan	Mohsin	Gu	MASc
Yilmaz	Mutlu	El-Hawary	PhD
Donavalli	Nagasatya Prasad	Chen	MEng
Puttamreddy	Nithinsimha	El-Sankary	MASc
Gautam	Nitin	Chen	MEng
Chennai Jagannathan	Raam Bharathwaat	Cada	MASc
Melvin	Scott	Ilow	PhD
Shehadeh	Shadi	El-Hawary	PhD
Kamali	Shahrokh	Leon	MASc
Kannan	Shanmunga Sundaram	Hughes	MASc

Zhou	Shijie	Gu	MASc
Haghgoo Poorvali	Soodeh Sadar	Ponomarenko	PhD
Padyath Ravindran	Sri Ragho	Ma	MASc
Singh	Sukhvinder	Gu	MEng
Zeb	Suleman	Chen	MEng
Elsalahati	Tamer	El-Masry	MASc
Arabi	Tamim	Chen	MASc
Zhang	Tianming	Ma	MASc
Puttamreddy	Udhayasimha	El-Masry	MASc
Chatharaju	Vinay Kumar	Hughes	MASc
Oweedha	Wayel	El-Hawary	MASc
Mao	Xiaoou	Cada	MASc
Alattar	Yousef	Gregson/Hill	MASc
Zhang	Zichen	Gu	MASc
Saheb	Zina	El-Masry	MASc

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Submarine Power Cable Line Parameters

Aaron MacNeill

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-3996; Fax: 1-902-422-7535; E-mail: ar286555@dal.ca

Abstract – Submarine power production installations use the power of the ocean to generate renewable energy for the population to use. To bring this electricity back to land, use of electrical cables is required. The choice of cable will affect both the quality of received power quality and the security of the transmission line.

To find the inductance and capacitance of these submarine transmission lines, a study of the electric and magnetic fields that are produced due to the power flow on these cables must be performed. The armor that is used to protect the cable from underwater hazards is significant in determining the cable losses and finding the equivalent inductance and capacitance.

The choice of metal to use as armor for the cable comes in two categories, an electrically conductive metal, or a ferrous based metal. The cable configuration can help to determine which armor should be used to minimize power losses and the expense of the cable.

Finding the inductance and capacitance of the submarine cable will allow for the determination of the two port parameters of the cable. These parameters will allow for the analysis of the transient and steady state performance of the cable, based on the cable configuration and armoring that is used.

Index Terms – Renewable energy, Submarine power cable, Cable parameters

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Modeling and Simulation of a Small Wind Energy Conversion System with a Permanent Magnet Synchronous Generator Including a Matrix Converter

Abdulhakim Nasr

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-579-2778; Fax: 1-902-422-7535; E-mail: ab903758 @dal.ca

Abstract – In this thesis, a small Wind Energy Conversion System (WECS) with a direct driven Permanent Magnet Synchronous Generator (PMSG) is proposed. The PMSG is connected to a supply grid through a matrix converter. The Matrix Converter (MC), an AC to AC converter, uses to connect PMS generator with the electrical grid. The MC is considered one possible direct AC- AC converter approach. The variable voltage and variable frequency output from the wind generator are converted by the matrix converter into a fixed voltage and frequency. The design and implementation of the Matrix Converter are described.

PMSGs are mainly used with variable-speed wind turbine systems. They are directly connected to wind turbines, and have some advantages such as high accuracy, no needed to gearbox, high power density, and simple control method. The voltage and frequency output of generators can be controlled by a Matrix Converter.

This thesis presents three dynamic models: a dynamic model for variable- speed wind turbine and the PMSG model, dynamic model for the matrix converter, and then an overall dynamic model for a small wind turbine system.

The dynamic model for the variable – speed wind turbine can be connected with both induction and synchronous generators. This model includes a rotor model, shaft model, pitch – angle controller, rotor speed controller, and generator model.

The dynamic model for a matrix converter will be simulated by Matlab/Simulink, which can be usable for transit and steady-state analyses. This model includes the control of the output voltage and frequency of power output.

Index Terms – PMSG; matrix converter; wind energy conversion systems; small wind turbine

Annual Electrical and Computer Engineering Graduate Conference
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Automatic Generation Control of Renewable Energy Resource

Abdulrazig Alarabi

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494- 6065; Fax: 1-902-422-7535; E-mail: ab517932@dal.ca

Abstract – Renewable energy sources are one of the main keys to solving the problem of electric power generation using fossil fuels. Currently, wind energy is one of the most important renewable sources as the development in this area has been progressing fast during the past two decades.

This project will deal with the problem of automatic generation control (AGC) for wind turbines generators. It also investigates the performance of automatic generation control (AGC) to improve the quality of generation control of renewable energy resource. The main functions of the AGC for multi-area interconnected system are to maintain the steady frequency at nominal value (60 Hz), control the tie-line flows, and distribute the load among the participating generating units.

Analysis is performed of wind turbines generators in terms of design and operation used in multi-area control. The studies of simulation and modeling of wind turbine generator are conducted on the Matlab software simulink. A model for a single wind turbine generator with an appropriate AGC algorithm will be tested using simulated system to control the frequency and tie-line flow power system. The model is extended and algorithms are considered for multiple winds turbine generators systems.

Reduced order modeling for multi-wind turbines generator is developed. The work develops design requirements for wind turbine generators.

Index Terms – Automatic generation control (AGC), wind turbine generators

Annual Electrical and Computer Engineering Graduate Conference
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Simulation and Modeling of Doubly Fed Induction Generator coupled to a Wind Turbine

Abobkr HamidaAbobkr

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-999-2175 ... ; Fax: 1-902-422-7535; E-mail: ab253644 @dal.ca

Abstract – With increasing concern over climate change, more and more countries have implemented new renewable energy sources. One way of generating electricity from renewable sources is to use wind turbines. Wind energy conversion is increasingly gaining interest as appropriate source of renewable energy. It is now recognized that much of this wind generation plant will be a doubly fed induction machine used in generation mode [DFIG]. In order to investigate the impacts of these DFIG installations on the operation of the power system, precise models and simulations are needed. Consequently, the dynamic models of double fed induction generator, wind turbines, converter and grid were established to study the transient characteristic of the system. Mathematical model of the machine written in an appropriate d-q reference frame is established to investigate simulation. Also, current vector control method oriented by the stator flux was applied in converter control. Based on these models, Matlab Simulink was used in building the models and simulating the performance of the system.

Index Terms – wind energy, doubly fed induction generators, modeling, and simulation

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A Method for Analyzing and Determining Energy-Security Diversity

Ashish Ranjan

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-6128 ; Fax: 1-902-422-7535; E-mail: as354852@dal.ca

Abstract – Energy plays an essential role in any jurisdiction, affecting both its society and economy. All jurisdictions are associated with an energy system which is responsible for meeting the energy demands of its different energy services. Energy systems evolve over time with respect to changes in the availability, affordability, and acceptability of the energy they convert and transport for the ultimate consumption by the energy services. Not surprisingly, energy systems differ from jurisdiction-to-jurisdiction, with a wide-range of processes and energy flows all contributing to the improvement or deterioration of its energy security.

The International Energy Agency's definition of energy security, "the uninterrupted physical availability at a price which is affordable, while respecting environment concerns'' can be parsed into three generic energy security indicators: availability ("uninterrupted physical availability"), affordability ("a price which is affordable"), and acceptability ("respecting environment concerns"). Energy diversity, defined as the reliance on a variety of mutually disparate suppliers and their energy supplies, is seen by many as a proxy for energy security.

Although diversity of supply is important, focusing on the mix of the different energy sources and omitting the internal processes of the system leads to a narrow view of diversity. By considering the internal structure of an energy system with its processes and flows, a greater understanding of the causes and possible impacts of dynamic events can be gained.

This presentation describes a method for the analysis of energy-security diversity in an energy system, its processes, and flows using graph theory and linear algebra. This view of energy-security diversity thus provides a better understanding of the relationship between both the internal and external components of an energy system. Energy diversity is measured in terms of the three energy-security indicators.

This method can be applied to any generic energy system regardless of jurisdiction, society, or economy. It also provides a more systematic, transparent and complete way to enunciate disparate perspectives and approaches, thus being helpful to apprise more robust and accountable policymaking.

Index Terms – Energy system, energy-security diversity, processes, flows and weighted adjacency matrix (WAM).

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Intersymbol Interference Mitigation in Differential Code-Shifted Reference Impulse Radio Ultra-Wideband Transceiver

Atheindhar Viswanathan Rajendran

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-488-5519; Fax: 1-902-422-7535; E-mail: at276307@dal.ca

Abstract – Recently, ultra-wideband (UWB) communication systems gained much interest due to a variety of attractive applications such as wireless sensor networks. An UWB system is defined as a system that transmits radio signals over either a bandwidth of at least 20% of its center frequency or a -10 dB bandwidth of at least 500 Mhz. Out of the two available signaling technologies to utilize such a wide bandwidth is the impulse radio (IR) UWB technology, where pulses or pulsed waveform with very short duration is transmitted without a carrier; as a result, an IR UWB system has the advantages of low complexity, low power and good time-domain resolution, making it the best candidate for wireless sensor networks and other related applications such as wireless health monitoring and ubiquitous computing. A differential code-shifted reference (DCSR) ultra-wideband transceiver was then designed as a form of IR UWB technology. The DCSR has reduced the power spent to transmit the reference pulse sequence so as to improve the bit error rate of the systems. In DCSR UWB transceiver, by differentially encoding M information bits to be transmitted simultaneously, one data pulse can be used as the reference of another data pulse sequence.

The peak data rate associated with a DCSR detector or a transceiver is constrained to a low value when intersymbol interference (ISI) is present. In order to overcome this constraint, in this presentation, a simple maximum-likelihood sequence estimator (MLSE) can be introduced in the DCSR transceiver just after its integrator unit to mitigate the impact of intersymbol interference. This MLSE is first tested with its applicability to a pulse position modulation (PPM) IR UWB system and then investigated with a DCSR UWB transceiver. In literature there exists a wide research on MLSE for energy detectors focusing primarily on linear model by neglecting or avoiding non-linear cross correlation terms. The work presented here applies MLSE principle to the non-linear output of an analog DCSR UWB transceiver frontend, taking into account of non-linear cross-correlation term and data dependent variances. These MLSEs have very reduced channel state information (CSI), whereby achieving good or even complete ISI cancellation. Preliminary results are shown in this presentation.

Index Terms – Ultra-wideband, impulse radio, differential code-shifted reference, maximum likelihood sequence estimator, pulse position modulation, intersymbol Interference, channel state information.

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Solar Energy DC-DC Converters Circuits: Compering and Guidelines

Bader Alluhaidah

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3J 2X4, Canada
Tel: 1-902-494-6065; Fax: 1-902-422-7535; E-mail: bluhaidah@dal.ca

Abstract – In the midst of limited fossil fuels sources, their international relation complexities, and the risks associated with nuclear power, scientist are searching for alternative energy sources. Moreover, these sources, which are non-renewable, cause harm to the environment such as global warming. For these reasons, renewable energy sources offer good solutions to such kind of challenges.

Solar energy is one of the best renewable energy sources. The overall efficiency of solar energy systems is still low due to material and design issues. Electrical engineering Researchers are working to transfer solar energy provided by solar panel to power grid or to be stored by using electrical converters.

DC-DC converters influence solar system efficiency. They should be compact, low cost and work in high efficiency. This research is focused on comparing between different types of converters circuits used in solar energy in terms of efficiency, size and cost. Also, their advantages and disadvantages will be reviewed. Finally, some guidelines will be presented for improving converters circuit design.

Index Terms – Solar converter, DC-DC converter, power electronics

Residential Photovoltaic in Saudi Arabia: A Case Study

Bandar Mutwali

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-456-5187; Fax: 1-902-422-7535; E-mail: bmutwali@dal.ca

Abstract – The need for renewable energy (RE) sources, such as solar, wind, and biomass has increased rapidly due to air pollution (i.e. carbon dioxide concentration in the atmosphere) and global warming concerns. The photovoltaic array is at the threshold of becoming one of the important suppliers of electricity. Saudi Arabia has been involved in solar energy development since 1960. Yet solar energy has not made reasonable progress due to several obstacles. This paper discusses the utilization of a roof top photovoltaic (PV) system in a residential area in Saudi Arabia. An energy consumption residential daily profile has been established. Different scenarios have been examined depending on different penetration levels of the PV system. The economic effects and reliability of PV system is also included in consideration. The calculation have been done using load demand and solar radiation for the year 2011.The purposes of this thesis are to emphasize the need of solar energy system in Saudi Arabia, show the obstacles that slow the implementation of PV system, and to present potential solutions. Homer and Microsoft excel software have been used in the study.

Several factors control the photovoltaic output power:

1. Solar irradiation data.
2. Geographical location
3. Tile angel and direction
4. Obstacles (tree, building)
5. PV array material
6. Balance of System

There are three steps that must be accomplished, in order to have a dependable economic analysis:

1. Data collection of household hourly demand.
2. Stipulate the PV system output power.
3. Gathering PV system prices from authentic distributors
4. Calculate the net value.

Index Terms – Residential PV, Solar system, Saudi Arabia

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Switching Losses and Harmonic Reduction in Multilevel Inverters

Baset Almarghani

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-3996; Fax: 1-902-422-7535; E-mail: Baset@dal.ca

Abstract – The use of multilevel inverters has increased noticeably during the last decade. Multilevel inverters are suitable for high voltage and high power application due to their ability to synthesize waveforms with better harmonic spectra. Numerous topologies have been introduced and widely studied for utility and drive applications.

The total harmonic distortion (THD) and switching losses decrease with the increase in the number of levels in the output voltage. However, with the decrease in carrier frequency, the THD level increases and switching losses reduce proportionately. Maximizing the levels for different multilevel inverters' topologies is accomplished by setting their input voltages to certain values. The selective harmonic elimination method for multilevel inverters can eliminate specific harmonic, however that does not guarantee that THD is not significant.

The main objective is to develop a higher-level inverter which optimizes the overall functionality. A key activity will be to develop and establish a complete simulation model for overall system performance, and simulate the multilevel inverter to achieve the best possible performance. The purpose of this research is to design and build high efficiency converters for different application. Two main issues will be considered. First, the harmonics accompanying with power converters. Second, the switching losses associated with multilevel inverters. The goal is to use multilevel inverters that generate harmonics as low as possible and minimize the switching losses.

Index Terms – Multilevel inverter, Harmonic distortion, Switching losses

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Plasmon-Enhanced Second-Harmonic Generation

Che Franklin Mbende

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-6131; Fax: 1-902-422-7535; E-mail: franklin.che @dal.ca

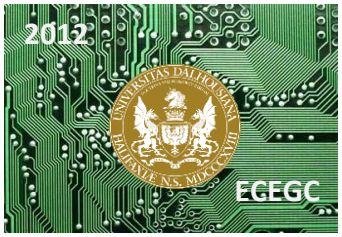
Abstract – Plasmon-enhanced second-harmonic generation is a non-linear optical phenomenon which deals with the frequency doubling of light that has been coupled into a surface plasmon. This technique has a wide range of applications in physics, biology and surface chemistry.

This talk presents the theory of surface plasmon-enhanced second-harmonic generation, using a plane wave approximation of the incident electric field. A 52-nm thick layer of gold on glass is used as our test structure. Two different illumination geometries are investigated. The first geometry involves illuminating the metal through the glass substrate while in the second geometry the metal is illuminated directly from air. The analytical calculations and graphs of the intensity of the second-harmonic wave radiated in reflection will be presented for both configurations.

The dependence of the second-harmonic intensity on the angle of incidence is investigated and the resonant enhancement is clearly demonstrated. In addition to this, the spectral behavior of the second-harmonic is also presented. To justify the use of a plane wave approximation, the results of the second-harmonic intensity using a plane wave are compared to the results obtained using a Gaussian beam. Theoretical calculations of the effect of temperature on the second-harmonic intensity are ongoing.

An experimental investigation of these theoretical findings using femtosecond infrared light is underway. Both the near field and far field second-harmonic intensities will be measured using our advanced Near-field Scanning Optical Microscope (NSOM) system.

Index Terms – Surface plasmons, Non-linear optics, Second-harmonic generation, NSOM



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The Power Analysis Side-Channel

Colin O'Flynn

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-6036 ; Fax: 1-902-422-7535; E-mail: coflynn@dal.ca

Abstract – Information security is a critical part of what has allowed the wireless channel to flourish. Since eavesdropping on wireless transmissions is trivial, all wireless protocols rely on information security techniques to protect the data; for example encrypting the data to lock out an eavesdropper.

The security of the data thus rides on the encryption algorithm chosen. Most recent protocols use proven secure algorithms such as AES; these algorithms typically guarantee that "breaking" them with currently available technology would require more time than the estimated age of the Earth.

These algorithms do not, however, run in a purely theoretical environment, they run on physical devices. These physical devices may have unintended emissions which form a *side channel*, accidently broadcasting information which should remain secret. Any CMOS device for example draws most of its power on the clock edges; by analyzing the power consumption of a device it is possible to infer operations being performed. An operation in a microcontroller which requires only a few gates will require less power than an operation which requires many gates. For certain algorithms knowing the operations being performed will leak the secret key, and allow an attacker to decrypt or spoof network traffic.

This presentation will provide a background in using power analysis to break encryption hardware, covering from the first substantial attacks by Paul Kocher in 1999, to more recent attacks which can be performed even on 'protected' hardware which should be impervious to side-channel attacks. Attacks using electromagnetic (EM) emissions will also be covered, which allow performing the attacks at a distance.

Work done at Dalhousie University will also be covered, which includes performing the attacks on the standard Side-channel Attack Standard Evaluation BOard (SASEBO), which is used internationally by security researchers.

These side-channel attacks are particularly of interest to people working on the upcoming Smart Grid. The Smart Grid would see deployment of small low-powered wireless devices on a large scale. These devices could easily be captured by attackers, and the planned deployment sees keys changing relatively infrequently (e.g.: same key used more than 24 hours). Work to secure the Smart Grid against this threat is instrumental to ensure the system remains secure for the planned lifetime of deployed nodes, which for certain devices such as smart meters, exceeds ten years.

Index Terms – side channel analysis, information security, smart grid, AES

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Ultra Wide Band Channel Estimation

Daljeet Singh

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3J 2X4, Canada
Tel: 1-902-452-2839 ; Fax: 1-902-422-7535; E-mail: daljeet.singh @dal.ca

Abstract – Ultra Wide Band (UWB) technology has gained a lot of interest in the recent past because it provides solution to the problem of the limited bandwidth in wireless communication. The UWB signal experiences different propagation impairments than traditional "narrowband" signals. Hence, there is a need of an accurate and good channel model which allows the capture of the unique characteristics of UWB signals. Such a channel model can be obtained through channel measurements.

The channel measurements can be done in frequency and time domain. In the frequency domain the measurements are carried by sweeping the band of interest with a vector network analyzer (VNA), which sends a tone through the channel and records the S-parameters of the channel. In the time domain the channel is sounded by a carrier signal, modulated by specially chosen waveform which makes it easy to analyze the effects of multipath environment on the received signal. In this time domain technique, the received signal can be stored on a digital sampling oscilloscope (DSO) for post processing and parameter extraction for the UWB channel model.

The UWB channel model can be considered as a statistic model. To measure it, an extensive measurement campaign is done by placing a UWB transmitter and a UWB receiver at various locations inside a building. The transmitter is kept fixed at a particular location but the receiver is moved from one position to another, so that the large and small scale effects on received signal can be evidenced. The impulse response of the channel is recorded every time the position of the receiver is changed, and form these recorded impulse responses the Power Delay profile (PDP) is created. The PDP is used to calculate path loss, multipath arrival times, rms delay spread and average multipath intensity profile, experienced by the UWB signal.

The measured channel parameters are important and useful for design of the UWB systems. The path-loss usually presents the local average received power relative to the transmit power. The rms delay spread determines the requirement of the UWB system, e.g. if in a building the rms delay spread is of the order of 30 to 60 ns, the UWB data transfer rates up to several Mps can be achieved without equalization; however, if the rms delay spread is as large as 300ns the data rates may be limited to few hundred kbps without equalization.

Index Terms – Ultra wideband, channel model, power delay profile (PDP), root mean square (RMS) delay, multipath arrival times, statistical models.

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Application of Photonic Crystal for a Silicon-based Kerr-effect Electro-Optic Switch

Deepak V. Simili

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494- 3996 ; Fax: 1-902-422-7535; E-mail: deepak.v.simili @dal.ca

Abstract – The application of nanostructures such as a photonic crystal in the design of a silicon-based electro-optic Kerr-effect switch is investigated. The desired characteristics of the switch are ultrafast switching time of the order of 10 ps, low bias voltage, polarization independence and operation at the telecommunication wavelength of 1.55 micrometers.

Since linear electro-optic effect does not exist in silicon, quadratic electro-optic Kerr effect was selected. This is because of its instantaneous response making it most suitable to be utilized for the application of ultrafast switching. Although the electro-optic Kerr-effect is advantageous because of its instantaneous response, it is hard to utilize in silicon because of the weak nonlinear properties of the material. However, the nonlinear properties can be enhanced using nanostructures such as photonic crystals to obtain an improved effective nonlinearity for the structure which could be utilised for ultrafast switching application.

The possible use of slow light photonic crystal waveguide is investigated as this structure would lead to a better light matter interaction leading to an enhanced nonlinearity required for the operation of the switch. The enhanced nonlinearity for the structure would result in a larger change in the refractive index compared to just silicon alone, making it a more efficient alternative to use in the design of an electro-optic switch. However, losses due to absorption effects such as two photon absorption would also be enhanced. Therefore a figure of merit or efficiency of the structure needs to be evaluated in order to justify the use of the slow light photonic crystal waveguide.

My future work is to perform a Kerr effect analysis of the photonic crystal waveguides discussed in literature and then use these waveguides in the design of a silicon-based Kerr-effect electro-optic switch.

Index Terms – Kerr effect, Silicon, electro-optic switch, photonic crystal

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Visible Light Communication

Durgesh Gujjari

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3J 2X4, Canada
Tel: 1-902-494-3258; Fax: 1-902-422-7535; E-mail: dr582758 @dal.ca

Abstract – Human kind has been utilizing light as a communication medium for many years, and it continued to be of excellent use. The invention of Light Emitting Diode (LED) has led to future interest in the field of optical communication, which is known as Visible Light Communication (VLC). LEDs are not only used for lighting but also for data communication in wireless optical communication technology. LED`s ability to transfer information signals over light makes it a very good source for the communication medium.VLC is a technology, which provides data communication over light using LEDs which has 400THz to 800THz of frequency and wavelength between 400nm to 700nm.

The basic prototype for VLC has been proposed and experimentally demonstrated, which is simple and effective in providing the serial data communication over the medium of light. The model demonstrates how the VLC can be effectively used for communication, utilizing the present infrastructure. The experimental setup consists of two computers (transmitter and receiver). The transmitter circuit converts RS-232 levels to Transistor-Transistor Logic (TTL) levels and LED is used at the TTL level to transmit the data over light. Photodiode (PD) on the receiver side detects the light signal, converts it into electrical signal and sends it to the receiver circuit, which converts the TTL levels to RS-232 levels, and that are processed by the receiver computer. The capacitance of the LED limits the transmission speed. Currently, I obtained up to 115.2 kbps. It is possible to reach higher speeds. The predicted data rates can be up to 1Gbps.

LED has an advantage in potentially fast switching, long life and very low power consumption (energy efficient).VLC can be utilized in the present infrastructures without making major changes; it can be used for both indoor and outdoor communications for internet access, traffic control and safety. VLC has several advantages over the radio waves. LED being visible light is nature friendly, which does not cause any health problems and hence can be used in places where we cannot use radio waves like in hospitals and undergrounds tunnels. Modulation in VLC involves the data transformation into bit sequences of 1`s and 0`s for serial communication. Visible light communication is an interesting field of research and very promising for the future wireless communication technology.

Index Terms– VLC, Wireless Optical Communication, LED, PD, RS-232, TTL

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High Voltage Direct Current Load on the Power Flow

Elssodani Abdelhadi

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-6065 ; Fax: 1-902-422-7535; E-mail: el272301@dal.ca

Abstract –This work presents the power flow of electric power network with High Voltage Direct Current (HVDC). The analysis of the Power flow is very significant, because it provides the necessary information of the system at different operational states. One of the main objectives of the power flow analysis is to determine the active and reactive power flowing, active and reactive power loss, and buses voltages.

This work describes the power flow problem, formulation and solution methods. There are many techniques used to solve power flow problem. The most common methods are Newton-Raphson's (coupled & decoupled) and Gauss-Sidel iterative methods. The Direct Current (DC) network can be solved using Gauss-Sidel method. These methods assigned one of the system nodes (bus) to be a reference bus by fixing its voltage and phase angle.

My future work would include developing a new control strategy for converter stations, which takes into account the inter-relation between the reactive power requirement, the DC bus voltages, DC currents transformer taps and the converter control angles.

Index Terms – HVDC, Power flow, Newton-Raphson's, Gauss-Sidel Method

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A Broadband Dual-Polarized Omnidirectional Antenna for 4G LTE Applications with MIMO

Farid Jolani

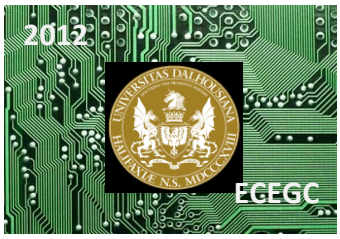
Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-489-9730; Fax: 1-902-422-7535; E-mail: farid.jolani@dal.ca

Abstract – Dual-polarized omnidirectional antennas are particularly preferable for indoor and base station wireless communications, since they can transmit or receive wireless signals of vertical and horizontal polarization to ensure full coverage of a surrounding environment. In a 3G network, they are often used together to form a multiple-input-multiple-output (MIMO) antenna system and provide polarization diversity in substitution for space diversity to improve communication performance, especially in multipath environments.

Recently, several designs of the dual-polarized omnidirectional antenna have been proposed in attempts to increase operational bandwidth to meet the requirement of a 4G LTE network. A typical E-plane omnidirectional antenna has been used for a 3G wireless network; however, it only provides a bandwidth of 10 % or less. Therefore, when it is used directly in the 4G Long-Term Evolution (LTE) wireless network, it is not adequate for the 4G requirements of higher data throughput and longer link range. A vertically polarized omnidirectional antenna has been widely investigated, but it is bulky and not easy to use.

In this presentation, a broadband dual-polarized omnidirectional antenna for use in 4G Long-time-evolution (LTE) wireless systems and networks is presented. Its vertically polarized module has an ultra-wide operational bandwidth of 2.5 GHz that covers existing CDMA, TDMA, GSM 900, PCS, DECT, GSM1900, UMTS, Bluetooth, ISM, and WLAN bands; whereas its horizontally polarized module operates from 1.88GHz to 2.5 GHz covering GSM1900, UMTS, Bluetooth, ISM, and WLAN bands with a VSWR lower than 1.6:1. Compact design, along with the omnidirectional radiation pattern, makes it very suitable for ceiling or surface mounted 4G indoor and automobile applications. In addition, a spacer is used to provide 30dB of isolation and two modules are positioned in such a way that cross-talk between the two modules is minimized and the power efficiency is maximized

Index Terms – Multiple input multi output (MIMO), dual-polarized antenna, long term evolution (LTE), omnidirectional.



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Robust PI Controllers for Tidal Current Turbine Based on Direct Drive Permanent Magnet Synchronous Generator for Improving Power System Stability

Hamed Hamed Hendawy Aly

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-6065; Fax: 1-902-422-7535; E-mail: hamed.aly @dal.ca

Abstract – The increasing penetration of renewable energy in the power grid makes it one of the most important topics for generating electricity for the near future. Tidal currents energy is one of the most rapidly growing technologies for generating electricity. Tidal energy is effective and clean in supplying electrical loads especially in remote and rural areas. Doubly Fed Induction Generator (DFIG) and Direct Drive Permanent Magnet Synchronous Generators (DDPMSG) are the most commonly used generators with tidal current turbines.

The aim of this paper is to analyze a typical configuration of a tidal turbine based on (DDPMSG) and propose PI controllers for the grid side converter and generator side converter for improving the stability of the overall system under different conditions. A model has been developed by using a synchronously rotating d-q reference frame with the direct-axis oriented along the stator flux position. The reference frame is rotating with the same speed as the stator voltage.

The dynamic modeling of the overall tidal turbine system contains all subsystems such as a fluid speed model used for generating a speed signal applied to the rotor, the rotor model, the generator, the converter, the rotor speed controller, the pitch angle controller (for changing the blade pitch angle to control the amount of energy during high speeds), and the voltage controller (for controlling the voltage near the reference value). The overall system is tested for a small disturbance using the proposed PI controllers. The analytical and the simulation results illustrate the robustness of the proposed PI controllers for improving the power system stability.

Index Terms – Tidal current power, direct drive permanent magnet synchronous generator (DDPMSG), power system modeling, power system stability

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A High-Output Impedance, Wide Swing Bulk-Driven Current Source with Dynamic Biasing

Haoran Yu

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-6132; Fax: 1-902-422-7535; E-mail: Haoran.Yu @dal.ca

Abstract – In recent years, mobile electronics have been blooming. Since these applications require designers to extend operation time as long as possible, low power design is necessary. On the other hand, the feature size of CMOS technology is keeping scaling down. In order to avoid breakdown, the supply voltage must be reduced. Thus low voltage low power design becomes more and more popular and necessary. However, the threshold voltage (V_T) of MOSFET is maintained to limit the off current. These factors impose serious challenges on modern CMOS circuit design.

Bulk-driven technology has been proposed to remove the voltage limitation accompanied with V_T at the signal path. The bulk-driven MOSFET works in a 'depletion mode' which allows negative, zero and small positive bias voltage at bulk node as long as the bulk-source junction is not excessively forward biased. This enlarges the input common-mode range as well as the signal swing which cannot be realized by gate-driven technology at low power supply voltage.

Current mirrors/ sources are an essential element in almost all analog circuits. Bulk-driven current mirror has been proposed for low voltage application. However, the bulk-driven current mirrors presented in the recent years have limited performances. Simple bulk-driven current mirror suffers from low output impedance. Cascode current mirror and current mirror with feedback amplifier can increase output impedance; however, the output voltage (V_{out}) is bound to $2 \cdot V_{SD,sat}$ or $V_{SD,sat}+V_{in}$. This limits their application under ultra-low voltage.

To achieve both high output impedance and wide swing, a bulk-driven regulated cascode current source with dynamic biasing is proposed. To increase the output impedance, a bulk-driven gain-boosted cascode feedback amplifier is used. Two dynamic biasing circuits are introduced: one is used to adaptively bias the gate of the current source output transistor while the other is used to supplement current into the output node when the output voltage is low. In addition, the dynamic biasing circuits help to boost the output impedance further. Simulation results show that under 0.6 V supply voltage, the minimum output voltage is below 100 mV and the output impedance is over 200 MΩ.

Index Terms – MOSFET, bulk-driven, current source, dynamic biasing

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Micro-Electro-Mechanical-Systems-Based Micromirrors for High-Resolution Imaging of the Ear

Hasan Tareq Imam

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494- 7866 ; Fax: 1-902-422-7535; E-mail: hs422913@dal.ca

Abstract – **M**icro-electro-mechanical-systems-(MEMS)-based micromirrors have been the subject of intense research for more than two decades. Initial interests in these mirrors were primarily for telecommunication and optical scanning applications. Recently, MEMS mirrors are finding their way into the biomedical market.

Optical coherence tomography (OCT) is a diagnostic imaging modality that uses low coherence interferometry to produce high-resolution, depth-resolved cross-sectional images of living tissues. It has recently been applied to imaging the ear, an area where traditional volumetric imaging techniques like computed tomography (CT) and magnetic resonance imaging (MRI) (MRI) lack the requisite resolution to capture the tiny anatomy of the middle and inner ear. The aim of this project is to design two scanning micromirrors for integration into a high-resolution OCT enabled microscope for otological diagnostic imaging. One mirror tilts in one-dimension (1D), and acts as a delay line controlling the imaging depth in ear tissue. A second micromirror tilts in a two-dimensional (2D) fashion, and scans laterally over the microscope's field of view.

In my prior work, electrostatically actuated traditional MEMS micromirrors have been designed, and their static and dynamic performance was thoroughly investigated. The main disadvantage of the traditional design is the "pull-in" phenomenon, and the coupling of X and Y tilts for 2D mirrors. Decoupling X-Y tilts will enable the use of multiple 1D control systems to control a 2D micromirror. In this work, micromirror devices with triangular electrodes are analyzed. Analytic expression for the decoupling mechanism was derived and the relations among the tilt angle, critical structural dimensions, and applied voltage were obtained. The analytical expressions have been verified using MATLAB simulation and finite element analysis (FEA) tools. Both analytic and FEA simulation results show significant improvement in the linearity performance of X and Y tilt, and the tilts are relatively decoupled. To control the micromirror system, a multi-loop digital proportional, integral and derivative (PID) controller is proposed and implemented. Design mechanism and MATLAB simulation of the control system is also discussed. Test structures are fabricated using standard PolyMUMPS surface micromachining process.

Future work of this project involves calibration of the fabricated devices, control system testing, and in-lab fabrication of the micromirrors using the facilities of Dr. Yuan Ma and fabrication facilities of Dr. Rob Adamson.

Index Terms – micromirror, decoupling, PID control, OCT system

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State Estimation in Electrical Networks

Hossam Mosbah

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3J 2X4, Canada
Tel: 1-902-6218; Fax: 1-902-422-7535; E-mail:hs617117 @dal.ca

Abstract – State estimation issues have been one of the critical challenges in many different departments, so the accuracy of the state estimation completely relies on the reliability of the systems. One of the important reasons of using state estimation is to detect, identify, and eliminate errors which may occur because of unreliable measurements or data. This research is divided into four main parts. The first part talks about the general idea of state estimation such as the history of state estimations and how has this method been constantly developing.

In the second part the research goes deeply into discussion of one of a challenging method which is the Least Squares Method (LSM). It is a well-known statistical or technical method which computes the best fit model that can pass most of random variables; in other words, the Least Square Method is a relation between observatories and predictors by involving some theoretical equations. The concept of the Least Squares Method (LSM) has been invented early in the nineteen century and has been involved in several challenge applications; for instance, the location of aerospace vehicles. For many years the Least Squares Method has been developing and used in wide applications in different departments.

The third part of this research will discuss two different applications in Weighted Least Squares which is a useful method to estimate some variables from several methods to compute numerical values of parameters by minimizing the sum of squared deviations between observed responses and functional portions of certain models. In addition to that, we will involve two important methods to develop the Weighted Least Squared method, i.e the Kalman Filter (KFLS), which is a set of mathematical equations that estimate different processes by taking into account both incoming measurements and predictors to obtain an optimal estimation of a certain system state. The second important method is Robust Least Square (RLS) which is one of the state estimation's method used to overcome some limitations of parametric and non-parametric methods.

In the fourth part, we will gather all the data obtained from several electrical networks by programing two new applications in order to illustrate and discuss them with comparing the difference between using different approach including the Kaman filter (KFLS) and the robust estimation (RLS).

Index Terms – state distribution, Kalman filter state estimation, weighted least square, absolute least value

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Extracting Left Ventricular Contour by Multi Valued Neural Cellular Neural Networks, Universal Binary Neurons Cellular Neural Networks and Region Based Level Set Method

Hussin Shaban Ketout

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3J 2X4, Canada
Tel: 1-902-494- 6102 ; Fax: 1-902-422-7535; E-mail: Hussin.Ketout@dal.ca

Abstract – In this work, the detection of the boundaries and extraction of the area of left ventricular are proposed. The echocardiographic image is preprocessed to enhance the contrast and smoothness by utilizing Multi Valued Neural Cellular Neural Networks (MVN_CNN) non linear filter. Universal Binary Neurons Cellular Neural Networks (UBN_CNN) is applied to the smoothed image to detect the heart boundaries. A non threshold Boolean function with nine variables is utilized to detect the edges corresponding to the upward and downward brightness overleaps.A region based level set method is applied to extract the area of left ventricular. Some experimental results are given for different echocardiographic images. The detection and extraction combination of UBN_CNN and region based level set approach showed better results for extracting the LV boundaries.

Index Terms– Endocardial, Echocardiography, artifacts, CNN, MVN_CNN, UBN_CNN, level set method.

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Bandwidth Efficiency in Beam-Forming Based Modulations for Wireless Communications

Javad Hoseyni

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-2332 ; Fax: 1-902-422-7535; javad.hoseyni@dal.ca

Abstract – The ever-increasing demands for high throughput and high spectral efficiency are key factors that drive research in wireless communication systems. Multiple antennas, multiple input-multiple output (MIMO) systems, multi-carrier modulation, adaptive coding, space–time coding (STC) and turbo decoding algorithms are all examples of compelling up-and-coming techniques in future wireless systems. Yet, while multiple-antenna techniques are central to modern wireless communications, they trade off power and bandwidth efficiency for system complexity and cost.

A variety of techniques that utilize an antenna array have been standardized to improve bandwidth efficiency. Among them recently developed MIMO and Space Modulation (SM) are directly related to the proposed work. In particular, MIMO is a powerful performance-enhancing technique that uses an array to achieve spatial diversity, spatial multiplexing, interference reduction and noise robustness. SM uses an array for mapping information bits to the spatial positions of the transmitting antenna in the array.

In order to increase the spectral efficiency of wireless communication systems, we propose a novel space, time and frequency modulation scheme that uses an antenna array to map the information bits to the beam angle of the transmitted signal. In this beam-forming based modulation, an array consisting of a minimum of two antennas is engaged to transmit the data bits encoded in the spatial dimension. The software-configured beam-forming modulation called here Beam Angle Channel Modulation (BACM) is investigated to exercise the power and bandwidth efficiency trade-offs. Based on this technique, different configurations of conventional time and frequency modulations concatenated with BACM will be presented as applied to different communication scenarios ranging from single to multiuser transmissions.

Index Terms – Bandwidth efficiency, channel modulation, beam angle, concatenated modulation

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Wireless Power Transmission Design for Small Implantable Medical Devices

Jeetkumar Atulkumar Mehta

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494- 2592; E-mail: jeet.mehta@dal.ca

Abstract – Wireless Power Transmission (WPT) is a technology to transfer power at a distance without any physical connection. WPT has gained lot of attention in last decade and has been extensively researched for its application in our day to day life such as wirelessly charging of electronic devices and more recently wirelessly transmitting of power for implantable medical devices such as a pacemaker.

This presentation presents a highly-efficient wireless power transmission system via magnetic resonance coupling (witricity) that has been exploited here for medical implantable device application. The implementation of the system along with the distances and dimensions that have been used to build the entire system is described. Two circular transmitting coils with different sizes has been implemented at the transmitter side while two coils of two different shapes, i.e. helical and rectangular, are used at the receiver side. The resonance between transmitting and receiving coils is achieved by terminating it with lumped resistors and capacitors. A proof-of-concept prototype was simulated and fabricated. The simulated efficiency of 87% is achieved at a distance of 14 cm and 65% at a distance of 20 cm, respectively.

Index Terms – wireless power transfer, magnetic resonance coupling, transmission efficiency, transmission distance.

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Denoising ECG Signals Using Wavelet Transform

Khald Hamed

Department of Electrical and Computer Engineering Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494- 6102; Fax: 1-902-422-7535; E-mail: kh200274 @dal.ca

ECG is an important diagnostic tool for assessing heart function. According to the publication Leading Causes of Death in Canada, 2008, heart disease was the second leading causes of death in Canada, were responsible for 50,109 of deaths in 2008.

The recorded ECG signal is often contaminated by noise and artifacts that can be within the frequency band of interest and can affect the characteristics of the ECG signal itself. This noise can mask some important features of the ECG signal.

In this work, I will implement and evaluate a wavelet filter technique to remove the baseline wandering noise, the baseline noise may be caused in the chest lead ECG signals by coughing or breathing, with large movements of the chest, or when an arm or leg is moved during the ECG data acquisition.

The wavelet transform transforms ECG signal from the time domain into wavelet coefficients at wavelet domain. Wavelet coefficients are modified by thresholding to de-noise the signal. Three different methods are used to calculate the threshold value and soft threshold and hard threshold function used to de-noise the ECG signal.

Index Terms – Wavelet transform, Threshold, Denoise

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Differential Code-Shifted Reference Impulse-Radio Ultra-Wideband Receiver: Timing Recovery and Digital Implementation

Khalid Aldubaikhy

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
E-mail: kh595217@dal.ca

Abstract – Ultra-Wideband (UWB) is a wireless system which transmits signals across a much wider frequency spectrum than traditional wireless systems. Impulse radio and multicarrier are the two different techniques for UWB signal transmission. In particular, the impulse radio technique uses very short duration pulses of nanoseconds or less, rendering the UWB system with low power, low complexity, low detection probability and low interference susceptibility. Along this line, code-shifted reference (CSR) and differential code-shifted reference (DCSR) have recently been proposed by our research group to improve the performances over the previous impulse radio UWB systems.

In spite of the above developments, impulse radio UWB technology has also presented several implementation challenges. Synchronization between the transmitter and receiver is one of them that need to be addressed.

The synchronization of the impulse radio UWB system involves two steps: code synchronization and timing recovery. This presentation is focused on the timing recovery between the transmitter and receiver. A new non-coherent energy detection technique and its algorithm are proposed and shown for timing recovery by means of a phase-locked loop (PLL) circuit. The timing recovery algorithm for the non-coherent DCSR-UWB receiver is implemented with Lattice ECP2 field programmable gate array (FPGA) standard evaluation board with VHDL (a VHSIC hardware description language). Simulations were presented to verify the proposed algorithm with the use of ALDEC's Active HDL software which is a Windows based integrated FPGA Design Creation and Simulation solution. The results show that the timing synchronization can be effectively achieved without much error.

Index Terms – UWB, ultra wideband, impulse radio, code-shifted reference, differential code-shifted reference, receiver, synchronization, timing recovery.

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Partially Coherent Self-Similar Pulses in Resonant Linear Absorbers

Laleh Mokhtarpour

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-6131 ; Fax: 1-902-422-7535; E-mail: Laleh.Mkht @dal.ca

Abstract -- The growing interest in the ultrafast optical communication systems has motivated the recent surge of activity in the field of ultrafast statistical optics. The progress was initiated in the way that extended the optical coherence theory of statistically stationary fields to the non-stationary case. Propagation properties of statistical pulses-especially the ones that maintain their temporal profile on propagation- have been explored in linear dispersive media far from internal resonances. Although shape-invariant propagation of fully coherent ultra short pulses in linear amplifiers and absorbers in the vicinity of an optical resonance has been recently examined; the influence of statistical properties on pulse evolution has not been explored in the resonant case.

The objective of this presentation is to present explicit classes of partially coherent pulses that propagate in resonant linear absorbers without changing their shape. We show how such pulses can be constructed from the previously discovered shape-invariant modes of resonant absorbers by extending the coherent-mode representation of optical coherence theory to the case of statistical pulses.

To set the stage, we examine small-area statistical pulse propagation in a homogenously broadened resonant absorber under exact resonance condition. A dilute atomic vapor filling a high vacuum cell can serve as a physical realization of the medium. The proposed self-similar pulses can be realized with nanosecond small-area input pulses in a few centimeter long cells filled with the homogeneously broadened dilute vapor.

Next, we prove that the system supports a class of fully coherent shape-invariant modes. Then, it is shown that similar to the fully coherent case, the partially coherent pulse shape depends on the magnitude of the spectral mode profile at the source. For sufficiently large spectral mode profiles at the source, the source field has a spectral hole at the center, resulting in the self-similar evolution of the pulse from the outset. Otherwise, the transient pulse reshaping causes the spectral hole to appear at the pulse center, which is followed by shape-invariant pulse propagation.

Index Terms -- statistical optics, partially coherent pulses, resonant case, linear media and absorbers.

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Surface-Enhanced Second-Harmonic Generation Excited by Gaussian Mode and (10) Hermite-Gaussian Mode Laser Beams

Luyu Wang

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-999-2630; E-mail: luyuwang@dal.ca

Abstract – The second order nonlinear excitation of surface plasmons on a metal film by different statistical laser beams has been of interest to both academics and industry. An excitation beam of frequency ω can be used in a Kretschmann configuration to induce a second-harmonic (SH) polarization and give rise to surface plasmon excitation at frequency of 2ω. However, the current theoretical treatment has only taken into account of surface nonlinear polarization $\chi^{(2)}_{s,xzx}$, while it has been observed that another component $\chi^{(2)}_{s,zzz}$ is also critical in explaining the experimental results. In addition, for simplicity, the existing works often employ plane wave models to represent incident beams. As a result, little information is provided about the beam effects. In this presentation, by using realistic beam models, we solve the above problem and obtain the SH far-field beam profiles (intensity).

We first statistically describe the incident beam in angular spectrum, for both G_{00} and HG_{10} modes. The paraxial approximation is validated for the case of the radius of beam waist being much greater that one wavelength. Then, because Kretschmann configuration consists of three-layered media, prism, metal, and air, fields are computed with adapting electromagnetic theory for modeling multi-beam interferences. Once the fields on prism-metal and metal-air interferences are obtained, the SH surface polarizations are calculated, forming the sources of scattered SH waves. Green's theorem is finally applied to represent the nonlinear ways in integral forms. The numerical results show that for the fundamental Gaussian mode (G_{00}), its SH far-field beam profile remains Gaussian; but for (10) Hermite-Gaussian mode (HG_{10}), the mode profile exhibits multiple dark rings (zero-valued poles), which is unique and presents some potentially interesting applications in the future. We show that the proximity to the plasmon resonance strongly affects the structure of the generated peaks and dark rings in the far-field SH.

Index Terms – surface plasmons, second-harmonic generation, nonlinear surface polarization, higher-order laser mode, zero-valued poles

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Self-Sufficient Radio Frequency Power Harvesting

Maziar Rastmanesh

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-6132; Fax: 1-902-422-7535; E-mail: mz318623@dal.ca

Abstract – Radio frequency (RF) power harvesting has been a current line of research with numerous applications in RFID, Biomedical, Sensor network and others.

Rectifier is the main element of the circuit. It is challenging to design an efficient rectifier, as the maximum available RF input voltage (300 mV AC) is much smaller than threshold voltage of a MOSFET (nearly 600mV). Many techniques have been proposed to reduce the threshold voltage. Our proposed method mainly focuses on the application of V_{gd} in PMOS through pre-charged capacitor, recharging this capacitor periodically. To charge the nodes there are switched capacitor switches (one for each stage) which send current to the node.

The required hardware is: ring oscillator for clock generation, a clock shaper, and a clock booster to increase the pulse amplitude of the clock to push the switches for maximum closures. All of these modules are part of self sufficient RF to DC power harvester.

Charging the capacitors creates some ripple on the output voltage as a result of chopping. This ripple can be alleviated by increasing the output capacitor size in each stage. To optimize the design, tradeoff has to be made between capacitor size, output ripple and the output voltage.

The rectifier exhibits lower input threshold and a high output voltage. The efficiency improvement will concentrate on the multi stage rectifier for maximum AC-DC conversion. Further improvement could be achieved by tradeoff among impedance matching, power reflection, number of stages and the output voltage.

Index Terms – 90-nm CMOS, RF power harvesting, threshold compensation techniques, efficiency

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Energy Saving for Fixed-Speed Motors

Medhat Esmat

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-6065 ; Fax: 1-902-422-7535; E-mail: Medhat.Esmat@dal.ca

Abstract – The rapid increase of energy demand is expected to gather further momentum in the coming years and thus the limited energy sources require finding new energy sources rather than the conventional sources.

There are many alternative sources of energy like wind, tidal, wave, and solar but their capacity is limited.

In the industrial field 75% of used energy is consumed by different types of motors including energy waste. There are several methods to save energy such as a use of variable speed motors.

Our work will discuss the possibility of saving energy by monitoring the relation between the load (torque on the motor shaft), voltage, and current. As both voltage and frequency are fixed, monitoring the load will reduce the current accordingly to provide the only necessary energy to the motor.

Controlling the firing angle of thyristors feeding the motor will control the current value and consequently the power consumed by the motor while keeping the speed fixed.

Successful application of this idea will lead to consume the exact load energy, not the motor power, (i.e. 20 KW motor with 2 KW load will consume only 2 kW instead of 20 KW).

Index Terms – Energy system, Renewable Energy, Variable Speed Motors, Fixed Speed Motors

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Stochastic Flash Analog to Digital Converter

Mithun Ceekala

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-488- 0454 ; E-mail: mithun.ceekala @dal.ca

Abstract – A standard Flash ADC uses string resistor to set the comparator strip points. Normally a resistor cannot be manufactured exactly without any deviation from the desired value and also each comparator has an internal offset which is referred to as Input Referred Offset. Internal offset of comparator is caused by static mismatch, due to variations in threshold voltage and in oxide capacitance and also a Dynamic mismatch, due to internal node parasitic capacitors imbalance. Input referred offset and resistor deviations in a Standard Flash ADC requires offset cancellation circuit for the comparators and also trimming the resistor reference ladder to make the Flash ADC to work properly. This requires a large chip area and increased power consumption. Without any special processing or calibration the resolution is limited to 5-bit resolution due to offset and resistors mismatch.

A Stochastic Flash ADC uses comparator random offset as the trip point while all the comparators have the same reference voltages. Since the offset of a basic comparator depends on number of independent random variables, the offset will follow randomly distributed Gaussian function and this can be verified by performing the Monte Carlo analysis of a dynamic comparator. Since the offset is random signal instead of deterministic values, we have to use more than 2^n-1 comparators- the random Gaussian function of dynamic comparator implemented using 90nm CMOS technology has a standard deviation of 140mVand the cumulative distribution of the Gaussian curve will be linear for the range ±140mV. It means that a Stochastic Flash ADC implemented using this comparator will have an input dynamic range of ±140mV. To increase the input range, in this research work the reference voltages of the comparators in the stochastic ADC are generated using an inverse bell-shape random function. With the proposed technique, the input dynamic range of a stochastic flash ADC can be increased from ±140mV to ±400mV with also increase in resolution with the same number of comparators.

As a conclusion, if a stochastic flash ADC with inverse bell-shaped random signal is applied to the reference voltages of the comparators, then the input dynamic range of the ADC can be increased and an effective number of bits (ENOB) of more than 7-bit can be obtained.

Index Terms – Input referred offset voltage, Dynamic comparator, Monte Carlo analysis, stochastic signal, Gaussian signal, inverse bell-shape random, cumulative distribution and Resolution.

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Modeling Simulation and Optimization of Residential and Commercial Energy Systems

Mohamed Abdussalam Bregaw

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-6218; Fax: 1-902-422-7535; E-mail: mh279479@dal.ca

Abstract – Residential Energy Management System (REMS) in smart grid can be defined as processes of control systems designed to control, measure, monitor, and modify energy demand and energy consumption. REMS provides a capability to manage daily load curve in order to reduce power consumption and energy cost. Consequently, REMS offers significant benefits for both the electricity suppliers and consumers in terms of control and schedule time of use of major appliances in residential sector.

In recent years, however, the rate of energy demand has increased rapidly throughout the world while energy prices have been fluctuating over time. In order to find the solution for such problems, REMS establishes the optimal daily operation of home appliances. Numerous methods are used for REMS; this study analyzes many candidate scenarios during peak and off peak load periods compared to the tariff of residential sector to reduce the usage and its associated costs. It presents simulated results of proposed REMS to provide automated least cost demand response. The main approach is to ensure the satisfaction of the requirements with constraints on efficient use of energy. In this research multiphasic system behavior and individual sets of components simulation of smart appliances in residential and commercial energy systems with a realistic manner are proposed.

Index Terms – Residential Energy Management System, energy demand, daily load curve, multiphasic system, demand response

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Optimal Siting and Sizing of Distributed Generation in Distributed Systems

Mohamed Darfoun

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-292-5455; Fax: 1-902-422-7535; E-mail: M.Darfoun@dal.ca

Abstract – Distribution Generation (DG) has gained increasing popularity as a viable element of electric power systems. DG is a small source of electric power generation (typically range from less than a kW to tens of MWs) that is not a part of central power system and is located close to the load, and it is usually deployed within the Distribution System (DS).

The connection of DG has a great impact on the operation and planning of distribution network. It is very useful in reducing the line losses, as well as improving the voltage profiles which has a relation to the selection of installation site and optimal capacity of DG.

The problem of optimal DG placement and sizing can be divided into two sub-problems: where is the optimal location for DG placement and how to select the most suitable size? In My work, the DG integration problem for single and multiple installations is handled via deterministic and heuristic methods, where the results obtained justify the importance of optimal placement of distributed generation (DG) for minimizing losses and maximizing saving while maintaining appropriate voltage profile at all the buses. The proposed approach has been tested on IEEE 33-bus distribution test system and the program was simulated using MATLAB software.

Index Terms – Distributed Generation (DG), Radial distributed network, Optimal location, Optimal size, Loss minimization

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Models of Semiconductor Surface-Plasmon Dispersion Including Losses

Mohamed Eldlio

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494- 3258; Fax: 1-902-422-7535; E-mail: meldlio @dal.ca

Abstract – The aim is to study and develop a theoretical treatment to find a suitable model of surface plasmon, which works for semiconductors. By using different models, we derived new plasma dispersion formula. We chose the Drude-Lorentz (DL) model for our work. The comparison of the surface plasmon interaction at an interface between two different materials for different models is a very important issue in our work. For example, when going from Drude model to DL model, including the imaginary part, which means the losses are taken into account, one observes the changes in the surface plasmon polariton (SPP) resonances. Large losses seriously limit the practicality of the metals for many novel applications of SPPs.

The term Surface Plasmon Polaritons comes from coupled modes, which can be used to confine light and increase the electromagnetic fields near those interfaces of an interface between two media of which of least one is conducting. The plasmon study is challenging and is complex due to the large losses at interfaces, which comes from the relaxation time (i.e., damping). Little attention has been paid to this phenomenon because it is very difficult to deal with. These losses, in absolute, are relative to the plasma dispersion. However, they affect the shape of plasmonic dispersion curve near the resonant frequency. At its most fundamental level, the dielectric permittivity theory can be extremely complex, requiring relatively advanced mathematics and physics.

We started with our model for a metal first, and later for a semiconductor. For semiconductor plasmonic, there are different models available. We begin by presenting the Debye, Cole-Cole, Drude, Lorentz, and Drude-Lorentz. All models that have been listed here have different applications, properties and requirements. In semiconductors, the energy of a photon maybe absorbed resulting in loss. To understand loss mechanism, the solutions of Maxwell's equations are required. The recent work in our group found a new solution for an optical plasmon at a semiconductor/dielectric interface, but the losses were not included. Our present work considers losses to complete the analysis and look for potential applications.

Index Terms – Surface plasma polariton, semiconductors, optical excitation

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Kinematic Simulation for PA10-7C Robot Arm

Mohamed Meftah

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-6102; Fax: 1-902-422-7535; E-mail:mf225030@dal.ca

Abstract – PA10-7C robot arm is an open kinematic structured chain with 7-Degrees of freedom, made by Mitsubishi Heavy Industries, Ltd., widely used in industry and in research. Kinematics provides a means to connect the operational space and joint space where the position and orientation of the end effector are conveniently described in the operational space while the robotic manipulator is controlled by motors in the joint space.

Kinematic modeling of PA10-7C robot arm involves forward kinematics and inverse kinematics. Forward kinematics is a mapping from the joint space to the operational space while Inverse kinematics is a mapping from the operational space to the joint space.

In the paper, the forward kinematics of PA10-7C robot arm is calculated efficiently based on the D-H model. D-H model parameters are used to describe the relationship between two consecutive frames of joints, then the Kinematic model is derived to describe the robot motion with respect to a fixed reference Cartesian frame by ignoring the forces and moments that cause motion of the structure.

The inverse kinematics of PA10-7C robot arm is calculated efficiently. Jacobian matrix for PA10-7C robot arm is derived to describe the relationship between joint angular velocities in the joint space and the end effector's velocities in Cartesian space.

A Matlab model of PA10-7C is built in the paper for the simulation. Robotic Toolbox; Simscape Toolbox and Control Toolbox are used to test the robotic arm. Finally, simulation results are discussed and the paper is concluded.

Index Terms – PA10-7C robot arm , Kinematic, forward kinematics, inverse kinematics, Jacobian

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Delay-Element-Based Analog-to-Digital Converter

Mohideen Raiz Ahamed Thulukkameetheen Uduman Ali

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-401-0568; E-mail: mh446310 @dal.ca

Abstract – The increasing problems with respect to nano-scale Complementary Metal-Oxide-Semiconductor (CMOS) process are the demands for fully digital CMOS gates operating at low supply voltages. Even the rapid advances in CMOS technology have increased the performance of digital circuits. Considering the history of analog electronics and transistors, many techniques have been presented to improve the analog amplifiers and circuits; these improvements include power consumption, accuracy, noise, bandwidth, high resolution and speed.

Fully digital-analog to digital converters (ADC) have potential applications in very low power Integrated Circuits (ICs) and can be implemented in digital CMOS technology. The basic object of this research work is the design of a fully digital ADC. This circuit will have a main building block delay elements, which are nothing but inverters, along with a frequency counter, latch and a thermometer encoder. The target technology used for designing the system is 90nm CMOS technology.

Variable delay elements have many applications in VLSI circuits. They are extensively used in digital delay locked loops, digitally controlled oscillators, microprocessor, memory circuits and sensors. In these entire circuits delay element is one of the key building blocks which directly affect the overall performance of the circuit.

In a fully digital delay based ADC the delay elements play the main role in digitization of the analog input. The amplitude variation of the input signal is converted to delay variations using delay elements and then the delay is digitized. As the delay of the inverter is a function of its input voltage. Typically in a delay element the relationship between controlling voltage and delay are highly non-linear which has a negative impact on the performance of an ADC. By tuning the control voltage and implementing different structure of inverter, a linear relation between delay and the controlling voltage can be obtained to increase the resolution of delay based ADC. Tuning the control voltage is the main process in a delay element. It has to be done in many ways, one of the methods is to control by giving the digitally programmable input to the delay element. The existent delay cells have a limited linearity. The main object of this research work is to propose a linear delay cell that is suitable to construct a medium resolution ADC

Index Terms – Delay element, latch, counter, encoder, digital ADC, high resolution, low power

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Impedance Control and its Implementation on Bilateral Teleoperated Robotic Arm

Mohsin Khan

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-8499 ; Fax: 1-902-422-7535; E-mail: mohsinkhan@dal.ca

Abstract – Teleoperations is a significant field in robotics research; its applications range from emergency rooms in hospitals to space station orbiting earth to Mars rovers scavenging the red planet for microscopic life. Our research work can be divided into three main parts: Development of adaptive impedance control for PA10 robotic arm, data compression for force data relay, and video encoder for video compression and transmission. The developed system is a single robot, a single user but multiple collaborator system. The master interface is developed using Adobe Flash and is cross operating system compatible.

For video broadcasting purposes, a H.264/AVC encoder is developed using Intel IPP which uses latest multicore capabilities of new processors and can encode and transmit high definition videos over internet in real time. Encoder is designed to be used for video with slow moving objects in it. Use of Intel IPP provides better compression ratio, shorter encoding time and improved PSNR than existing video encoders. The results of our compression algorithm have been verified using PSNR analysis and human perception survey. PSNR and human perception survey results of our H.264/AVC encoder showed better performance than comparable encoders at the same bandwidth. Our approach of using Intel IPP libraries and keeping video encoding separate from control software makes it easier to develop it using two different technologies and also enables it to run on a separate computer than the one which is connected to robot.

Index terms – Teleoperations, impedance control, H.264/AVC, PSNR

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Robust Decentralized Control of Power Systems

Mutlu Yilmaz

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-789-5877; Fax: 1-902-422-7535; E-mail: mutlu.yilmaz@dal.ca

Abstract – In this study, we propose appropriate robust control strategies and improve the control of a nonlinear system with fast changing configurations, like an electric power system. We begin by emphasizing the design of robust decentralized control. A new decentralized robust control design is applied to the excitation and turbine/governor control for more complex machine models. The design envisioned here is to enhance the performance controllable devices for a power system. The methodology is based on Linear Matrix Inequality (LMI) framework, which allows for the inclusion of a wider class of nonlinearities. This work extends these concepts to larger systems such as the IEEE 118-bus and 300-bus systems.

In the deregulated environment of a power industry there has been a shift towards innovative control methods. Any efficient method for control of large-scale power systems must accomplish the following requirements. Firstly, the control must operate more efficiently in a *decentralized* way, since power systems are modeled by different control devices with a variety of objectives. The decentralized control requires that each controllable device and/or subsystem is implemented independently based on its locally available measurements. These controllable devices are associated with governors, automatic voltage regulators (AVRs), power system stabilizers (PSSs), flexible AC transmission system (FACTS) controllers, and HVDC links. Because of the complex interaction between these controllable devices in the system, the analysis is difficult and the required models are highly nonlinear. Secondly, the control needs to be *robust,* in a sense that a robust control is identifies the class of all uncertain systems and enhances the stability of a system to guarantee desired performance over a wide range of operating conditions. However, robust control is responsible for reducing the influence of disturbances to output of to the system. To achieve robustness, we first identify the location of the control and controllable devices. Then, the allowed parameter range of the devices should be chosen. Recently, much of the work is based on a feedback linearization technique, which converts a nonlinear system to a linear one. One of the major challenges is that after conversion, the controller is still nonlinear and is still difficult to implement in practice. In addition, the design of a primary generator control has a number of unresolved problems. The first one is that in most realistic systems, all state variables cannot be chosen for control purposes. This pertains to the structurally constrained decentralized control which is still a difficult problem. The second is that a decentralized control technique may not ensure stability over a wide range of operating conditions. In this study, the method is based on LMI, which has recently been enhanced to nonlinear systems for a wide variety of stability.

Index Terms – Robust decentralized control, linear matrix inequality

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A Flexible Antenna Design for UWB Systems

Naga Satya Prasad Donavalli

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494- 2592 ; Fax: 1-902-422-7535; E-mail: ng647707@dal.ca

Abstract – A communication system is said to be ultra wideband (UWB) if the instantaneous spectral occupancy of the system is more than 500MHz or fractional bandwidth is more than 20%. Ultra-wide band communication systems have become one of the future technologies for low-cost, low-complexity, and short-range wireless systems. They are capable of high or low data rate transmission as well as accurate locating and positioning. As a result, UWB systems can find applications such as sensor networks, health monitoring and RFID tracking and location. In these applications, design of an appropriate UWB antenna becomes very challenging. In addition to satisfy the important electrical specifications of the UWB system, such as ultra-wide bandwidth, omni-directional radiation pattern, low dispersion and small size, the antenna is often required to be flexible, bendable and conformal to the objects it will attach to.

In this presentation, we will review the state-of-the-art in designing flexible UWB antennas and compare the existing methodologies and designs. We will then propose a potential new UWB antenna that is flexible, small size and operates in the band of 3.1GHz -10.6GHz per FCC standard.

Index Terms – Ultra wideband (UWB), flexible antenna, small size.

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Time-Difference Amplifiers for Time-to-Digital Converters with Low Sensitivity to Process Variations

Nithinsimha Puttamreddy

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-266-6785; E-mail: nt461071 @dal.ca

Abstract – In recent CMOS Technology, Process variations have become major issue in the design of integrated circuits using deep submicron technologies**.** This makes the design an increasingly complicated challenge, as circuit performance has to be maintained in all possible manufacturing and environmental situations. The compensation of process variations in analog integrated circuits (ICs) usually requires trimming, calibration and self-tuning. Recently, some techniques have been proposed for generating bias currents with a constant value that is independent of temperature and process. Although these circuits may prove effective in generating a constant voltage or current by themselves, there is no prior guarantee that once connected to the biased circuit this latter will have constant behavior.

This paper examines the technique to meet the energy conservation requirement of electronic circuits. Low-power design will certainly be the main-stream development of the future CMOS integrated circuits (ICs), which also poses significant challenges. To maintain energy-efficient sub-threshold operation, we must reduce variation and suppress leakage current. Sub-threshold technique is an effective way to solve these low-power problems.

This work proposes a new technique to reduce process-related sensitivity in sub-threshold ICs and its circuit implementation in Time difference Amplifiers. Time Difference amplifiers are used in time-to-digital converters (TDC) because the time resolution is better than the voltage resolution in recent integrated circuits. However, the conventional time amplifiers are limited in their time gain and input time difference range, because of their positive-feedback closed-loop architecture. An open-loop time amplifier is proposed in my work to achieve a large time gain up and relatively time gain is same as the current ratio. In addition, the gain of the TDA is very dependent on process &device mismatches. The TDA exhibits improved tolerance to process variations using the sub-threshold voltage characteristics and improves Gain linearity and speed in both low-gain and high-gain implementations, thus making it a strong candidate for multi-stage and coarse-fine TDC circuits. The proposed combined technique features a wider application prospect in ultra-low-power IC design in further-scaled fabrication processes.

Index Terms – TDC, process variation, sub-threshold, time difference amplifiers, TDA, high gain, low power

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Antenna Design for Ultra Wideband Communication

Nitin Gautam

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3J 2X4, Canada
Tel: 1-902-494- 2592; Fax: 1-902-422-7535; E-mail: nt943090@dal.ca

Abstract – Ultra Wide-Band (UWB) technology is one of the promising solutions for future communication systems due to its high-speed data rate and excellent immunity to multipath interference. The allocation of the 3.1-10.6 GHz spectrum by the Federal Communications Commission (FCC) for Ultra Wideband (UWB) radio applications has presented a myriad of exciting opportunities and challenges for design in the communications arena, including antenna design.

Successful transmission and reception of an Ultra Wideband pulse that occupies the entire 3.1-10.6 GHz spectrum require a UWB antenna to have a linear phase and VSWR ≤ 2 over the entire band of 7.0GHz. Compatibility with an integrated circuit also requires a UWB antenna to be unobtrusive and electrically small.

In this presentation, a comprehensive review of the fundamental antenna parameters that should be considered in designing any antenna, narrowband or UWB is presented. A compact microstrip patch antenna (dimensions 3cm×2cm) is then designed and prototyped on a FR4 substrate which is commonly used and commercially readily available. Both simulations and experiments are performed and the results are presented.

Keywords- Ultra wideband (UWB); antenna; microstrip patch; radiation pattern;

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An Empirical Study on Exchange Rate Forecasting Using Particle Swarm Optimization (PSO)

Raam Bharathwaaj Chennai Jagannathan

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-449-7138; E-mail:rm644424 @dal.ca

Abstract – Foreign exchange (Forex) market is a highly volatile environment that operates 24 hours a day with turnovers exceeding approximately 4 trillion USD dollars. It operates through a global network of banks, professionals and other individuals trading various currencies for another. Even though forex market has been in existence for long time, what's new over the years is the availability and accessibility of the exchange rate information to an individual. This triggered an array of substantial studies in understanding the market and has attracted a large number of researchers and financial experts to facilitate a way to forecast market conditions in near future.

Forecasting exchange rate is important as it determines the benefits and risks involved in international business environments. Technical forecasting has served as an important aspect in fundamental forecasting techniques which involves in effective use of technical indicators to quantify market data by considering current and past market conditions. Forex market being highly dynamic in nature, exhibits stochastic and random behavior. Evolutionary computational techniques have served as a vehicle for understanding and analyzing such chaotic environments. Their superior ability to explore a given search space and identifying various non-static dependencies in such environments, has invited their use in the field of time series forecasting. This research study focusses on one such popular technique known as Particle Swarm Optimization (PSO) and its ability to forecast.

Particle Swarm Optimization (PSO) is a population based stochastic optimization technique developed in 1995. The idea of achieving an objective using an individual and its interaction among the group is the main theme behind its development into an optimization technique. The backbone of this research study is to explore the possibilities of using PSO directly as a forecasting tool instead of an optimization technique. Key idea of this study is to feed technical indicators as input and let the algorithm explore the search space and determine a near optimal solution which would be the forecasted result. Present state of this study is focused on finding a suitable fitness function to quantify each individual in the algorithm. Future goal of this study is to generate appropriate buy and sell signals based on the forecasted results for generating profitable scenarios.

Index Terms –Time Series Forecasting, PSO, Evolutionary Computation, Forecasting Exchange Rate

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Opportunistic Network and Erasure Coding for Wireless Networks with Asynchronous Traffic

Scott Harold Melvin

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-3223; Fax: 1-902-422-7535; E-mail: scott.melvin@dal.ca

Abstract – In the traditional model of communication networks, the intermediate nodes operate as store-and-forward packet relays that transmit packets over point-to-point links. To deal with the complexity of exchanging data between terminal nodes, communication protocols allow independent data flows to share network resources to enable their arrival at their final destinations. While these protocols have been very successful in routing data flows across a network, they may not provide the most efficient means to do so when multiple flows of data use the same route.

Network coding seeks to break with the tradition of independent data flows, opting to allow information from numerous information flows to intermix at the various nodes that exist along the transmission path, allowing the formation of new flows. Instead of the nodes in the network simply acting as store-and-forward relays for the information packets they receive, they can now combine several of these independent packets into one or more new packets and forward these new packets on.

When deploying network coding in a wireless relay network with bi-directional exchange of data, the issue of time synchronization requires special attention. If the two terminal nodes exchanging data generate traffic flows with the same average rate and random arrival times, to utilize network coding based on XOR-ing of packets at the relay to its maximum potential, buffering of the traffic flows is needed, which may lead to prohibitive delays.

To restrict the amount of delay experienced by any data packet when network coding is used, this work proposes to periodically flush the packet buffer at the relay of any unpaired packets. When this flushing occurs, if there are any unpaired packets waiting to be network coded at the relay, "single packet" broadcasts will be used to transmit these unpaired packets. While the extra broadcasts introduced by this flushing will reduce the throughput efficiency of the network, these opportunistic "single packet" broadcasts are used in our work to send erasure coded packets. This is with the purpose of improving the overall reliability of the data exchange.

In particular, two methods to restrict the delay experienced by packets at the relay node are employed. The approaches are to either impose a time limit for buffering the packets, or limit the number of network coded transmissions before flushing the buffer and broadcasting any unpaired packets combined with erasure coded packets. Performance trade-offs between erasure based improvements in Packet Loss Rates (PLRs), delays, energy conservation and throughput are documented for traffic with Poisson arrival times.

Index Terms – Wireless Network Coding, Erasure Coding, Asynchronous Relay Networks

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Improving Power System Performance for Renewable Energy Resources Integration

Shadi Hazzem Shehadeh

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494- 6065; Fax: 1-902-422-7535; E-mail: sh790078@dal.ca

Abstract – Fossil fuels and nuclear power are non-renewable sources which are diminishing yet the demand for energy is continually increasing. In addition, these power sources cause environmental pollution. Furthermore, not all communities have access to a central grid. Renewable energy sources are part of the overall solution to such obstacles.

Investments are being made and research is taking place to improve energy efficiency and to implement energy supply technologies that use renewable energy. On the other hand, there are many obstacles to using renewable energy generation technology. Renewable energy sources, such as wind and solar, are intermittent and variable resulting in power fluctuations. Integrating renewable energy and storage resources, such as pumped storage hydro and, thermal storage are some of the solutions to compensate for the variability and intermittently of the energy generated by renewable sources.

Significant advances in power-electronic technology perform a vital function as far as the smooth integration of renewable energy sources into the existing power grid is concerned. It is completely feasible to foresee development of the power-electronic interface for the highest of projected turbine ratings in order to facilitate the most efficient conversion and transmission of energy, as well as harness reactive power. The technology should also yield methods of reducing distortion, and enable achieving of high levels of efficiency over a broad power spectrum at a minimal cost.

Index Terms –Renewable energy, System integration, Energy storage, Power system modeling

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Implementation of Filtering Beamforming Algorithms for Sonar Devices Using Graphics Processing Unit

Shahrokh Kamali

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-405-9275; Fax: 1-902-422-7535; E-mail: sh499217@dal.ca

Abstract – Beamforming is a signal processing technique used in sensor arrays for directional signal transmission or reception. This is achieved by combining elements in the array in a way where signals at particular angles experience constructive interference and while others experience destructive interference. Beamforming has found numerous applications in radar, sonar, seismology, wireless communications, radio astronomy, acoustics, and biomedicine. Adaptive beamforming is used to detect and estimate the signal-of-interest at the output of a sensor array by means of data-adaptive spatial filtering and interference rejection.

Traditionally, expensive custom hardware has been required to implement data-intensive sonar beamforming algorithm in real-time, so that approaching to real-time signal processing in sonar devices has a magnificent role. High-resolution sonar generally consists of an array of underwater sensors along with a beamformer to determine from which direction the sound is coming. The sensor element outputs must be combined to form multiple narrow beams, each of which "looks" in a single direction.

The purpose of this thesis is to accelerate the signal processing speed by using parallel processing technique. In other words, specify a parallel implementation of beamforming in time and frequency domain by using the Graphics Processing Unit (GPU) as digital beamformer.

We used INVIDIA GeForce 320M GPU under MAC OS X Version 10.6.8 operating system and CUDA as a programming language. CUDA is a parallel computing platform and programming model invented by NVIDIA. It enables large increases in computing performance by harnessing the power of the GPU.

GPU computing or GPGPU is the use of GPU as a co-processor to accelerate CPU for scientific and engineering computing. The GPU accelerates applications running on the CPU by offloading some of the compute-intensive and time consuming portions of the code. The rest of the applications still run on the CPU. From a user's perspective, the application runs faster as it is using the massively parallel processing power of the GPU to boost performance. This is known as "heterogeneous" or "hybrid" computing.

Advantages of GPU computing:
1- Improve performance and solve problems more quickly by implementing parallel processing.
2- With CUDA, you can send C, C++ and Fortran code straight to GPU, no assembly language required.
3- No need to design an expensive hardware.

Index Terms – Beamforming, Parallel Signal Processing, Sonar, Digital Beamforming, GPU, Sensor Array

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Impact of Electric Vehicles on Reducing Greenhouse Gas Emissions Using Regional Wind-Electricity

Shanmuga Sundaram Kannan

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-488-5747 ; Fax: 1-902-422-7535; E-mail: shanmuga.sundaram@dal.ca

Abstract – Worldwide, the transportation sector is one of the major consumers of fossil fuels and a significant contributor of greenhouse gas (GHG) emissions. Today, growing public concerns over anthropogenic climate change have prompted many governments and automakers to develop clean, efficient and sustainable vehicles for transportation. In recent times, there has been a great deal of enthusiasm about the worldwide development and increased production of electric vehicles (EVs). This is mainly due to the greater fuel efficiency and reduced GHG emissions. The amount of GHG emissions reductions from EVs are mainly based on the energy sources used to generate electricity, such as coal, oil, natural gas or renewables. Wind is a renewable energy source, which is available freely and abundantly in nature. EVs charged from renewable wind-electricity do not produce any emissions at all. However, wind is intermittent in nature and the wind electricity generation depends on the wind availability.

This paper examines the potential impact of EVs using the regionally available wind-electricity to reduce the jurisdiction's GHG emissions. It also considers four different proposed wind allocation methods to charge EVs from the electricity generated from intermittent wind, with grid electricity as backup and discusses the impact on overall GHG emission reductions. The thesis includes a case study for the City of Summerside, Prince Edward Island. The simulations show that most of the EV demands can be met with available wind-electricity, thereby greatly reducing the jurisdiction's GHG emissions. The benefits as well as the limitations of the research are discussed.

Index Terms – Electric vehicles; Wind-electricity; Renewable energy; greenhouse gas (GHG) emissions; global climate change

Annual Electrical and Computer Engineering Graduate Conference
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A Novel Time-Domain Diagnostic Method for ECG Analysis System Based on a Smart-Phone

Shijie (Kevin) Zhou

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3J 2X4, Canada
Tel: 1-902-494-6102 ; Fax: 1-902-422-7535; E-mail: shijiezhou @dal.ca

Abstract – The paper describes a novel diagnostic method on smart-phones for Electrocardiogram (ECG) Tele-monitoring signal analysis. Firstly, the ECG signal is detected and systematically classified. The result is shown to users in the form of a personalized diagnostic report on a smart-phone. If there are several life-threatening cardiac arrhythmias during a period of time, the smart-phone automatically sends alarm messages to a remote Emergency Health Center for accurate assessment and treatment. The proposed system mainly focuses on QRS complex detection, beat classification and arrhythmias classification. In the regular process, the ECG signal is detected and classified as normal sinus rhythms (SRs) or premature ventricular contractions (PVCs) by the Pan-Tompkins algorithm. Subsequently, the LZ (Lempel-Ziv) complexity measure, including the K-Means clustering algorithm and the LZ complexity analysis, is utilized to further separate the high risk arrhythmias, ventricular tachycardia (VT) or ventricular fibrillation (VF). Meanwhile, a window length long signal will be further classified as VT or VF by several new decision rules with heart rate detection when detecting three PVCs in a row. Furthermore, the diagnostic report is created in terms of the time frames, improving the reliability and error detection of arrhythmias in the proposed system. Finally, the proposed system is successfully implemented on a smart-phone. The new diagnostic method indicates fairly good performance results when applied to the MIT-BIH.

Index Terms – K-Means clustering algorithm, Lempel-Ziv complexity measure, Pan-Tompkin Algorithm, ECG Tele-monitoring signal analysis, Coarse-graining process.

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Self-Induced Transparency Quadratic Solitons

Soodeh Haghgoo Poorvali

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494- 6131; Fax: 1-902-422-7535; E-mail: soodeh@dal.ca

Abstract – We discover and theoretically explore self-induced transparency quadratic solitons (SIT-QS) supported by the media with quadratic optical nonlinearities, doped with resonant impurities. The fundamental frequency of input pulses is assumed to be close to the impurity resonance. We envision an ensemble of inhomogeneously broadened semiconductor quantum dots (QD) in the strong confinement regime grown on a substrate with a quadratic nonlinearity to be a promising candidate for the laboratory realization of SIT-QS. We also examine the influence of inhomogeneous broadening as well as wave number and group-velocity mismatches on the salient properties of the introduced solitons.

The solitons have been at the heart of nonlinear physics for more than three decades. The reason being they emerge as ultimate survivors of virtually any wave evolution scenario in conservative nonlinear systems of unprecedented physical diversity, from hydrodynamic and plasma waves to pulses in optical fibers and matter waves in Bose-Einstein condensates. In the optical context in particular, the interest in the quadratic solitons (QS), which are coupled self-trapped entities in the media with quadratic nonlinearities, has been recently reinvigorated thanks to the advances in fabrication of phase matching structures.

However, most common quadratic materials have very low group-velocity dispersion (GVD) and fairly large group-velocity mismatch (GVM). Thus, extremely long samples and/or short pulses are required to explore the quadratic soliton regime. These obstacles hampered temporal QS generation until the application of an ingenious technique for tailoring GVD and GVM culminated in the experimental observation of their key signatures. Yet, in the pioneering experiment the nonlinear crystal was too short and pulses too long to unequivocally observe a dispersion-free propagation regime over several dispersion lengths. Thus, the existence of alternative routes to temporal QS formation –not relying on balancing $\chi^{(2)}$ nonlinearities with the GVD– is a highly relevant open question, which, to our knowledge, has not yet been adequately addressed.

In this presentation, we present a new type of QS, self-induced transparency quadratic solitons (SIT-QS), formed in resonant $\chi^{(2)}$ media. The SIT-QS generation does not at all require any bulk medium GVD, thereby circumventing the major obstacle for temporal $\chi^{(2)}$ soliton generation. We assume that an input FW pulse is nearly resonant with one-exciton transitions in QDs, grown and randomly spread over a substrate exhibiting a quadratic nonlinear optical response. As the FW pulse enters the medium, it coherently excites the QD ensemble and – provided the pulse has a right area– it can open a "transparency window" in the medium leading to the fundamental and SH soliton formation.

Index Terms – quadratic solitons, group-velocity dispersion, group-velocity mismatch, inhomogeneous broadening

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Electrostatic Micro-Electro-Mechanical-Systems-Based Three-Dimensional Mirror

Sri Raghu Padyath Ravindran

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-7866 ; Fax: 1-902-422-7535; E-mail: sr782309@dal.ca

Abstract – Micro-Electro-Mechanical-Systems (MEMS)-based micromirror is attracting more and more attention for optical switching, high definition display, and biomedical imaging. In the biomedical imaging field, fast-scanning MEMS optical mirrors compete well with the conventional galvanometric mirrors in terms of accuracy and speed, while providing significant benefits of much smaller size and lower cost. The micromirror usually works in one or two degrees of freedom (DOF) tilting fashion for the scanning purpose. An additional degree of freedom of the micromirror will enable the scanning in the third dimension. This will greatly improve the functionality and reduce the footprint of the imaging system. For this project, MEMS micromirror will be investigated for a possible three-dimensional (3-D) actuation.

There are several actuation principles available for adding the third DOF. Electrostatic actuation has been chosen for its inherent design simplicity, fast response and low power consumption. For the initial stage of this project, a cylindrical deformable mirror will be designed to achieve different degrees of curvature. The static and dynamic characteristics of the device are studied using mathematical software MATLAB. The structural performances and analysis are carried out using the Finite Element Analysis (FEA) tool ANSYS.

The proposed deformable MEMS micromirror will be fabricated using surface micromachining processes UWMEMS and POLYMUMPS through CMC Microsystems. The performances of the device will be characterized. In the second stage of the project, the integration of the deformable mirror with a 2-D micromirror will be investigated for the implementation of a full 3-D MEMS mirror.

Index Terms – 3-D micromirror, deformable mirror, electrostatic actuation, biomedical scanning.

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Kinematic Analysis and Trajectory Planning of Stewart Platform

Sukhvinder Singh

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3J 2X4, Canada
Tel: 1-902-494-6102; Fax: 1-902-422-7535; E-mail: sukh @dal.ca

Abstract – The Stewart Platform (6 DOF Motion Base) is one of the most popular parallel manipulators. It is a six degrees-of-freedom positioning system that consists of a top plate, a bottom plate, and six extensible legs connecting the top plate to the bottom plate. The Stewart Platform was originally proposed and presented to academia in 1965 as a flight simulator by Stewart. This structure consisted of three linear actuators in parallel. Gough was the first one realizing benefits of this kind of a manipulating structure; however, research on this subject began with Stewart's paper. Therefore, it is a tradition to call the structure as Stewart Platform, or sometimes it is also referred as Stewart-Gough Platform. The Stewart Platform is a widely accepted design as a motion control device. This is largely because of the system's high load capacity and accurate positioning capability. Stewart Platform provides a large amount of rigidity that enables the system to provide a significant source of positional certainty.

The Stewart platform has been the choice of the industry for several different applications that require manipulation of heavy load with high precision and speed. The forward kinematics analysis involves the solution of a system of non-linear coupled algebraic equations to determine the pose of the mobile platform with respect to the variables describing the link-lengths of the legs and the geometry of the platform. Forward Kinematics problem for parallel manipulators does not have a unique closed form solution. For my project, the iterative Newton-Raphson method is used to obtain approximate solutions.

In an application of a Stewart Platform it is desirable to move the platform from one point to another, sometimes in straight line and sometimes on arbitrary paths. The trajectory planning problem, within kinematics setting, deals with determining these controlling parameters in order to move the platform on a desirable path. A solution to trajectory planning problem will take a sequence of poses and will generate appropriate velocity profiles for the variations in strut lengths in such a way that the platform moves through the given points.

In this work, algorithms have been extensively tested for the different types of trajectories. We divided our whole testing phase into the three stages as Sampling World Poses (WP) for desirable trajectory patterns, Testing Forward Kinematics Transformation, & finally we performed trajectory planning on the sequence of sampled points for each trajectory pattern to see how close the planned trajectory is to the desired one.

Index Terms – Stewart Platform, Stewart-Gough platform, Kinematic Analysis, Trajectory Planning

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Narrowband Interference Sensing in Energy Detection Based Impulse Radio Ultra-wide Band Receivers

Suleman Zeb

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
E-mail:suleman.zeb@dal.ca

Abstract – Ultra-wide band (UWB) is a wireless technology for information transmission over a large bandwidth (greater than 500 MHz). It has evolved as a technology that offers to satisfy the ever increasing demands for low-cost, low complex and high bandwidth requirements. It promises to provide high data rate applications in multiuser scenario. However, to do so it has to address the issue of coexistence with the existing communication systems which present narrowband interferences to UWB systems.

Impulse radio UWB systems use low power and low duration pulses (of the order of nanoseconds) to carry information, and therefore they are vulnerable to harmful effects of narrowband interferences. Since many existing narrowband radio systems operate within the UWB IR frequency band, relative high-power narrowband interferences (NBI) from these systems can greatly degrade the performances of the UWB systems. As a result, narrowband mitigation techniques need to be implemented. Of the mitigation techniques, NBI detection is the first step where whether or not an NBI is present and how it behaves needs to be determined.

In the literature published so far, most of the work focused on interference cancellation techniques rather than on NBI detection of NBI first. Very little has been seen in the NBI sensing or detection in the energy detection based impulse radio UWB systems. In this presentation, we address the issue by proposing an NBI sensing algorithm in energy detection based impulse radio UWB receiver. The first step in our proposed algorithm is to determine whether there is an NBI or not by employing an energy detection technique which is simple and robust. A fixed threshold for detection is used when a relatively clean channel is present. In a noisy channel, the fixed threshold is replaced with an adoptive threshold. As the adaptive threshold changes with the environments, the NBI sensing performance improves even in a very low SNR channel without increasing complexity to the system.

Index Terms – UWB, impulse radio; ultra wideband; narrowband interference; signal to noise ratio; adaptive threshold; NBI sensing; energy detection.

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Higher Precision Clockless ADC and DAC Using Wavelet Neural Network

Tamer Elsalahati

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-440- 4349 ; Fax: 1-902-422-7535; Email: Tamer@dal.ca

Abstract – A continuous-time system is studied that converts analog input to a continuous-time (CT) digital representation without sampling, and then processes the information digitally without the aid of clock. As the conventional digital signal processing (DSP) suffers from aliasing and quantization noise, in this research we develop higher precision Clockless ADC and DAC using Wavelet Neural Network (WNN). The input signal will be encoded by a delta modulator without clock into a series of non-uniformly spaced tokens when a quantization level is crossed, which are processed by the digital signal processing in CT and converted to an analog output using a custom DAC that guarantees there are no glitches in the output waveform. ADC quantizer resolution and number of tokens based on the rate change of the input signal constitute great challenge in CT.

The CT systems suited for Burst-like signals and low power applications such as those in hearing aids, ECG for monitoring and pacemakers, and neuron sensing for implantable prosthesis processing, as with an inactive input, the CT-ADC waits for a change in the signal while dissipating no dynamic power. Also CT-DSP offers the advantages of noise immunity and programmability as in conventional digital systems but without the use of a clock. Furthermore, no sampling is used; thus, no aliasing occurs.

In this work, we propose a new method to realize a high precision ADC-CT converter with low precision ADC-CT using WNN technique for calibration, based on two stages. In the first stage, the input signals is converting to CT digital codes, and in the second stage, the quantization error or residual signal of the CT-ADC and resample DAC are calibrated by WNN to get higher precision CT-DAC. Because of the quantization error, the CT-ADC possess strong nonlinearity, and it cannot be corrected by traditional calibration techniques such as offset and gain adjustments. In contrast to traditional calibration techniques, WNN can be employed to remove errors from ADC converter, also WNN incorporate the good and fast learning ability and generalization of NN and the good property of localization of wavelet transform.

Index Terms –Analog-to-digital converter (ADC), continuous time digital signal processing (CT DSP), Wavelet Neural Network (WNN). Digital-to-analog converter (DAC), Neural Networks (NN)

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Pulse Synchronization in the Differential Code-Shifted Reference, Impulse Radio Ultra-Wide Band System Receiver

Tamim Arabi

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3J 2X4, Canada
Tel: 1-902-494-2592; Fax: 1-902-422-7535; E-mail: tamim.arabi@dal.ca

Abstract – Ultra-Wide Band is a revolutionary technology in radio communication systems that utilizes a large portion of the frequency spectrum while maintains low power levels and high data rates. Ultra-Wide Band systems can be used both indoors and outdoors within the FCC power-levels masks, thus making the technology very versatile. One of its main advantages is its robustness to multi-path diversity. Ultra-Wide Band technology have attracted research and industry alike owing to the possibility of implementing low-power, low-complexity, and low-cost devices.

A widely recognized method of transmitting Ultra Wideband signals is the use of Impulse Radio technology to transmit information. Impulse Radio Ultra Wideband (IR-UWB) uses repetitive pulses of very short duration, low duty cycle, and low power levels within the regulated FCC rules. One implementation of Impulse Radio Ultra Wideband pulses in non-coherent transmission is the use of Differential Code-Shifted Reference pulses (DCSR). In this technique, the main challenge at the receiver is achieving pulse synchronization that times the received pulses at the right moments for accurate pulse detection.

In this poster presentation, two designs are proposed in attempt to achieve the pulse synchronization. The first design is based on a fast-switch- controlled integrator circuit. The second focuses on the use of active low pass filter and a phase-locked loop circuits to achieve proper clock timing. Both designs will be presented, together with schematics, computer-aided simulations, and lab testing results.

Finally, conclusions on both designs are drawn and further recommendations will be stated.

Index Terms – Ultra wideband (UWB); differential code shift reference; impulse radio, pulse synchronization; clock timing.

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High Quality Factor Free-Free Beam Micro-Resonators Fabricated with Standard Surface Micromachining Process

Tianming Zhang

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-7866 ; Fax: 1-902-422-7535; E-mail: Tianming.Zhang@dal.ca

Abstract – In recent years, MEMS based mechanical resonators have played an increasingly important role in high performance frequency-selective applications in RF systems due to their promising characteristics in achieving high Q values and good stability.

In this project, several electrostatically actuated flexural-mode free-free (FF) beam micro-resonators are designed and fabricated using a standard commercially available surface micromachining process, UW-MEMS process. The fundamental resonant frequency of the beam in the z-direction is theoretically calculated by Euler-Bernoulli equation. Finite-element analysis (FEA) tool, the COMSOL Multiphysics 4.2a, is then used to simulate the effects of the critical structural dimensions and electromechanical coupling. Direct mechanical-to-electrical analogy is subsequently derived by solving the motional impedance *R* in the system. Thus, a transformer ratio is able to be achieved to transfer all mechanical parameters to lumped parameters. Finally, the electrical models are built and simulated by the software ADS to verify the applicability of this analogy.

The designed resonators were fabricated using the UW-MEMS process through the CMC Microsystems, and tested using Vecco NT-9100 system. The validity and accuracy of the modeling for a 90 um resonator are demonstrated by comparing the dynamic response of the resonator with S-parameter simulations. Quality factor is measured as high as 1230. Throughout electromechanical coupling, the spring softening effect is also well studied. Both theoretical calculation and CAD simulation show that the resonant frequency is evidently decreased with increasing bias voltage. This phenomenon provides an effective way to control the resonant frequency by tuning the offset DC voltage, which can be potentially applied to future oscillating applications.

Index Terms – MEMS, resonator, fundamental frequency, quality factor, electromechanical coupling.

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Area-Efficient Digital-to-Analog Converter for Applications in Active-Matrix Organic Light-Emitting Diode Driver Circuit

Udhayasimha Puttamreddy

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-440-4312 ; Fax: 1-902-422-7535; E-mail: vd858072@dal.ca

Abstract – The object of this research work is to design an area-efficient digital-to-analog converter (DAC) with a minimum resolution of 8 bit for Active-Matrix Organic Light-Emitting Diode (AMOLED) display drivers. The architecture of AMOLED display contains column drivers and gate drivers, of which the major die area is occupied by the column drivers, which consist of latches, registers, DACs, buffers; among these components DACs occupy largest die area. The DAC plays a key role in the column driver by reconstructing the signal for pixel driving from digital data. Considering the increase in column of pixels in mobile oriented devices for high image quality, the chip area occupied by the DAC for driver circuit must be greatly reduced.

Different DAC architectures are available in the literature such as Current steering DACs, Resistor string DACs, Switched Capacitor DACs, Delta sigma DACs etc. Each architecture has its own advantages and drawbacks. Current steering DACs can be used to achieve high resolution but the accuracy of matching the current sources is critical. On the other hand, R-String and Switched Capacitor DACs they are area consuming, e.g. –to achieve a higher resolution 2^N resistors are required for N bit resolution. Delta sigma DACs has more of analog components in its architecture that would lead to design sensitive to noise.

R-String DAC would be considered as one of the choice for AMOLED display drivers because of its simplicity in design and speed of operation targeting at a resolution of 8-bit. Recently, Pseudo floating gate (PFG) has been used in the design of low resolution DAC where resolution is limited by increasing capacitance ratios. Designing a 8-bit resolution segmented DAC with R-String and PFG successfully would lead to a new architecture which reduces the area substantially. For instance, the design consists of $2^5 = 32$ resistors for 5-bit and area of PFG for 3-bit is much less, compared to existing 8-bit R-String DAC that requires 256 resistors, which leads to a reduced area. Moreover, an effort is currently made towards achieving an 8-bit resolution with PFG-DAC by controlling the capacitance ratios to keep it in a small range and also by trying to replace the analog capacitors with MOSFET capacitors that have a reduced chip area.

Index terms – Active-Matrix LEDs (AMOLEDs), R-String DACs, Column drivers, Pseudo Floating Gate (PFG), MOSFET Capacitors.

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A Visualization Tool for the Analysis of the Effects of Changing Policies on Energy Security

Vinay Kumar Chatharaju

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-449-7039; E-mail: vn592628@dal.ca

Abstract – All jurisdictions have an energy system consisting of processes responsible for the transformation and transportation of supplies of energy from various sources to meet the end-use energy demands. Energy systems are dynamic as they respond to uncertainties such as higher energy costs, new energy technologies, public concerns over the environmental impacts of energy production, evolving consumption patterns, and the ageing of existing infrastructure. These changes can affect the energy suppliers, the end users, and those responsible for operating the energy system. To reduce possible adverse effects and improve the energy security of the system, energy policies are often designed by those responsible for the processes. However, changes to the energy policies can impact the system's energy security. Therefore, it is critical to study the possible effects of changing energy polices before they are deployed.

In this research, a set of methods will be developed and implemented as a visualization tool for the analysis of the effects of changing energy policies on a jurisdiction's energy system. The three energy security indicators Availability, Affordability and Acceptability, derived from the International Energy Agency's (IEA) definition of energy security will be used to measure the impact of policy changes. This presentation will elaborate on the methods and implementation of the visualization tool.

Index Terms – Energy policy, Energy security indicators, Energy system

Solar Photovoltaic Systems in Saudi Arabia Industrial Application

Wayel Oweedha

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-489-9222; Fax: 1-902-422-7535; E-mail: wy523020 @dal.ca

Abstract – The key to create a clean energy future for the whole world is to exploit renewable energy sources. Saudi Arabia has plentiful of solar radiation and long sunshine hours, solar energy applications both small and big have excellent opportunities. Since 1960, Saudi Arabia has been researching in photovoltaic applications. Up to now, the progress towards solar system is not sufficient. In Saudi Arabia the Industrial section, reserve a big portion in the load demand. The biggest industrial cities in Saudi Arabia are Dammam, Al-Jubile, Jeddah, and Riyadh. This paper presents a study for using solar energy system in industrial section in Saudi Arabia. A typical energy consumption daily profile is assumed. Then the solar array, battery, and inverter sizes are optimized. The study is focus on one of the factories in the industrial city in Dammam. The study will show weather a photovoltaic (PV) system is sufficient alone or combined with another system. The objective of this thesis is to examine the percentage of solar system penetration needed to reduce the electricity bill and cost effective. Furthermore, the economic reliability and feasibility study will be included. HOMER and Microsoft excel software will be used in the study.

There are many factors that motivate the need of renewable energy sources:

1. Most of the people in rural area in the developing countries have no access to electricity.
2. The exponentially growing need of energy due to the global population increase.
3. The effect of global warming.
4. The fast depleting reserves of traditional sources, such as, fossil fuel.

Index Terms – Industrial area, Saudi Arabia, Solar system, PV system

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Optical Frequency Surface Plasmon Polariton in Semiconductors

Xiaoou Mao

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-449-4572; E-mail: xz513853@dal.ca

Abstract – A theoretical treatment is presented of a plasmonic interaction at an interface between a semiconductor and a dielectric, as opposed to the more traditional configuration whereby a metal/dielectric interface is investigated. Our work is to show that structures using semiconductors instead of metal to excite surface plasmon can support not only terahertz frequencies plasmons but also optical frequency (around 10^{15}Hz) plasmons.

Surface plasmons Polariton (SPPs) are those plasmons that are confined to surfaces and that interact strongly with light resulting in a polariton. It can be roughly defined an electromagnetic surface waves propagating between a dielectric and a conductor, evanescently confined in the perpendicular direction. They arise via the coupling of the electromagnetic fields to oscillations of the metal's electron plasma.

Most of the effort has been concentrated on investigating SPPs in the visible domain on metal surfaces. However not only metals support electron plasma oscillations, semitconductors can also support SPPs with a resulting plasma frequency typically in the terahertz domain. By a theoretical treatment, a new solution for an optical plasmon at a semiconductor/dielectric interface was found which results from the permittivity of the plasmon medium - a heavily doped semiconductor – being higher than that of the other medium (dielectric) in the studied interface structure. Such a situation cannot occur with a metal/dielectric or metal/semiconductor configuration, and thus the new solution does not exist in those metal-based structures.

Future work is to research in detail and perform more accurate calculation of this new mode found in the semiconductor/dielectric structure. This includes studying the effect of doping on the semiconductor's permittivity and effective mass of electrons, investigating the new mode discovered to prove that the frequency of SPPs of the new found solution can be in the optical communication wavelength range (e.g. 1.55μm). Potential applications of the new solution are studied.

Index Terms – Optical plasmons, lightwave propagation, interaction of light with matter, surface plasmon polarionts, semiconductor optical plasmons.

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Utilizing Nanosphere Lithography to Structure ZnO in ZnO/P3HT Solar Cells

Yousef Alattar

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-2239 ; E-mail: Yousef.Alattar@dal.ca

Abstract – Organic photovoltaics (OPVs) have been in development for more than 30 years and have seen remarkable improvements in power conversion efficiencies. These improvements are in part attributed to techniques such as nanosphere lithography (NSL) which have allowed researchers to fabricate structures on the scale of nanometers (the exciton diffusion length in P3HT films is on the order of 5 nm). In this work it is desired to nanostructure ZnO which will provide a larger interfacial area over which excitons can disassociate and ultimately increase the efficiency of ZnO/P3HT devices There are a variety of methods reported in the literature for NSL. The technique adopted for this work was continuous convective assembly (CCA) of polystyrene nanospheres to produce an array of hexagonally close packed structures that will act as an etch mask.

Index Terms – Solar Cells, OPVs, NSL, Polystyrene Nanospheres

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Evaluation of Genetic Algorithm on Grasp Planning Optimization for 3D Objects: A Comparison with Simulated Annealing Algorithm

Zichen Zhang

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
Tel: 1-902-494-6102; Fax: 1-902-422-7535; E-mail: zichen.zhang@dal.ca

Abstract – Vision-based grasp planning can be approached as an optimization problem where a hand configuration that indicates a stable grasp needs to be located in a large search space.

In this paper, we study the applicability of genetic algorithm (GA) on grasp planning optimization. The details are given on the selection of operators and parameters. A quantitative analysis including the comparison with simulated annealing (SA) method is performed to evaluate the performance of the GA-based planner.

GraspIt! simulator is used for implementing the proposed algorithm and as the test environment. The candidate solutions at each generation are visualized for better understanding of the evolution process.

The result shows that genetic algorithm can be applied to obtain solutions with qualities comparable to those from the SA planner.

Index Terms – Grasping; Dexterous Manipulation; Multifingered Hand

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Floating Gate Transistor using 90-nm Technology: Problems and Drawbacks

Zina Saheb

Department of Electrical and Computer Engineering
Dalhousie University, Halifax, NS B3H 4R2, Canada
E-mail: ZINA.SAHEB @dal.ca

Abstract – As the industry is pushing towards smaller form factor, MOSFET devices have been shrinking dramatically in the last 10 years while the silicon gate oxide thickness has scaled down aggressively to 3 nm and below. The decreased thin gate oxide induces gate leakage current that becomes a major problem for circuit performance. The floating gate (FG) technique is an interesting method to operate analog circuit at low power supply. The direct tunneling gate leakage current in MOSFET has a significant impact on the behavior of floating gate transistors. In this research work, the effect of gate leakage on the floating gate transistor in sub-100-nm technologies is studied. A new model of floating gate MOSFET transistors is proposed.

According to the BISM4 model proposed by Berkeley University, there are five components for the direct tunneling gate leakage current which is a strong function of Vgs (gate to source voltage) and Vds (gate to drain voltage), respectively, and Tox (oxide thickness) where the tunneling increases in an exponential way. The floating gate technique is an unconventional way to bias the transistor for low voltage applications or limited power supply where the gate of the transistor is floating (no DC path to ground). Usually it is implemented using a double poly at the gate where multiple inputs are deposited at the control gate and capacitively coupled to the floating gate transistor.

Our analysis and simulation using the conventional FG transistor (a DC model implemented by a voltage control voltage source) and a capacitor connected at the gate of Transistor revealed that the gate leakage current is not able to discharge the floating gate and consequently a new model for FG MOSFET is needed. For this aim an experimental testing chip has been submitted for fabrication to allow the development of more accurate model for FG transistor. In this chip, floating gate transistors using TSMC 90-nm technology, constructed using Poly and 9 metal layers, and a MIM (metal insulator metal) capacitor, are used for the first time to implement the FG transistor instead of double poly. A special setup also has been added to test the floating gate voltage and leakage current. For example, a source follower structure (common drain) is connected to the floating gate to mirror the floating gate voltage to the output without disturbing the floating node. The Semiconductor Device Analyzer B1500A from Agilent will be used to characterize the chip after fabrication and to extract the new model.

Index Terms – direct tunneling gate leakage current, floating gate transistor DC model, MOSFET, MIMCAP, 90-nm technology