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Halifax, N.S. Canada

NSERC CRSNG

ASPIRE | *Applied Science in Photonics and Innovative Research in Engineering*

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Message from the Chair

The goal of the Electrical and Computer Engineering (ECE) Graduate Conference is to provide our graduate students the opportunity to present their research in a public forum. The ECE Department has organized this conference (ECEGC) in the Scotiabank Auditorium in the Faculty of Arts and Social Science Building for the third year. As in the past, the conference is structured in such a way that second year and higher PhD and Masters Students communicate their research through oral and poster presentations. By attending, the first year students learn from their peers on how to deliver high impact presentations. This single-session conference provides an opportunity for students to network with all faculty members in the ECE Department and our guests from industry.

The proceedings of the conference are published as a Book of Abstracts. This year we have 60 abstracts. To have a single track conference, we exempted 11 PhD students who made two oral presentations in the past ECEGC conferences. As a result, we have 15 oral presentations and 32 posters. We expect close to 90 graduate students from ECE Department to attend this event. As with last year's conference the work produced by our graduate students is very impressive and covers a wide range of subjects. The conference starts with the Keynote presentation on Big Data Analytics by Prof. Stan Matwin from Faculty of Computer Science at Dalhousie.

I would like to offer my appreciation to all the students, their advisors and committee members who have put forth enormous efforts in bringing this conference together. This conference is organized to enrich the graduate experience, for graduate students by graduate students, where students are involved in all logistical activities. We are grateful to all members of the ECE Grad Conference Committees as listed on the following pages. We greatly appreciate the sponsors for their support of the presentation awards: Faculty of Graduate Studies Annual Fund, Faculty of Engineering and NSERC ASPIRE Program.

We hope that the conference will be stimulating, informative, enjoyable and a fulfilling experience to all who attend it.

Jacek Ilow
ECE Graduate Advisor
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ABSTRACTS

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Signal Extrapolation Using Bandlimited Prolate Spheroidal Wave Functions

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Abstract – Power losses in the power grid are important topic, and as the power losses decrease the efficiency will increase. This research is to develop an enhanced version of the Newton-Raphson Power Flow (NRPF) method in polar form for systems with High Voltage Direct Current (HVDC) subsystems. The point of departure for this procedure is based on decoupling the NR Power Flow method Power flow problems are solved for many fundamental problems in the operation and planning of the power system. Although many methods are available to solve these problems, this thesis focuses on developing an enhanced HVDC power flow method with improved computational efficiency and convergence stability.

A comparison of the results with those of the full Newton-Raphson Power Flow method is presented and discussed in order to evaluate the performance of the proposed method. Using the MATLAB environment, simulations have been conducted on the 5-bus, 14-bus and 30-bus IEEE systems from which numerical results were obtained. Two and three converters are included in the systems are shown to improve the voltage magnitude, active and reactive power profile for three modes of operation (for mode 1 the active power, tap ratio and the control angle are constant, for mode 2 the current magnitude, tap ratio and the control angle are constant, and for mode 3 the voltage magnitude, tap ratio and the control angle are constant). The overall results indicate that mode 1 is the best mode compared to others.

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Multidimensional Optimal Control of Wind Turbine/Generator

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Abstract – Wind speed, direction and inflow angle vary with time and terrain, and power-system operation requires well-predicted wind-power output from wind farms. Multidimensional optimal control of wind turbine/generator model is proposed in this presentation to simulate the effects of wind speed, direction and inflow angle in wind power output. The effects of changes in wind speed, direction and inflow angle with wind turbine generators are also considered in the proposed model. An experimental simulation technique setup is developed to evaluate acceptability changes of wind speed, direction and inflow angel.

Moreover Matlab software simulation is used to compare the results between practical experimental simulation and Matlab simulation. The simulation results show that those effects have an important impact on power output of multidimensional optimal control of wind turbine/generator and system reliability.

Index Terms – Wind turbine, Universal Joint, Rotor yaw actuation, Rotor angular deflection actuation, Yaw actuator, Power Output, measuring speed, free connection joint and Optimization

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Optimal Filter Placement and Sizing Using Ant Colony Optimization in Electrical Distribution System

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Abstract – Renewable energy is growing fast these days. One of the most challenging problem deals with the renewable energy is the harmonics produced by their power electronic converters. This presentation presents an application of the Ant Colony algorithm for optimizing filter placement and sizing on a radial distribution system in order to reduce power losses and keep the rms voltages and the corresponding total harmonic distortion (THD) to lie within prescribed limits. First, a harmonic load flow (HLF) algorithm is performed to demonstrate the effect of harmonic sources on total power loss. Then the Ant colony algorithm is used in conjunction with HLF to place a selection of filter sizes available at each possible location so that both power loss and THD are minimized. As a result the optimal adjustment of location and size of the filter are determined. Results demonstrate improvement and effectiveness of using the filters at optimal location.

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Relay-Assisted Downlink Transmissions to Support Increased Data Rates

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Abstract – In order to meet the ever-increasing demands for the higher data rates in the finite spectrum, increasing bandwidth efficiency is always an ultimate goal in wireless communications. Nowadays, smart phones with video streaming, games and other real time applications require high quality communications while their data exchange volume is skyrocketing. This demand is faced with the challenge that the available bandwidth for these services is limited. The conventional techniques to support multi user communications partition the bandwidth and allocate a portion of the system spectrum to every user so they can accommodate as many users as they can with the minimal interference. A new technology known as interference alignment allows all users to share the available bandwidth and cooperate so that every user receives the desired messages free of interference. This technique requires high signal to noise ratio and global availability of the channel state information (CSI) which makes it difficult to be implementable in practice.

To relax the requirement for perfect CSI knowledge, a blind interference alignment has been introduced allowing the transmitters to send their messages without knowing the channel conditions. In some scenarios, this approach achieves optimal data rate such as in the downlink multiple-antenna-single-transmitter and single-antenna-multiple-receivers configurations. However, this scheme requires fixed channel conditions over the period of multiple symbols transmitted and each receiver has to perform some sophisticated processing of the received signals from multiple receive antennas.

Using communication relay nodes to maintain desirable channel conditions with some cooperation among the users, we propose an algorithm for resource allocations in wireless communications that achieve high data rate within a small interference. In the proposed cooperative network, a transmitter with M antenna can serve N single antenna users and send M*N independent signals over M+N-1 time slots. This data rate is achieved by dividing the communication process into two parts. In the first part, the transmitter uses N time slots to send M signal to each user. In the second part, every receiver and its relays form an independent network and all networks communicate concurrently and cooperate to keep the transmission power at the minimum acceptable level. This approach has promising results especially in the low to moderate signal to noise ratio.

Index Terms – Wireless communications, Cooperative networks, Interference, Relay network, Data rates.

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Solar Energy Forecasting Using Artificial Neural Networks

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Abstract – There are many restrictions on using PV technology. Solar energy is intermittent and variable, resulting in power fluctuations which require precise prediction techniques. Many solutions have been proposed to overcome these challenges such as artificial intelligence (AI) techniques. AI techniques include expert systems (ES), artificial neural networks (ANN), genetic algorithms (GA), fuzzy logic (FL), and various hybrid systems.

ANN is the most common AI technique and has been used for the last two decades. It can model complex and nonlinear systems because of the networks ability to adjust its weights and biases. There are many ANN structures such as the multilayer perceptron (MLP), recurrent neural network (RNN) and radial basis function network (RBF). These various structures make ANN's very versatile in their applications. ANN can be used to predict solar radiation, which helps the management of power generated from a PV system.

Numerous meteorological and geographical parameters such as maximum temperature, relative humidity, sunshine duration, cloud cover, latitude, longitude, and altitude have been used to develop ANN models for solar prediction.

The proposed system is using fewer parameters to predict the solar radiation. This technique is less complicated and will allow for an increase in the accuracy and speed of these solar radiation predictions.

Index Terms – Solar energy, Forecasting, Artificial neural networks, Radiation.

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A Grid-Connected Wind Turbine System with a Dynamic Multilevel Inverter

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Abstract – Wind energy systems use synchronous permanent magnet generators, squirrel cage induction generators, and doubly-fed induction generators. Although synchronous permanent magnet generators and squirrel cage induction generators have high efficiency, they have to be connected to the grid through converters, which means extra power losses and harmonics. Doubly-fed induction generators (DFIGs) are commonly used for wind turbine grid interconnection. DFIGs solve the wind fluctuation issue but suffer power losses for two reasons: 1) they are wound rotor induction machines, which are less efficient than squirrel cage machines, and 2) their rotors are supplied through AC-DC-AC converters that cause rotating flux inside the machine to contain harmonics, which leads to non-sinusoidal output voltage.

Waveforms of inverters used in wind turbine systems are non-sinusoidal and contain harmonics. Harmonic contents can be reduced by using a filter circuit or by employing pulse width modulation (PWM) techniques. The use of PWM techniques provides a less distorted current and voltage but at the cost of higher switching losses due to high switching frequencies. Multilevel inverters can reduce total harmonic distortion at low switching frequencies by using a higher number of levels and increasing the frequency of PWM techniques. Switching losses are compounded by increases in switching frequency. Therefore, optimization of the switching frequency is needed to reduce both total harmonic distortion and switching losses.

My research focuses on implementing multilevel inverters for connecting wind turbine systems to the grid. The purpose is to achieve high efficiency and high power quality as well as the ability to respond to changes in wind speed and load demands.

Index Terms – Wind turbine, Multilevel inverter, Harmonic distortion, Switching losses.

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Real Time System to Process Digital Images

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Abstract – Real time image processing has gained lot of attention lately because of the wide usage in new commutation such as video conference, video calls, media, digital cameras and mobile cameras. Because of this, image identification has become popular topic recently. The goal of our work is to develop a real time digital image processing system, which aimed at feature identification and identification.

Our work will contain a toolbox that include a number of different filters, including classical high and low pass filters as well as a number of novel morphological filtering tools. In subsequence work we will add edges and feature detection algorithms.

In this work we present the first phase of the work of noise removal from noisy images (signal to noise ratio of 10% or more). Noisy images are created and then a variety of filters including mean, median, erosion, dilation, open and close filters. These filters are then used to denoise the original images. Erosion and Dilation filters are the two basic filters in the area of mathematical morphology. However we have used them in gray scale level, although they are usually used in binary pixels level. The Mean and Median filters do similar job, except the median filter preserve more important details in a processed image than mean filter does.

In addition to previous filters, Laplacian filters are also applied to increase contrast of edges and thresholding techniques are then applied as a first attempt feature identification.

Although our initial work is done in Matlab, the next phase of the project is to implement the algorithm in CUDA on Graphical Processor Units, with a goal of implementing the system in real-time or near real-time. Moreover, some algorithms for segmentation and automatic identification features will be also developed in CUDA.

Index Terms – Index Terms –Real-time; morphology; Segmentation; Mean and Median filters; Erosion and Dilation filters; Matlab, Median, Mean, Laplacian; Image processing; CUDA; Laplacian filters.

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Multi-Resolution Multicast in OFDMA Wireless Networks with Relay Nodes

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Abstract – In order to provide high-speed data rates, new generations of wireless networks are moving toward cooperative communications. In cooperative communication, a number of relay nodes (RNs) are assigned to help a source in forwarding information to its destination(s), hence forming a virtual antenna array.

Multimedia service is an important aspect in next generation cellular systems. While recently design of unicast transmission schemes has received a lot of attention in the context of virtual array, not much work has been published in the area of spectrally efficient algorithms for multicast transmission using cooperative communications. For these reasons, our research is focused on multicast scheduling and design of concatenated modulation schemes in Orthogonal Frequency Division Multiple Access (OFDMA) for wireless networks with relay nodes.

Conventional multicast sessions suffer from different channel conditions among users. Our main goal in this research is to design an efficient scheduling algorithm and selection of relays with the corresponding allocations of bit sub-streams so that all users can receive the highest data rate based on their channel conditions for multi-resolution images streaming representing video frames. Our objective here is to come up with an algorithm and the design of multi-resolution modulation in which fairness and efficient resource allocation can be balanced or achieved.

In our research we will be using multi-resolution coding for the data and we will design an efficient scheduling algorithm which will be comprised of two phases: In phase one, called Frequency Allocation, best frequency blocks will be identified for each user based on their channel conditions and then decision will be made on which frequency blocks the data will be sent to a group of users associated with a given RN. In phase two: called Bit Allocation, as we are using multi-resolution coding, bits will be allocated to different frequency blocks and transmitted symbols in multi-resolution modulation based on our source code characteristics. After finishing the design of the transmission algorithm to transmit the data to the users in a group, RNs will be used to compensate users who suffer bad channel conditions. Relay Nodes will not be sending all information; they will only send the most likely corrupted bits representing less important information that users with bad channel conditions couldn't receive.

Index Terms – Orthogonal Frequency Division Multiple Access (OFDMA), Relay Node (RN), Frequency Allocation, Bit Allocation.

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Medium Access Control for MU-MIMO Uplink Transmissions in Wireless Networks

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Abstract – Multiple-input multiple-output (MIMO) systems have been deployed in wireless communications to improve the link reliability and bandwidth efficiency with the main focus on single user MIMO (SU-MIMO) models. In recent years, spatial multiplexing allowed several users within a MIMO system to communicate simultaneously with a single base station (BS). This configuration is recognized as multiuser MIMO (MU-MIMO) model on a downlink, where the base station with multiple receive antennas is capable of resolving the mixed signals from different users. Mathematically, this model is simplified as parallel spatial channels between the BS and the different users.

All the conventional medium access control (MAC) algorithms currently used in wireless local area networks (WLANs) are designed for SU, hence, these scheduling protocols are not optimal nor suitable for the MU-MIMO. There are some preliminary investigations into MAC for MU-MIMO systems on the downlink by assigning pre- and post-processed data streams to multiple transmit and multiple receive antennas on different hosts, such as applying beamforming or taking advantage of the zero forcing approach. In particular, IEEE 802.11ac in its new standard for WLAN has adopted only the downlink transmission approach for the MU-MIMO system because of feasible implementation of the channel state information (CSI) that is accessible at the BS. However, implementing the uplink transmissions along with the corresponding medium access control (MAC) is still an open problem and is the focal point of this research.

Specifically, this research focuses first on introducing a low complexity implementation at the physical layer for the MU-MIMO uplink transmissions. Simulation results are considered to validate the performance of the proposed model and compare it with conventional systems. Second, a suitable MAC scheduling scheme for the proposed uplink transmission is considered in a cross layer fashion, and it is compared with the conventional MAC scheduling algorithms from the perspective of the transmission throughput and the collision ratio as determined by stochastically controllable amount of multiple access interference.

Index Terms – Multiuser multiple-input multiple-output, wireless local area network, medium access control, cross layer protocol, zero forcing, and multiple access interference.

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Linear Plasmonics with Radially Polarized Light

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Abstract – Both linear and nonlinear optical properties of surface plasmon polaritons (SPP) generated from thin metal films in the so-called Kretschmann configuration have been studied extensively. Several interesting optical effects in the spectrum and intensity behaviors of plasmon coupled light, ranging from enhancement of the electric field intensity to spectral anomalies in the non-linear spectrum have been thoroughly investigated.

However, most of this was done, both theoretically and experimentally, using linearly polarized light. It has been shown not long ago that strongly focused radially polarized light beams give rise to a pronounced longitudinal electric field at the focus. This longitudinal component, which is negligible in linearly polarized focused beams, leads to an enhancement of the SPP intensity at the metal-air interface. This new effect could lead to novel optical properties of surface plasmons generated using radially polarized light, with potential applications to the field of optical sensing.

In this talk, we present the results of the simulation of the near-field distribution of the electric field intensity of a focused radially polarized Bessel beam coupled into an SPP. In our calculations, we use a 50 nm gold film deposited on glass in the Kretschmann configuration. The evanescent nature of the field is also demonstrated by plotting the variation of the field intensity with distance from the metal surface. A comparison of the near field distribution from radially and linearly polarized beams highlighting the differences in local field intensity and energy flow is also presented.

The role of surface plasmons in enhancing the fundamental SPP field is clearly demonstrated, with much reduced field intensities observed for focusing angles below the plasmon coupling angle. Assuming a simple Gaussian distribution for the incident electric field, the near-field spectrum is calculated. It clearly shows the effect of the Bessel and Gaussian nature of the beam.

Index Terms – Surface plasmons, Radial polarization, Linear plasmonics, Bessel beams.

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Metamaterial and its Fabrication by Nano Imprint Lithography

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Abstract – On the path to new prospects for manipulating light, artificially engineered materials, which we called Metamaterials, attract a great deal of attention. Metamaterials denote artificially constructed materials having electromagnetic properties not generally found in nature. One of the most prominent examples is the negative refractive index double media which has both negative permittivity and negative permeability. Metamaterials that have a negative index of refraction may lead to the development of novel devices ranging from optical antennas with superior properties and a perfect lens capable of imaging objects with resolution much smaller than the wavelength of light, to ultra-compact optical circuits and special coatings that can make an object invisible. These applications are of particular interest if such materials could be engineered to work at optical wavelengths.

To create Metamaterials at optical wavelengths, one should deal with small periodicities (300 nm or less) and tiny feature size (less than 50 nm) to ensure effective-medium-like behavior. Thus, the fabrication of optical Metamaterials is challenging since we aim at high precision, high throughput and low cost manufacturing process. But features sizes for Metamaterials operating in the infrared or visible range can be smaller than the resolution of state-of-the-art photolithography due to the diffraction limit. Alternative methods for nanofabrication include extreme ultraviolet lithography (EUV), X-ray lithography, focused ion beam (FIB), electron beam lithography (EBL) and nanoimprint lithography (NIL) etc.

NIL was first introduced in 1995 by Stephen Chou and quickly recognized as a potential candidate for post-optical lithography. The main advantage of NIL is that it can offer high resolution without the need for imaging optics or complex light sources as in the case of other alternatives. In this work, stamp replication process was developed and experimentally demonstrated. First, polymer stamp was fabricated by patterning a polymer printable material using a nanoimprint lithography system and a silicon/metal master stamp. The obtained bendable and transparent polymer stamp can then be used in UV-imprinting process, roll-to-roll imprinting process or used as the basement to fabricate metal copies of the mater stamps. Second, the fabricated polymer stamps went through a few other fabrication processes such as metal sputtering, electroforming to fabricate a metal copy of the original master stamp. After that, all the fabricated samples were evaluated by tools like AFM and SEM. According to the evaluation results, the features of the master stamp were replicated with good efficiency and high accuracy. This experimental demonstration shows that NIL could be a promising technology enabling low-cost, high throughput fabrication of Metamaterials.

Index Terms – Metamaterial, Negative index media, Nanofabrication, Nanoimprint lithography.

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Degree of Polarization of Surface Plasmon Enhanced Electromagnetic Fields Excited By Tightly Focused Statistical Beams

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Abstract – Surface plasmon polaritons (SPP) are collective excitations of the free electron gas density, just like ripples on the surface of a pool are a mode of the water molecules of the liquid. Importantly, SPPs in realistic metals can only be generated at optical frequencies. Plasmonics is the field of study dealing with the light coupling with collective electron excitations in metals.

Our work in plasmonics is concerned with the way excited SPPs affect polarization properties of statistical twisted Gaussian-Schell model (TGSM) beams tightly focused on a thin metal film. Our goal is to explore the behavior of the 3D degree of polarization of electromagnetic fields in the vicinity of the metal film generated by focusing a TGSM beam onto the film. We also aim to evaluate numerically the energy density and energy flow (Poynting vector) of the produced near fields and explain their qualitative behavior in terms of SPPs.

To date, we have simulated the spectral density of in-coupled light and shown that it is strongly affected by the SPP generation. This also confirms our original assumption that strong plasmon coupling can be realized in this configuration. The degree of polarization of the transmitted beam is expected to be influenced by the twist parameter magnitude of the TGSM beam. In addition, most of the incident beam energy should be coupled into SPPs in accord with our spectral density simulations.

Index Terms – Surface Plasmons, Focused beam, Statistical.

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Signal Extrapolation Using Bandlimited Prolate Spheroidal Wave Functions

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Abstract – About half a century ago an interesting study was done by David Slepian, an American mathematician, and his colleagues on a special set of functions called prolate spheroidal wave functions (PSWFs). These functions were bandlimited and exhibited interesting orthogonality relations. Generating these set of functions practically seemed difficult because of the complexity involved and limited computational capabilities existed. Hence, there hasn't been any significant interest in this field up until very recently. It was Michael Cada, my supervisor for this research, who derived for the first time the robust algorithm for calculating the linear prolate functions with desired high precision.

This research comes under the area of signal processing namely signal extrapolation which is just one of the numerous applications centered on PSWFs. The proposed extrapolation method by Slepian is studied and implemented. Previous studies have shown that Slepian series is potentially optimal over other schemes like Fourier series when processing signals. Linear prolate functions set obtained from Cada's algorithm forms the basis set for our computations. Much of the emphasis is on improving the extrapolation range without losing accuracy of the results as compared to previous works. Another objective is to incorporate more higher-order PSWFs in to the computational formula with increasing Slepian frequency (c). The exactness of numerical integration when computing overlap integral seems to be a prominent factor and challenging task. For extrapolation, a new algorithm is proposed which already gave favorable results for some standard test functions. Mathematica, a software tool excellent for high-precision computing, is used throughout this work for the simulations and plots.

Having implemented the algorithm successfully, the current focus is on to carry out extrapolation on random signals like part of an image, piece of speech and historical stock market data. Efforts are being made also to improve the efficiency of the algorithm proposed so as to be more generic with respect to the kind of signal being extrapolated.

Index Terms – Signal extrapolation; Prolate spheroidal wave functions; Slepian series; Overlap integral.

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Surface Plasma Dispersion in Inhomogeneous Semiconductors

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Abstract –The field of plasmonics in semiconductors and its applications have attracted significant attention recently, whereas less attention has been paid to the tunable properties of plasmonic media. Several novel physical phenomena and their applications have been demonstrated thus far in plasmonics, but there is a need for state-of-the-art plasmonics technological research in order to solve the incompatibility between electrons and photon due to their different sizes and resulting nanoscaling problems. The interaction between free carriers photons at an interface is a phenomenon known as surface plasmonics (SP). SP comes from coupled modes, which can be used to confine light and increase the electromagnetic fields at an interface between two media where at least one is conducting. There is enormous potential for advanced SP applications in fields such as optical sciences, physics, photonics, nanotechnology, etc.

The key to plasmonic properties of semiconductor materials is the availability of free carrier concentrations of electrons and holes, which gives rise to a plasma frequency. The effect of concentration profiles depending on the coordinate perpendicular to the interface has not yet been satisfactorily explained. Therefore, there is a need for a study that would provide a description of the inhomogeneity of a semiconductor in terms of the concentration profiles depending on the perpendicular coordinate. We wish to take this a step forward by deriving dispersion curves via satisfying boundary conditions for the fields electromagnetic.

Starting with a semiconductor/dielectric interface, we seek to obtain a surface plasmon wave travelling along that interface with a contribution of the concentration profile depending on the perpendicular coordinate. This contribution might enable us to understand the physical properties of optical plasmons and plasma dispersion in semiconductors. To complete the development of an optical plasmon in semiconductors theoretically, the dielectric function has to be described through the free charge concentration.

This work is concerned with a detailed analysis of surface plasmons and the calculation of dispersion relations in semiconductor/air interfaces, starting with Maxwell's equations. This will bring a solid understanding of coupling light between two different media, and achieve anenhanced electromagnetic field by using special approaches to match the wave vectors.

Index Terms – Inhomegounoes,semiconductor, plasmonics, dispersion.

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Higher Precision Clockless ADC and DAC Using Wavelet Neural Network

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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 a 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 signal is converted to CT digital codes. 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 incorporates 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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Using Superconducting Fault Current Limiter to Improve Fault Ride-Through Capability of DFIG-Based Tidal Turbine

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Abstract – Today's technology is focusing on the utilization of renewable energies that are used as substitutes to the environmental polluting fossil fuels. As a clean and sustainable source of energy, renewable energies are considered as the best solution to maintain high quality of life on this planet, currently and for the future. Tidal and wind are new sources of renewable energies, it is essential to keep tidal and wind turbines connected with the power system grid during different turbulences such as grid faults to avoid general blackout status.

The objective of this thesis is to use Superconducting Fault Current Limiter (SFCL) resistance type as a proposal for limiting the fault current level as well as improving the Fault Ride-Through (FRT) ability of the generating source.

One example of tidal-turbine generator is doubly fed induction generator (DFIG), which will be tested and simulated on MATLAB software. The simulation in fault conditions will be done with and without SFCL, the stator and rotor currents. In addition, the voltage shape and dip at the generator terminals will be measured as well. The results obtained will be analyzed. Furthermore, the consequence of SCFL limiting resistance value will be examined. Finally, the voltage dip characteristics will be discussed and analyzed.

The expected results of this proposal are SFCL that will decrease the fault current as well as the voltage dip at the generator terminals and reactive power consumption from the grid.

Index Terms – SFCL, Improve F R T, DFIG Tidal Turbine.

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Application of Coordinate Transformation in Solving Electromagnetic Complex and Moving Boundary Value Problems

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Abstract – Many numerical techniques have been developed over the past a few decades to solve various problems in electromagnetics. Treatments of boundary conditions are often required in most problems, which may become very challenging when the boundaries are not of regular shapes, being either curved, moving, or of complicated conditions.

Conventional numerical methods such as meshless methods are attractive for solving electromagnetic problems due to their capabilities in solving arbitrary problems. However, significant errors may arise from modeling the boundaries, e.g. approximation of non-Cartesian or curved boundaries. For moving boundary conditions, numerical methods need to re-mesh at every time step to account for changing positions of the moving boundaries.

In this report, transformation techniques coupled with meshless method are adopted in solving the complex boundary values problems. The basic idea of the method is to map a physical domain into another domain with all its boundaries being a regular and solvable shape. The associated transformed operator and governing equations are then developed and solved in the transformed domain. Numerical examples are presented to verify the proposed techniques.

Index Terms - Meshless method, Coordinate transformation, Boundary condition, Radial point interpolation method (RPIM).

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Fuzzy Model Based Control of Nonlinear Systems

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Abstract – Takagi-Sugeno (TS) fuzzy modeling framework supported by a parallel distributed compensation (PDC) approach is well suited for the control of nonlinear systems with guaranteed global system stability. The control scheme uses the sector nonlinearity method to represent the nonlinear terms in the physical plant model as fuzzy membership functions thereby decomposing the plant into various subsystems defined by the fuzzy rules. For each fuzzy model rule, a corresponding control rule is defined that has the same premise part but uses a linear state feedback control law in the consequent part. The local control gains for all model rules are found by solving a set of Lyapunov conditions sharing the same common positive definite matrix to ensure the global stability. A weighted combination of these local control gains based on the TS fuzzy inference mechanism yields the net gain for the plant.

To better deal with the parameter uncertainty of nonlinear systems, interval type-2 TS fuzzy modeling approach can be employed that uses interval type-2 fuzzy controller to enhance the control performance. This work compares the performance of the type-1 and interval type-2 TS fuzzy controllers when the plant is modeled through type-1 as well as type-2 TS-fuzzy approach. MATLAB simulations reveal the superiority of interval type-2 fuzzy control scheme.

Index Terms–Nonlinear systems, TS fuzzy modeling, Type-1 fuzzy controller, Interval type-2 fuzzy controller.

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HIGH SPEED WIRELESS COMMUNICATION SYSTEM USING THE CONCATENATED MODULATION TECHNIQUE

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Abstract – The ever-increasing demands for high speed 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 modulation techniques that utilize an antenna array have been standardized to improve bandwidth efficiency. Among them recently developed MIMO and Space Modulation (SM) are related to the proposed work. In particular, MIMO is a powerful performance-enhancing technique that uses an antenna array to achieve spatial diversity, spatial multiplexing, interference reduction and noise robustness. SM uses multiple antennas for mapping information bits into the relative spatial positions of the transmitting antennas.

In order to increase the throughput of a wireless communication systems, two different configurations of digital modulation can be engaged in parallel to transmit the data bits. In our work, we propose a novel space-time modulation technique that concatenates (i) beam-forming to map some of the information bits in the "space-time" data symbols to the beam angle of the transmitted signal and (ii) the conventional time and frequency modulation scheme representing other data bits with the conventional time symbols like in QAM. The software-configured beam-forming modulation called here Beam Angle Channel Modulation (BACM) is investigated to develop a high speed wireless system to trade-off system complexity and bandwidth efficiency.

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

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Energy Efficient Asymmetric Constellation Design for Unequal Error Protection Based Image Transmission

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***Abstract* –** In wireless communications, research has been conducted for quite some time to design energy efficient constellations for higher order modulation schemes with simple detection schemes. The widely used Square Quadrature Amplitude Modulation (SQAM) provides easy to implement decision regions but is not optimum in the sense of power efficiency. Also, in the case of multimedia communications, the compressed source exhibits different level of importance among different portions of the encoded bit stream. This unequal nature of importance can be addressed by creating Unequal Error Protection (UEP) where different signal points in a constellation are placed at different distances from the adjacent symbols according to their importance and results in different bit error rates on bits these symbols represent.

In this work, we propose first a new design for Asymmetric M-ary QAM suitable for UEP which provides considerable power gain over the conventional asymmetric SQAM while keeping low detection complexity. In particular, information bits after source coding are grouped into bits according to their priority and then mapped into asymmetric 64-QAM in such a way that high priority (approximation) bits have better protection from error then the low priority (details) bits. We also vary the Euclidean distances between symbols with the objective to create different UEP scenarios. This is followed by bit into symbol mapping to minimize Gray Mapping penalty and to ensure the detection method is practical from a point of view of implementation. Then, performance analysis, in terms of power efficiency and Bit Error Rate (BER) of different UEP scenarios for asymmetric 64-ary QAM, was carried out and presented in simulation results.

Second, a scenario of image transmission is considered using the proposed asymmetric64-QAM with UEP. The results documenting the quality of the reconstructed image are obtained for different Signal to Noise Ratio (SNR) in the channel and the performance of the transmission system is analyzed in terms of Peak Signal to Noise Ratio (PSNR) of the received images. The results clearly show that the proposed asymmetric 64-QAM based image transmission system can provide at least 0.375 dB power gains over conventional asymmetric SQAM.

Index Terms – Unequal Error Protection, Triangular Quadrature Amplitude Modulation, Asymmetric QAM.

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Active Control of 2 Dimensional MicroElectroMechanical Systems (MEMS) Micromirros with Decoupling Electrodes and Integration in Optical Coherence Tomography (OCT)

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Abstract – A MicroElectroMechanicalSystems (MEMS) micromirror is a moving mirror, typically made of silicon and fabricated using photolithographic processes common in the semiconductor industry. Electrostatically actuated torsional micromirrors fabricated using MEMS technology are the fundamental building blocks for many optical network applications, such as optical wavelength-selective switch, configurable optical add-drop multiplexers and optical cross-connects. In recent years, MEMS micromirrors are finding their way into the biomedical market as well.

Traditionally, 2D electrostatic micromirrors are designed with a gimbal surrounding the mirror plate and four square electrodes underneath. The main disadvantage of this type of design is that the X-Y tilts are extensively coupled. This coupling nature makes design of a control system difficult. In this work, design and control of an electrostatically actuated 2D MEMS micromirror is reported. Triangular shaped electrodes have been used to achieve relative decoupling around X and Y axis. A multi-loop proportional, integral and derivative (PID) controller is designed and implemented to control a 2D micromirror system bellow and beyond the pull-in point. The simulation and experimental results show decoupling for small tilting angles have been achieved. The designed control system can operate over a larger controllable tilting angle than the pull-in angle resulting in significantly enhanced device performance and functionality.

Another objective of this project is to design two scanning micromirrors for integration into a high-resolution optical coherence tomography (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. At present slow, bulky galvanometric mirrors are used for this application, but the system could be considerably improved by making use of MEMS mirrors. The small form factor of MEMS mirrors makes them ideal for a module meant to plug into existing microscopes since the end product will need to fit into a case not much bigger than a microscope-adapted camera. For this project, the required micromirrors are modelled, simulated using finite element analysis and fabricated through a combination of bulk and surface micromachining process.

Index Terms – Decoupling, MEMS, micromirror, PID, 2D control, OCT.

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Wireless Optical Printer

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Abstract **-** In this paper, we propose an optical printing technique through the wireless medium using visible light communication (VLC) between light emitting diode (LED) as a transmitter and photodiode as a receiver. My objective is to design a new system which can print the data received by the photodiode while taking care of data speed rate, bit error rate and signal to noise ratio. An optical indoor wireless communication system that used white LEDs for transmitting data and a photodiode that receives the data is used. In my project, I had first used microcontroller EKK-LM3S9D92 to match the frequency of the signal received by the photodiode using embedded C programming language, but upstream port doesn't provide the desired frequency level needed, which can match frequency level with the printer USB port and send serial data to the printer. But it does not give good results. Now I am using PIC24FJ64GA002.It has an upstream port which can interface with printer, USB port which can use software code made in MPLAB using C/C++ language and provide the frequency needed by printer to work and match the frequency. Advantages of the proposed system, LEDs are more widely used over the other light sources such as fluorescent lamps can act as a transmitter of our system and thus reducing cost. The main idea is to utilize this optical source of light in the visible spectrum for communication process. A challenge to use existing infrastructure, thus reducing cost and objective to make this application for mobile devices becomes the motivation to develop this system. The major advantage of this system is to use visible light which is harmless to human beings and thus preventing from diseases and hope to get higher data speed utilizing wavelength in the visible spectrum. A microcontroller PIC24FJ64GA002 is used to match the input frequency equal to the frequency required by the printer.

Index Terms – Visible light communication; LED; Photodiode; EKK-LM3S9D92, PIC24FJ64GA002 microcontroller.

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A Track and Hold Comparator-Based Switched-Capacitor

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Abstract - Comparator-based switched-capacitor (CBSC) is a new approach that replaces op-amp in sampled data-systems for low-voltage applications. In the op-amp based circuit, the virtual ground is utilized for the complete charge transfer. In the CBSC, op-amp is replaced by threshold detection comparator and a set of current sources. The function of the comparator is to detect the virtual ground condition and triggers sampling. In CBSC, fine phase output overshoot and voltage drops across switches create non-linearity and offset conditions. Mainly CBSC is expected to meet the scaling technologies and to avoid various trade-offs occurred by op-amp circuits.

In this work, offset and non-linearity are the main problems to be treated. To stabilize the circuit and for high gain control we can implement the track and hold concept to the comparator based switched capacitor. Track and hold amplifier is used to ensure better matching between channels. In this method gain stage is not dependent on capacitor matching and a double sampling technique is used to reduce the offset and obtain a finite dc gain. By using the offset compensation technique we can reduce the offset to a considerable extent. We are trying to implement the circuit using 65nm technology in cadence.

As a conclusion, if we could use a CBSC with track and hold amplifier then better performance of the circuit can be achieved. We can implement it in many applications such as pipelined ADC, delta-sigma modulator ADC.

Index Terms – Comparator based switched capacitor, Delta-sigma modulator, Pipelined ADC.

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A Novel Planar Wireless Power Transfer System with Strong Coupled Magnetic Resonances

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Abstract – The wireless power transfer (WPT) technique, as a means of delivering electric power from a source to an end-user device without physical wires or contacts, has received increasing attention recently due to increasing demands for truly wire-free portable electronic devices. WPT systems using magnetic induction have already been used in home appliances and medical implants. However, the inductive nature makes the power transfer efficiency of those systems very limited as it decays rapidly over the distance. In 2007, the first mid-range WPT system using magnetic resonant coupling was proposed by a research group from MIT, and since then, several research groups have been focusing on the development of magnetically coupled resonance WPT (MCR-WPT) systems using helical and spiral resonators to extend transmission distance of a WPT link. With strongly coupled magnetic resonances, higher power transfer efficiencies over considerably larger transmission distances were realized.

In this letter, a fully planar wireless power transfer (WPT) system is presented. Via strongly coupled magnetic resonances, the WPT system is planarized by utilizing printed spiral coils (PSC) and printed loops. The equivalent circuit model of the proposed system is derived to facilitate the design and analysis. The quality factor of individual loops and resonators, mutual coupling between resonators, and frequency splitting phenomenon of the proposed WPT system are also discussed and analyzed. Furthermore, the effect of the input impedance of the system on the power transfer efficiency in PSCs of different numbers of turns is investigated. Finally, a parametric study is performed to realize the maximum power transfer efficiency of the proposed WPT system. The planar structure and sufficient transfer efficiency make the proposed design a suitable candidate for wireless power transfer of small portable electronic devices.

Index Terms – Magnetically coupled resonant, parasitic strips, printed spiral coils (PSCs), wireless power transfer.

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Medical Nano Robots: Solution to Human Health

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Abstract – Medical field is one of the most challenging and demanding area of research now days as there are lots of diseases and some of them are still incurable. Moreover, even though scientists have invented a treatment for some of them but the medical treatments are painful and/or open gates for another problems in a human body as the time passes. Nano robots are expected to enable new methodologies in diagnosis, medical therapies and minimally invasive surgeries. Nano robots can be useful to prevent damages to body during treatment of incurable diseases like cancer, Alzheimer.

Human body is made up with the common unit called DNA (Deoxyribonucleic Acid) that it has a twisted helix structure. This twisted helix structure has four units called adenine, guanine, cytosine and thymine. Any changes in the pairs of these four units can cause problems in human body and turn into any disease. DNA makes amino acids to produce protein and get the signals from enzymes. Excess production of amino acids leads to cell growth into odd numbers as they grow in even number, and it can lead to cancer.

Basically three treatments: Chemotherapy, Surgery and Radiation therapy are being used now days to prevent cancer. All the techniques have their disadvantages beside advantages. Chemicals are used to destroy unregulated DNA, which can cause other cancer and can damage bone marrow. Surgery is not an ideal situation for in vivo cell growth and in radiation therapy radio waves are used, which is one main cause of cancer.

Nano robots can provide efficient early diagnosis of cancer. They can be useful in drug delivery and reducing the side effects of chemotherapeutic process. Temperature of body, concentration of chemicals and normal symptoms are three basic parameters for identification of any diseases. As cells and DNAs are the reasons for cancers, Nano robots can be injected into human body through injection to destroy unwanted cells and DNA. Chemicals and thermal sensors like SWNT (Single Wall Nano Tube) can be used to identify the effected areas as these sensors are sensitive to metallic ions concentrations. For propulsion of Nano robots, we can use the 50 to 70 mV DC voltage generated during protein adhesion. For energy supply, data storage and transmission, remote inducting can be used to deliver power in mW.

Index Terms – Nano Robots, Cancer, Chemotherapy, DNA, Cell growth.

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Implementation of Organic Thin-Film Transistor in Analog Circuits.

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Abstract - The field of organic electronics is an up coming technology which explores a totally different path in analog integrated electronics with a new and specific position in applications such as flexible displays, organic lighting, and smart sensor systems. This application field is the driving force for the development of the technology and the presentation of the organic thin-film-transistors (OTFT) with organic semiconductors. The advantages of this technology include high sensitivity, low cost, easy fabrication, flexibility and biocompatibility.

In this work, we are going to utilize OTFT in the realization of different analog circuits such as analog sensors, amplifiers, and data converters. As the sensitivity of these devices is dependent on the thickness of the organic semiconductors, we are going to propose a decomposition process by various fabrication approaches like thermal evaporation, spin coating, screen printing and inkjet printing. We can reduce the supply voltage up to 3~5v by reducing the thickness of these organic semi-conductor layer and reducing the thickness of insulator.

As compared with silicon transistors, OTFT's have less trade-off conditions because of the unique electronic properties. With this Thin-film transistors we can emerge new electronic circuits with less supply voltage and density.

Index terms - Organic thin film transistors (OTFTs); organic sensors,amplifiers and dataconverters.

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Integration of Distributed Generation using Fuzzy Logic Controller for Demand Side Management

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Abstract – Power consumption is one of the daily resources without which we can't imagine our life. According to BP Energy Outlook 2030 report the power sector is the key driver of global energy growth where all the primary fuels compete and in 2030 total electricity consumption will be 61% higher than in 2011. Due to increasing depletion of primary energy sources, supply and demand gap of electrical energy is also rising. Global proven reserve of oil and natural gas at end of 2011 were about 54 years and 64 years respectively. Moreover, the total population growth of the world is also increasing energy demand. Following the study of the World Energy Outlook 2011 world's total population will increase by 26% in 2035. Establishing new power plants requires longer time and huge investment along while increasing the possibility of emitting greenhouse gases. Therefore optimal consumption of energy resources is an interesting area of research to mitigate potential shortages in power distribution network.

The intention of this research is to assist the energy consumers by preserving same level of comfort without changing energy consumption practice. To follow up on this thought distributed generation (DG) at customer's site can play an important role. DG is the process of generating power at the distribution network level. But distribution network is usually designed as a loop where power flow is one directional with no or very little redundancy compared to mesh designed transmission network. Moreover, low voltage distribution network has higher resistance than high voltage transmission lines which cause significant voltage drop along lines. Hence the connection of DG can have a noticeable influence on local voltage level. Fuzzy logic controllers are proposed in this study to integrate DG with distribution network by observing the supply and demand gap of energy consumption to maintain the expected voltage level.

In this research simulations have been carried out on a 10 kV and IEEE 13 node test distribution feeder to show the impact of adding distributed generations in the medium voltage distribution network. Case studies have been done to show the under loading and overloading situations while connecting distributed generations. Equations of power line loss coefficients have been determined for both test feeders. A fuzzy logic controller has been proposed in the 13 node test distribution feeder to determine the amount of DG output to be added in the network on the basis of power demand gap and time of the day. Another fuzzy logic controller is proposed to select the bus where the distributed generations need to be connected using the input of DG amount needed to be installed and distance of generation from the distribution transformer in the network.

Index Terms – Fuzzy Logic Controller, Distributed Generation, Distribution Network

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Dispersion Managed Airy Pulses in Fibers

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Abstract – Non-spreading Airy wave packets were first discovered in the context of quantum mechanics. Later the concept of Airy beams was extended to the optical domain and finite-energy Airy beams were successfully generated in the optical laboratory. The most remarkable feature of this Airy packet is its ability to freely accelerate in free space. After the Airy beam has been generated in the laboratory, the majority of the follow-up research in this area has so far focused on the finite-energy optical Airy beams propagating in free space. Due to a mathematical analogy between paraxial beam diffraction in free space and pulse dispersion in linear media, low-intensity pulse propagation in optical fibers obeys the same wave equation as does beam spreading in free space. Hence, Airy pulses should propagate in linear optical fibers without distortion. However, unlike free space beam diffraction, pulse dispersion in a fiber can be controlled by adjusting the group-velocity dispersion coefficient of the fiber through an appropriate dispersion-management technique. This circumstance provides an additional degree of freedom that can be explored to engineer the properties of Airy pulses in optical fibers.

In this work, we study the Airy pulse propagation in dispersion-managed linear and nonlinear optical fibers. In the linear regime, we consider ideal Airy pulse propagation in commonly used dispersion-managed fibers. In particular, we focus on two commonly used dispersion maps: the exponentially "fast" decreasing dispersion and hyperbolic "slowly" decreasing dispersion. Our analytics shows that the Airy pulse acceleration can be controlled on propagation in such fibers. For a example, by adjusting the input pulse width the accelerating effect can be significantly inhibited in a controlled way. In the future, we plan to focus on finite-energy Airy pulse propagation in dispersion-managed nonlinear optical fibers. In the nonlinear regime, our analytical approach cannot be used. Therefore, we are currently developing the split-step Fourier code to analyze the problem numerically. We will examine whether propagation-invariant properties of low-intensity Airy pulses can be, at least, partially recovered for high-intensity pulses for which the optical response of the fiber is nonlinear. It is expected that this research will have applications for fiber optical communications with low- and high-energy pulses.

Index Terms – Airy Pulse, Dispersion-Decreasing Fiber, Diffraction free, Accelerating.

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Offshore Power System Design

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Abstract – Marine renewable energy is a promising energy alternative both for Nova Scotia and the rest of the World. There are many challenges associated with offshore power system design. These design challenges include the following aspects:

- Choice of AC or DC generation
- Determining the necessity of power conversion devices
- Transmission line choice, multi-core cable or multiple single-core cables, and how multiple offshore generation installations can be interconnected
- Protection settings for over voltages and transient currents
- Reactive power requirements of the system
- Magnetic field analysis of the underwater cables

To analyze and get intuition about these design issues, the offshore power installation must be modeled when it is connected to an onshore power grid. An IEEE standard power system can be utilized as a standard onshore power grid. From this, the steady state analysis, transient analysis, harmonic propagation, and stability can be evaluated when the offshore power grid is connected to the onshore one. The implications of this additional generation can be evaluated and the power system can be modified to include this offshore generation.

Index Terms – Offshore power system, power system design, underwater power transmission, design considerations, underwater cable magnetic field.

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Optical Surface Plasmon in Semiconductors

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Abstract – Surface Plasmons are 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 Surface Plasmons in the visible domain on metal surfaces, however not only metals support electron plasma oscillations, semiconductors can also support Surface Plasmons with a resulting plasma frequency typically in the terahertz domain.

We investigated the Surface Plasmons at heavily doped semiconductor/dielectric interface. Compared to the traditional metal/dielectric structure, Surface Plasmons excited at semiconductor/dielectric interface can be controlled by modifying the free carrier density of semiconductor. Current research on Surface Plasmons at semiconductors/dielectric interface is in millimeter wavelength (terahertz frequencies) and has been believed not to support Surface Plasmons at optical frequency.

By both re-deriving the dispersion relation of Surface Plasmons based on the classical method using Maxwell equations and from the traditional derivation, we find out a new solution which is only possible to exist in the semiconductor/dielectric structure while other two solutions of dispersion relation remain the same with the metal/dielectric structure. This is due to the permittivity of semiconductor is larger than metal's which is smaller than 1 normally. The new solution is like standing waves with group velocity equal to zero in theory. Silicon/SiO2 has been chosen as our prototype structure for several reasons. By investigating the optical properties of heavily doped Silicon, we proved through numerical calculations that the new mode solution can be excited under 1.55μm operating wavelength when the electron density of heavily doped Silicon equals to $2.35*10^{27}m^{-3}$. Error analysis has been taken into account to deal with the errors introduced during the step by step approach. This data from the preliminary numerical study is seen as a preparation for the future experimental research.

Index Terms – Surface Plasmons, Semiconductor.

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Calculating the Optimum Tilt Angles for a Flat-Plate Solar Collector in Khomas; Libya

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Abstract – Solar energy is a sustainable and clean renewable energy. It can be utilized in many applications, such as generating electrical power from (PV/CSP), and solar water heating system by using a solar collector. To maximize the solar radiation collected by a flat-collector in the Komas city, Libya, a mathematical method was used for the calculation of the optimal tilt angle. The monthly and yearly optimal tilt angles for a solar collector were obtained by using the Liu and Jordan model. By adjusting the optimal tilt angle (monthly/yearly), a significant increase of the global solar radiation and high energy collection efficiency was achieved, compared to flat-plate solar collector.

Index Terms – Solar radiation; optimal tilt angle; Khomas; Libya.

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Tele-Control of Neurosurgical Robotic Manipulator

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Abstract – Trauma and Head injury are an important cause of overall mortality and morbidity around the world; Tele-surgical robotics could be used to improve Health services by saving money , time delivery of care; and enable surgeons to perform surgery more precisely a robust, flexible, safe and from greater distances.

This proposal presents the control theory for a neurosurgical robotic system and the aim is to build a reliable neurosurgical control system features remote control; force-feedback control, dexterity, and flexibility. The challenging problems associated with the system is obstacle avoidance; differential kinematic control; force feedback and time delay.

A Robust trajectory tracking with multiple Obstacle Avoidance algorithm will be developed for the Tele-surgical manipulator. The simulations and experiments will be done to verify the proposed approach incorporating constraints on the robot arm such as singularity; joint limit avoidance and obstacle avoidance.

Index Terms – Tele-surgical; robotic manipulator; Obstacle Avoidance; force-feedback control

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Optical Coherence of Ultra-Short Pulses Propagating in Linear and Nonlinear Resonant Media

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Abstract – Optical coherence theory deals with the properties of optical field fluctuations arising due to unpredictable fluctuations of light sources or the media through which the light propagates. These fluctuations are measureable using experiments that provide information about correlations between the field fluctuations at two or more space-time points. The invention of modern light detectors and the development of lasers and other novel types of light sources has resulted in significant progress in optical coherence phenomena and statistical description of optical fields. This field of study has generated a wide range of applications in numerous areas, such as optical fibers, optical biopsy, image processing, and production of light fields with controlled coherence.

To date, there has been extensive research on modeling statistical properties of random pulses as well as on such fundamental issues as defining and measuring statistical pulse spectra and cross-spectral correlations. However, even though the propagation of partially coherent pulses in various linear and nonlinear media has been explored, no study has yet, to the best of our knowledge, investigated the coherence properties of stochastic pulses on propagation in the media near optical resonances.

In this work, we model a variety of partially coherent statistical pulses with different levels of coherence in both space-time and space-frequency domain. In particular, we explore the evolution of pulse coherence properties on their propagation through various linear and nonlinear media in the resonant regime. Both amplifiers and absorbers as the host mediua are explored. We consider incident Gaussian Schell-model (GSM) pulses as a generic statistical model of the source, displaying the behavior of the GSM pulse intensity profile on propagation in amplifier and absorber media for two cases: almost fully coherent and nearly incoherent input pulses. We also exhibite the energy gain factor for both pulses as the function of the propagation distance. It is clearly shown that the more coherent pulse is able to extract/insert much more energy from/to the medium over the same propagation distance than can the less coherent pulse. Furthermore, we studiy the behavior of the complex degree of coherence of GSM pulses for different propagation distances. Comparing the two cases, we discover that the pulses become progressively more coherent on propagation in the amplifying media and progressively their degree of coherence becomes more uniform across their temporal profiles on propagation in the media. In short, the shorter the pulse the more its is transformed by the medium.

Index Terms – Statistical optics, optical coherence, ultrashort pulses, and resonant media.

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FOREX PREDICTION USING PARTCILE SWARM OPTIMIZATION

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Abstract – Particle Swarm Optimization (PSO) is one of the evolutionary computational methods that's been widely used in the recent years in various fields. PSO is inspired by the swarming or collaborative behavior of biological populations. Biological evolution has been the source of motivation for addressing the various complex computational problems. Scientific research involves random processes which are complex and unpredictable in nature. Higher the understanding of the randomness in the research field the better understanding of the process and more accurate the results. Optical electronics has its fair share of random process that remain unexplained till date. The stochastic nature in process such as spontaneous emission, polarization effects, Phase noises, non-linearity in losses are still unexplained. These processes contribute to the degradation of optical devices which could be avoided with a better knowledge of the unpredictable nature involved in these processes.

The randomness in optical electronics could be related to various random parameters that are incorporated in various evolutionary computational algorithms like Particle swarm optimization. This research is an attempt to study the interaction of random parameters incorporated within Particle Swarm Optimization (PSO) algorithm by using it as a standalone algorithm for prediction and estimation. PSO has been used in almost all possible fields of research due to its versatility, superior accuracy over other optimization algorithms and high convergence ratio with optimal initiation parameters.

There has been a commendable contribution in this field by previous researchers from my group. This research aims to understand and use the versatility of particle swarm optimization by enhancing its random optimization pattern with statistically optimized parameters and optimized error minimisation. The current stage of this research uses FOREX market with its highly stochastic nature as the test bed to understand the randomness that is included in the PSO algorithm. This involves using the various parameters that determine the currency exchange rates of different currency pairs as particles in PSO. These parameters would be used to predict and estimate the currency exchange rates in FOREX trading which would be the stochastic process. By enhancing the efficiency of PSO algorithm in the test bed to predict the currency rates, we would be able to use this algorithm for our primary objective which is to understand the chaotic processes in Optical electronics.

Index Terms – Particle Swarm Optimization; FOREX.

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Harmonic Analysis of a Wind Energy Conversion System with a Permanent Magnet Synchronous Generator

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Abstract – Global energy demands are growing daily, with renewable energy options such as wind power emerging as attractive alternatives to fossil fuels. This thesis is mainly doing simulation using Matlab to filter harmonics which are found in a Permanent Magnet Synchronous Generator (PMSG) Wind Energy Conversion System (WECS) connected to a three-phase load through a full converter (AC/DC/AC). Harmonics are caused by the converter system. To reduce these harmonics, an effective filter is needed. There are two types of filters that are usually used, active and passive filters. Among the types of passive filters are band pass which block lower harmonics orders such as 5^{th}, 7^{th}, 11^{th}, and 13^{th}, and high pass filters which are responsible to filter higher harmonics such as 24^{th}. So, we use two different combinations of harmonic filtering. The first method includes a c- type high pass filter (for lower orders), a double – tuned filter (for 11^{th} and 13^{th}) and high pass filter (for higher orders). Secondly, this method includes a single – tuned filter instead of C- type filter with keeping the other filters. We applied Fast Fourier Transform (FFT) to determine the harmonics and purposes. In this thesis, we investigate and analyse the level of harmonic content of two AC/DC converters working at different wind speeds. Our findings indicate significant improvements in Total Harmonic Distortion (THD) with best results in the second method.

Index Terms – Active & passive filters, wind turbine, harmonics, THD.

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Wobble-Based Temperature and Process Variation Compensation Loop Using CMOS Self-Heating In 65nm Technology

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Abstract – Temperature and process variations have become critical issues in analog design. New methods are being used to reduce those variations as much as possible. In recent years different methods have been applied to the circuits like band gap reference, Zero Temperature Coefficient point, etc. In 65nm Technology, each MOSFET has a unique ZTC point in which biasing does not change with temperature variations. However, since there are process variations, it is not possible to find the exact ZTC point through manufacturing process for every single transistor. Here, a wobble-based calibration loop is being introduced. There is a phenomenon in CMOS transistors called "self-heating phenomenon" or "self-heating". When a MOSFET is biased, carriers start moving through semiconductor and collide each other and as a result, its Temperature goes up. Since its threshold voltage and charge-carrier mobility are highly dependent on temperature, MOSFET biasing current changes and this change causes more change in MOSFET temperature. Direction of current variation depends on V_{GS}. If V_{GS} is more than voltage of ZTC point (V_{ZTC}) its current increases. Vice versa, if V_{GS} is less than V_{ZTC}, its current decreases. In proposed technique, MOSFET current is compared in two different moments, and based on its direction, V_{GS} will change. This new V_{GS} is then applied to the CMOS for the next comparison. Eventually, transistor bias point converges to ZTC point and wobbles around it after they reach together. Therefore bias point temperature variations will decrease significantly. Bias point will be kept close to the exact ZTC point as long as MOSFET is in the loop. Even though ZTC point changes with process variations, since this calibration technique is dynamic, no matter where the exact ZTC point is, bias point always converges to it.

The circuit has been designed, simulated and analyzed in Cadence Virtuoso Analog Design Environment in 65nm Technology using SKILL programming language. CMOS inverter and current mirror, as two simple applications are calibrated using this technique and results show significant accuracy and acceptable error in comparison with other methods. Future works on this idea can increase its accuracy more. By using this dynamic calibration, it will be possible to bias circuits in different temperatures and have very reliable and stable references in any analog or digital application.

Index Terms – Temperature Compensation, Process Variation Compensation, Zero Temperature Coefficient, Self-Heating, ZTC Point.

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Synchronous Clock Recovery for Cryptographic Devices

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Abstract – Power consumption measurements for cryptographic side-channel analysis normally use an oscilloscope, which uses an asynchronous timebase inside the oscilloscope for sample timing. Synchronizing the sampling timebase to the clock of the target device, the storage and sampling requirements are considerably relaxed; an attack will succeed with a much slower sample rate. My previous work has demonstrated this on a system with an external and easily available clock; but devices may have an internal oscillator which is inaccessible, and may purposely vary the frequency this oscillator runs at. A comparison of the performance for a synchronous sampling system attacking a modern microcontroller running a software AES implementation is given in this work. This attack is characterized for three systems: with a stable clock, with a clock that randomly varies between 4.5 MHz - 12.7 MHz, and with an internal oscillator that randomly varies between 7.41 MHz - 7.49 MHz. Traces captured with the synchronous sampling technique can be processed with a standard Differential Power Analysis (DPA) style attack in all three cases, whereas when an oscilloscope is used only the stable oscillator system is successful. This work also develops the required hardware to recover the internal clock of a device which does not have an externally available clock.

In addition to logic performing the clock recovery itself, a system which samples the data at appropriate time instants is demonstrated, the system consisting of an entire measurement tool chain including PC-based software. The front-end consists of a high-speed ADC coupled with a FPGA device, where the FPGA stores the samples in internal memory (Block RAM). Partial reconfiguration of the FPGA is employed to allow flexibility in the manipulation of clocks, which is required for optimum performance in side channel analysis systems.

The hardware is also suitable for experimentation with glitch injection. Such attacks aim to inject glitches, such as clock glitches or power glitches, into the target device at specific instances or clock cycles. By using the synchronous capture technique, it is possible to inject glitches at a specific clock cycle, even if the device clock varies with time. This is a significant advancement over previous work, which could only inject based on time offsets from trigger events. If the device clock varies, significant jitter will be introduced into the time offset measurement using unsynchronized tools.

Index Terms – side channel analysis, power analysis, FPGA, cryptographic hardware.

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Optical Nanoantenna

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Abstract – The field of nanoantennas and their applications has attracted significant attention recently. Nanoantennas enhance optical radiation from free space into localized fields within subwavelength dimensions, and vice versa. The conventional radio frequency and optical antennas have some similarities, such as radiation pattern, directivity, and gain, but they differ in their resonance properties. This difference is due to the way in which light waves interact with metals differently from the way radio frequency waves interact. There are many applications of nanaoantennas in fields such as near-filed microscopy, light emission, near-field spectroscopy, photovoltaic enhancement, and sensing.

The unique properties of metal nanostructures, which have strongly coupled plasmas at optical frequencies, are achieved by the use of optical antennas. Plasmons come from coupled modes; these modes can be used to confine light and increase the electromagnetic fields at an interface between two media where at least one is conducting.

Our goal is to develop a theoretical treatment of optical antenna resonance, as well as the antenna geometry. In fact, the optical antenna length is not directly related to the received or transmitted radiation as in radio frequency, but is related to the plasmons wave and antenna geometry. Theoretical and experimental research has shown that the effective length of the optical dipole antenna is less than half of the wavelength, instead of half of the wavelength in the radio frequency antenna equivalent.

This work will present a literature review of this new topic and its applications. The numerical results of optical nanoantenna modelling, gleaned from the papers published by others, will be presented. This contribution might enable us to understand the physical properties of optical nanoantennas and potential applications.

Index Terms – optical antenna, plasmon , subwavelength

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Electrostatic Micro-Electro-Mechanical-Systems (MEMS) Based Deformable Mirror

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Abstract – Micro-electro-mechanical-systems (MEMS) technology-based micromirrors are considered an indispensable part of microswitches that are used in fiber optic network telecommunications. The key function of micromirrors are to achieve optimum performance in micro resonators, for optical switching and projection displays. In recent years, MEMS mirrors with large scanning angles have been deemed to have great potential in the fields of biomedical imaging and interferometer systems. For many biomedical applications MEMS mirrors with a controllable deformation are desirable. MEMS technology holds the greatest promise to result in a deformable mirror that will meets these very specific requirements. For this project, an individual MEMS micromirror with a controllable curvature will be studied, designed and fabricated.

As a primary step, a cylindrical deformable mirror will be designed to attain different degrees of curvature. The mirror will be anchored with two pairs of hinges and there will be electrodes underneath the structure for electrostatic actuation. Using the theory of material strength, the deformation of the plate will be parabolic only if the bending moments are applied at the anchoring ends with the electrodes beneath the mirror plate. The deformation observed in the micromirror is the result of torque developed due to the applied voltage. The static and dynamic characteristics of the device will be studied using mathematical software. Optimization in micromirror structure which includes placement of electrodes, designing a mirror plate, and applying substantial bias voltage, can be achieved by using Finite Element Analysis (FEA) tool - COMSOL Multiphysis.

The proposed deformable MEMS micromirror will be fabricated using surface micromachining processes offered by CMC microsystems. The performances of the device will be characterized, tested and the experimental results will be available in the near future.

Index Terms – MEMS, deformable mirror, electrostatic actuation, theory of materials, curvature

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A Novel Regenerative Electromagnetic Suspension System to Improve Vehicle Fuel Efficiency, Stability and Comfort

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Abstract – The main objective of this research is the design and development of a new generation of shock absorbers, specifically, a regenerative active electromagnetic suspension system for vehicles. It is aimed to develop a new generation of Electromagnetic Dampers (EDs) with energy harvesting capabilities to improve vehicle efficiency, stability and comfort. The drawbacks in existing variable damper technologies such as the degradation of Magneto-Rheological (MR) fluids, sealant failure, leakage, performance issues, and the high cost for MR fluid dampers can be overcome by the proposed EDs. This can be done through their non-contact operation achieved through the use of a combination of permanent magnets and electromagnets. In addition, they provide significant added advantages including power regeneration, safety, and comfort. Such systems are also cost-effective. An ED converts the vibration energy of a body mass to electrical energy, and acts as sensor and actuator simultaneously. The use of high-energy permanent magnets, and the regeneration of vibration energy, results in self-powered active suspension systems which mitigate the high energy consumption in ordinary active suspension systems. Also, the suspension system can operate in passive, semi-active, or active mode.

In this work, the body design of the linear permanent generator and fabrication have finished, and the electrical and electronic circuit for the linear generator was developed. Also, a PID sliding mode control strategy of DSP-based synchronous rectification Buck-Boost DC-DC converter was presented. The generator and the circuit have been tested and worked well. Now the control algorithm as presented is being tested on the system to optimize the output of the generator.

Index Terms – Regenerative; Electromagnetic Dampers; Energy harvesting; Linear Generator

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Surveillance of Sea-Ice surface using Autonomous Unmanned Aerial Vehicle (UAV)

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Abstract –Arctic Ocean is partially covered by ice throughout the year; due to which navigation of ships through this region becomes difficult especially in winter time. Therefore it is essential to have good technique of observing sea ice. While satellites can provide data in remote regions, their application to arctic environment is difficult due to persistent cloudiness and heavy computing time of processing satellite images. Radar can also provide solution but sometimes radar signal get scattered by air bubbles and other imperfections in the ice. Unmanned Aerial Vehicles (UAV's) are increasingly being used in modern reconnaissance in both military and civilian applications. Object identification and tracking being the typical elements of the most missions. Use of UAVs for surveillance of the sea ice for smooth navigation of the ships through Arctic region holds great promise. For this project, different techniques for sea ice detection, UAV navigation and landing will be studied and implemented.

As a primary step, the UAV will be equipped with visible light camera and infrared camera for the navigation and surveillance purposes. Our idea is to send the UAV from the ship and observe the sea surface ahead using cameras onboard. With this approach; we can get clear view of the surface. In this research our aim is to use fully autonomous UAV. The first goal of this research will be to differentiate the ice from the open water areas using different computer vision techniques. Cameras will be used as the sensors of the UAVs; computer vision coupled with simultaneous localization and mapping (air SLAM) will be used for navigation. SLAM is a technique where a robot creates the map of the unknown environment and also keeps track of its own location within that map. Lastly, we will try to land the UAV on the deck of the moving ship. For doing this it is essential to keep track of the moving ship as well as keeping track of UAV itself.

The proposed approach for the sea ice surveillance of the Arctic region using UAVs is very novel. There has been very few research in this area. The performance of the techniques will be analyzed, tested and results will be available in near future.

Index Terms – UAV, SLAM, Computer Vision.

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Time Difference Amplifier Using Closed Loop Adjustable Fractional Gain Control

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Abstract– As CMOS technologies advance to 22-nm dimensions and below, constructing analog circuits are difficult to design within permitted specifications. One of the reasons for this is a limit of voltage resolution. In this situation, time-mode processing is a technique that is believed to be well suited for solving many of these challenges. A primary advantage of this technique is the ability to achieve analog functions using digital logic structures. Time difference amplifiers (TDA) can be a key component to realize fine time solutions. TDA are an innovative method to improve the time resolution as well as the evolution of ADC.

This thesis introduces a TDA that amplifies the input time difference between two signals by a fractional gain. The closed loop gain control system used in this work consists of a pseudo differential current starved delay element (PDCSDE) and a monotonic digitally controlled delay element (DCDE). By using these elements to create a delay chain and a control loop, the result is a stable fractional time difference gain (TD gain). The system was designed and simulated in 65nm process at 1.2V power supply. The measured results show that this TDA achieves a fractional TD gain offset lower than 1.3%, with supply variation of ±15%, and input range as wide as ±250ps. The new design was also more resilient to process, voltage and temperature (PVT) variations.

Index Terms - Time difference amplifier, closed loop gain, delay element.

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Inverter based switched-capacitor filter design using Follow-the-Leader-Feedback technique

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Abstract– Operational amplifier (Op-amp) is a common analog building block used along with switches and capacitors to construct switched-capacitor circuits. The parameters such as power supply voltage, threshold voltage, and oxide thickness are being scaled down with technology scaling which affect the dynamic range of the op-amp and further scaling result in reduced voltage headroom.

Op-amp in a switched-capacitor circuit was replaced with a CMOS inverter for delta sigma modulator application. The advantage of using a CMOS inverter over an op-amp are: *design simplicity* with fewer components (*less area*), ability to operate under *low supply voltage*.

This work presents a SC filter design technique based on CMOS inverter implemented in the TSMC65nm CMOS technology. The proposed technique is demonstrated by the design of 6th order Follow the Leader Feedback (FLF) Chebyshev low pass filter. This technique resulted in filters with reduced sensitivities compared to the cascade realization.

Index Terms - Op- amp, Switched-capacitor filter, CMOS Inverter.

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Design Optimization & Performance Improvements of DCSR UWB Transmitter

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Abstract – This paper presents the design improvements of Differential Code Shifted Reference (DCSR) scheme of Ultra Wide Band (UWB) transmitter for optimal performance. DCSR is an impulse radio technique of transmission of UWB signals proposed by our research group. The transmitter built on DSCR scheme generates ultra-short 5ns impulses with repetition rate of 20 MHz in pulse amplitude modulation, thus making it low power consuming, less complex, but more immune to interference compared to conventional impulse radio transmission systems. The transmitted spectrum has the bandwidth of 500 MHz with the center frequency of 4.44 GHz, meeting the bandwidth requirement for UWB transmission.

In spite of simplicity, the implemented DCSR UWB transmitter faced several design and performance challenges. The amplitude ratio of the pulses before and after mixing at 4.44 GHz change due to nonlinearity of the mixer. The power spectrum of UWB signal from transmitter consists of spectral lines at every 20 MHz due to repetition of UWB pulses. In addition, digital signal combining with analog circuit elements results in significant interference noise in the transmitter which can't be modeled or simulated. In this paper, we will present the methods and techniques to solve or mitigate the above issues and problems through optimization.

Index Terms – Ultra Wide Band (UWB), Differential Code Shifted Reference (DCSR), Pulse Amplitude Modulation, Pulse Ratio, Spectral Characteristics.

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Analysis of PV Harmonic Distributions for Various Weather Variables

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Abstract – Renewable energy for the preservation of the environment is a very important research topic. Solar energy is an attractive medium of electrical energy production. Solar energy production methods have made significant progress in recent years.

Generation of solar energy requires the use of power semiconductor converters. This conversion process results in harmonics introduced into the voltage and current waveforms. In this work, the model of a Photovoltaic (PV) system is produced, including the inverting stages, and is discussed for three main cases. The data used in this paper is the solar radiation and temperature over three years in Halifax, Nova Scotia, Canada. The output of the equivalent PV model is fed to the load via an inverter and transformer. Three converter topologies will be modeled, square –wave inverter with 60Hz switching, 60Hz switching with blanking angle, and pulse width modulation (PWM). The harmonics are calculated for various hourly temperatures and solar radiation for each case. The total harmonic distortion is also determined for these cases. The probability density functions are determined for the fundamental frequency and several multiples of the fundamental harmonic.

Index Terms – Solar energy, Converters, Inverters, Photovoltaic systems, Energy conversion, Harmonics.

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Silicon Kerr Effect Electro-Optic Switch

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Abstract – My research focus is on a practical design of an ultrafast silicon electro-optic switch. Desired switch characteristics are modulation speeds up to 100 GHz, a drive voltage of few volts, compact size and operation at 1.55 micrometers. The development of electro-optic switches or modulators is reviewed. Silicon nanocrystals are chosen as the electro-optic material and the ultrafast Kerr effect is the physical effect utilized in the design. Preliminary results with a ring resonator structure and inclusion of photonic crystals in the design are discussed.

Index Terms – Ultrafast electro-optic switch, Silicon nanocrystals, Kerr effect, Photonic crystals

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Digital Micromirror Device and its implementation in Structured Illumination Imaging with rotating gratings

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Abstract – Confocal Microscopy is a well-established method for obtaining high resolution imaging and optical sectioning. However, it faces problems in terms of duration of scanning time and often yields poor contrast images. On the other hand, Structured Illumination Microscopy is a relatively new imaging technique which can achieve optical sectioning comparable to confocal microscopy with much higher imaging rates and better contrast. It is a powerful technique for optical sectioning in wide field microscopy at high resolution. The fast imaging rates of Structured Illumination offers a clear advantage over scanning microscopy.

Structured Illumination Microscopy usually uses a physical grating for producing fringes over the sample. But physical gratings tend to introduce errors in the acquired images. This research involves the use of a Digital Micromirror Device which produces the required fringe projection needed for carrying out the Structured Illumination Microscopy. A DMD chip is a micro-electronic mechanical system that has millions of microscopic mirrors on its surface arranged in a rectangular array which correspond to the pixels in the image to be displayed. Every pixel on a DMD chip is a reflective mirror used for Fringe projection, achieved through the turning on and off of alternate mirror element rows and their spacing. Image acquisition is to be carried out with phase shifted grating and also with grating rotated 360^{o} over the specimen. These interference patterns are successively shifted and multiple images are captured by a CCD corresponding to each shift. Then all the images are superimposed upon each other to form a single image for each Z plane with more resolution than any of the images alone.

The experiment needs to be set up and results are to be verified if useful higher resolution and optical sectioning is achieved. After this, the main objective is to be tested to see what result 360^{o} rotation of the fringe pattern yields.

Index Terms – Digital Micromirror Device, Structured Illumination Microscopy.

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Resolution Enhancement Using Linear Prolate Functions

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Abstract – Spatial Resolution is the measure of how closely spaced pixels in an image, be easily distinguished. The spatial resolution for familiar applications like camera or microscope is severely limited because of the Abbe-Rayleigh Diffraction Limit given by $\frac{\lambda}{2 * NA}$

Where λ is the wavelength of light and NA is the numerical aperture of the optical system being used. Thus Super Resolution is achieved when the optical system can distinguish two pixels in an image which are separated by a distance less than the Abbe-Rayleigh diffraction limit. For visible light the diffraction limit is approximately 200nm.

For this thesis super resolution will be obtained by the use of Linear Prolate Functions. Slepian used the angular and radial solution (first kind) of the spheroidal wave function to create Linear Prolate Functions denoted by Ψ_n. A Linear Prolate function has certain desirable properties which makes it useful for obtaining super resolution. Firstly they remain the same even after applying Fourier transform. Secondly they are orthonormal over the entire interval. Furthermore their energy concentration in a certain interval is maximum in both the time and frequency domain.

It is known that there are no existing functions whose Fourier Transform for an infinite interval is a Dirac Delta function. But for a finite interval the case above can be satisfied by the use of linear prolate functions as shown below

For $|\omega| \leq \Omega$

$$U_M(\omega) = (x_o/2\pi\Omega)^{\frac{1}{2}} \sum_{n\,(even)\,=\,0}^{M} (-1)^{\frac{1}{2}n}\, \lambda_n{}^{-\frac{3}{2}}\, \psi_n(0)\, \psi_n\left(\frac{\omega x_o}{\Omega}\right)$$

Whose finite Fourier transform provides a Dirac Delta function. Consider a low resolution image where a sinc pulse represents each pixel response. By using the above principle the width of each since pulse can be reduced to a delta function thereby increasing the resolution in the image. This hypothesis will be implemented in a software called Mathematica.

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Web Based Mobile Access to Solarenergy Device Sensors

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Abstract – Thermo Dynamics Ltd. (TDL) decided to introduce Web based, dynamic and user-friendly live graphs for the various devices the company uses to measure different parameters associated with Solar Energy Sensors. Companies make use of Web based technology to be able to meet with a wider range of audience. The current information available on the website www.welserver.com is in the form of excel files of all the data that is measured in each month. These excel files consist of too many numbers and the clients can make very little use of it. The various readings like the water temperature, the solar energy collected etc. measured by the Web Energy Logger (WEL) are shown in a graph which are non-interactive and static and thereby providing very little information. The Web Energy Logger (or WEL) is the most economical way to monitor temperature sensors and other energy related devices.

The proposed Website can be accessed on the Internet by the clients and the Website can provide them information about their system in an easy graphical manner. At Present the current dynamic and user friendly graphs are available only for the current month for which data is available and this project aims to develop a website to produce graphs for all the available WEL servers for all the months for which data is available.

In this project the existing work is to be improved to plot graphs for all the devices that are measuring the various parameters involved with Solar Energy devices. These Graphs are to show the live data that each of the WEL system is measuring. A script is written in PHP,HTML 5,CSS and JavaScript programming languages to download the live data and to plot the graphs every time a new data is being updated on the excel file. The graphs are interactive in nature and the clients are informed with various options such as hourly view, weekly view and monthly view.

The older website of the company has live feed graphs but they are not responsive and user-friendly and a layman cannot understand the graphs easily. The main objective of this project is to make those graphs dynamic, interactive and user-friendly for the solar energy sensors. The graphs should be accessible from anywhere to serve the clients better. The graphs should be generated automatically and give a better understanding of the data that is being updated every minute. Thus this project aims to provide the user about their Energy system in a way that is more easily accessible to them.

Index Terms – Web Energy Logger, dynamic and user friendly graphs, Web technology, Solar Energy Sensors

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The Design and Implementation of a Low-Cost Device for Measuring and Recording Household-Appliance Power-Consumption

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Abstract – The conservation and management of energy is an important topic today because of growing concerns over energy security issues, notably the availability, affordability, and acceptability of energy. Studies have shown that when consumers are aware of the electricity consumption of their appliances, up to 15% energy reduction can be achieved. In order to address these concerns and improve people's awareness of their electricity usage, this poster describes a low-cost tool for measuring and recording the power consumption of most 110VAC household appliances by creating a time-series profile. The time-series can be reviewed later and compared with other appliances using, for examples, graphs generated using Excel. The device offers features that cannot be exhibited by other similar competitor commercial products such as the Kill-a-Watt energy monitor, where the information are only available for viewing and the corresponding readings are not recorded.

The device contains a socket into which the plug of an appliance is inserted: a voltage sensor circuit then records the instantaneous voltage (V), while the current sensor circuit to sense the current flow (I). The collected information from the two sensors is then transferred to the data acquisition module where it is processed and filtered to obtain the active power (P), apparent power (S), voltage (V_{rms}), current (I_{rms}), and the power factor (P.F) which are written to an SD card for future examination.

A prototype of the device has been developed and tested on several home appliances including a washing machine, microwave oven, room-heater, toaster, and refrigerator. All results show accuracy greater than 98% for the appliances monitored. For example, when the refrigerator was turned on, the device showed that the compressor draws around 100 W during the refrigeration cycle and starts every five minutes, while the microwave's defrost cycle required nearly 950 W every ten minutes and the power factor was found to be stable and less than 1 with nearly six times occurrence of the transient current impulse. The toaster had a power factor of 1, proving that it is a purely resistive device, meaning that all power entering the toaster was consumed (the time-series of the power consumption showed there were no losses).

The time-series data collected by the device has other possible uses; for example, it could be used by home-energy auditors to measure appliance electricity consumption in order to compare it with known standards. In other cases, the data could be made available to a smart-home controller to allow the scheduling of an unknown appliance. It can also be used for educational purpose to show the power consumption difference between resistive, capacitive, inductive and electronic circuit appliances.

Index Terms – Appliance Power Consumption, Appliance Signature, Appliance Profiling, Smart Home.

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Energy Efficient Video Encryption for Wireless Sensor Multimedia Networks

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Abstract **-** Selective Encryption algorithms have been proposed to encrypt code words such as Intra Prediction modes, sign bit of residual coefficients, along with sign bit of Motion Vectors. These three code words are sensitive enough to provide effective scrambling effect with tractable computational cost.

In this paper we aim to optimize computational cost for energy critical applications. This paper demonstrates that encrypting critical code words in all the interceded macro blocks increases the computational cost. The analysis proved that not all intra coded macro blocks in P and B frames leak information. Hence, we have proposed an algorithm that adaptively selects critical code word candidates for encryption based on scene transitions in P and B frames.

In this paper we calculate the number of intracoded macroblocks in P and B frames and compare it with a threshold value to detect scene transitions. In case of videos with scene transitions intracoded macroblocks are chosen as code words to encrypt within P and B frames, whereas in case of no scene transitions, motion vectors are chosen as sensitive code words for encryption.

Experimental results showed that the proposed algorithm maintains guaranteed security with low computational overhead. The proposed selective encryption can save energy in real time environments, such as wireless sensor networks with proficient security.

Index Terms – H.264 Compression, Low Power applications, Wireless Sensor Multimedia Networks.

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Airy Pulses Properties and Propagation

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Abstract – In world of optics relatively a new discovery that of a light beam that appear to bend in air with the brightest patch of the beam also appearing to travel with almost no spreading called the Airy beam. We will be investigating the properties of airy beams and its propagation in some cases.

Initially Predicted by Berry and Balazs in 1979 the self-acceleration and non-diffracting beams retain their intensity features over several diffraction lengths. Its recently discovered property that it sufficiently intense airy beam can ionize the surrounding air molecules and create curved filaments of plasma adds airy beam study more potential in optical engineering.

My work is in direction as to numerically study propagation of Airy pulses in nonlinear optical fibers. The study will be near zero group velocity dispersion assumption where the higher order nonlinearity namely third order dispersion come into play dominantly. The properties of airy pulses in birefringent optical fiber where the refractive index of the material of fiber depends upon polarization and direction of propagation of incident light are also studied. Plots obtained by writing codes of the intensity equation of birefringent optical fiber in matlab are compared with scalar airy pulse intensity with different walk off parameter values in both equations.

Index Terms – Airy Beam/Pulse, Birefingent optical fiber, walk off parameter.

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Variance Detection for Non-coherent Impulse Radio UWB Receivers

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Abstract – Impulse radio (IR) ultra-wideband (UWB) systems have attracted increasing attention in academics and industry as a strong candidate for low complexity and low power consumption applications. An appealing characteristic of these systems is that the IR UWB signal can be transmitted without a radio frequency (RF) carrier, which makes possible for IR UWB transceivers to get rid of expensive and power inefficient RF mixers and oscillators. However, an IR UWB pulse generally has a bandwidth larger than 500 MHz, and it makes sophisticated digital signal processing based coherent detection algorithms practically not feasible because a sampling rate at a GHz level is required.

To achieve the low complexity and low power objective, in recent years, a group of non-coherent energy detection (ED) based transceiver technologies have been proposed, such as, pulse position modulation ED transceiver, code-shifted reference (CSR) transceiver, and differential CSR transceiver. These ED based transceivers detect the presence of a signal by measuring its energy and comparing the measured energy with a predetermined/reference threshold. The measurement and comparison require no channel state information. Thus, the ED-based transceivers can have a very simple structure, and are recommended as a low-complexity and low power solution in IEEE 802.15.6.

However, compared with coherent receivers, e.g., the well-known Rake receiver, the ED-based receivers have significant drawbacks: due to its large transmission bandwidth, IR UWB systems have extremely low averaged power in order to coexist and contend with many narrowband communication system. As a result, the received IR UWB signals can be corrupted easily by wideband additive white Gaussian noise (AWGN) and strong narrowband interferences (NBIs).

To solve the above problem, a novel nonlinear and non-coherent detection technique, denoted as variance detection (VD), is proposed in this paper. The VD still employs a conventional square operation to process IR UWB signals, but after the signals are squared, their variance instead of their mean is processed to recover information bits. The computer simulations show that the newly proposed VD-based receiver can achieve a much better BER performance in both AWGN and multipath channels. Furthermore, unlike the conventional ED-based receiver, which is vulnerable to NBI, the VD-based receiver has an inherent ability to mitigate the destructive effects caused by strong NBI.

Index Terms – Impulse Radio (IR), Energy Detection (ED), Variance Detection (VD), Narrowband Interference (NBI), Ultra-wideband (UWB)

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A Time-Domain Collocation Meshless Method with Local Radial Basis Functions for Transient Analysis

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Abstract – Many numerical methods, such as the finite-difference time-domain (FDTD), the finite element method (FEM) and the method of moment (MOM), have been developed for solving electromagnetic problems. In those traditional methods, for the solutions of the Maxwell's equations or wave equations, a solution domain has to be discretized with finite elements such as cubicles, tetrahedrons, rectangles, or triangles. Consequently, the adaptive gridding or re-gridding of solution domain is often difficult and time-consuming, because the relationship among finite elements has to be updated or even redefined throughout the whole domain of the finite elements.

To mitigate the above problems, meshless methods, such as the element-free Galerkin method, the smoothed particle electromagnetic method and the radial point interpolation method (RPIM), were successfully developed to solve electromagnetic problems. However, in these methods, dual sets of nodes (*E*-nodes for electric fields and *H*-nodes for magnetic fields) are required due to the coupling nature of the electric and magnetic fields. Interlaced positioning of E-nodes and H-nodes poses a great challenge in the implementation of the meshless methods.

In this work, we have developed a node collocated time-domain three-dimensional RPIM meshless method for transient analysis of EM problems. Instead of solving coupled Maxwell's equations directly, the time-domain wave equations for electric fields only or for magnatic fields only are solved with the use of the point interpolation based on the local radial basis function (RBF). As only one set or type of nodes is required to be dealt with for the solutions of wave equations, the proposed collocated time-domain RPIM method not only benefits in implementation complexity reduction but also in modeling efficiency and accuracy improvement, in comparison to other meshless methods. Numerical examples are provided to verify the claims.

Index Terms –Meshless, RBF, Time domain analysis, Wave equations.

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Hierarchical Control of Large Renewable Generation

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Abstract –The electricity industry consists of a large electric power system and enables the integration of diverse resources into power pools. The diversity of resources depend heavily on renewable energy resources. The amount of generation capacity of renewable resources, particularly from wind and solar power, contributes to a significant increase in the electric power systems. The primary challenge of today's large electric power system is to achieve the large-scale integration of renewable resources and enhance the control and stability of these resources in the electric power system. In general, the present challenges can be classified into real power/frequency control and reactive power/voltage control as well as maintaining system stability.

Conventional resources such as tribune-driven synchronous generators and renewable resources have different dynamic characteristics. First, renewables are not natural synchronous sources locked to the nominal frequency value of the system. Second, they are coupled to the system with power-electronics components indirectly. Third, the amount of real power capacity of these individual resources is smaller, so large-scale integration is required. Therefore, the displacement of traditional synchronous generation with large-scale renewable generation results in an impact on system inertial response. Notice that inertia specifies the sensitivity of system frequency due to supply/demand mismatch in the power system. However, the large-scale integration of renewable resources leads to the lack of well-establish dynamic models for large electric power systems. Since renewable resources have uncertainties in their difficult to predict operating conditions, renewable generation causes greater variability in the operating point of the power grid. Therefore, the increasing renewable generation penetration has significant impact on power grid control.

In this study, our main objective is to improve the integration of large amount of renewable generation, while increasing the electromechanical stability of the power grid and to present available control techniques for enhancing system-wide performance of a large electric power system. For our purposes, we aim to control the electric power grid, including a very high portion of renewable generation, using robust and optimal control methods, and then develop an efficient hierarchical control which adopts a coordinated control across the entire system for all operation conditions, states, and parameters in each local area. We try to achieve a wide and diverse range of regional control, while maintaining hierarchical stability of the power grid. In addition, the methodology is also based on Linear Matrix Inequalities (LMIs) framework.

Index Terms – Hierarchical control, robust control, large renewable generation.

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Modified IM_2 Injection Technique for IM_3 Cancellation of Differential Bulk-driven Amplifier

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Abstract – The ratio between the power supply voltage (V_{DD}) and the threshold voltage (V_T) has been decreasing continuously. Thus analog complementary metal–oxide–semiconductor (CMOS) integrated circuit (IC) experiences harsh voltage swing limitation. Bulk-driven (BD) technique has been proposed for low voltage applications. BD MOSFET works in a depletion mode which allows negative, zero and small positive bias voltage at the bulk terminal. This technique increases the input common mode range as well as the signal swing, which cannot be realized by gate-driven (GD) technique at low V_{DD}.

Many BD analog/ radio frequency (RF) circuits have been presented and BD differential amplifiers have been reported. To design RF BD differential amplifier, linearization techniques are desired to suppress the third-order intermodulation (IM_3), since IM_3 causes crosstalk when an unwanted signal is presented at frequencies close to the input signal's frequency.

Second-order intermodulation (IM_2) injection was proposed to improve IIP_3. A squaring circuit was used to generate the IM_2 injection. The phase shift of the IM_2 arising in the generation was considered as detrimental. Besides, it was found that a single injection cannot suppress IM_3 product completely. In this research, it is proved that a proper controlled phase adjustment of the low-frequency IM_2 injection is desirable by analyzing BD differential amplifier and squaring circuit on system-level using Volterra Series.

A modified IM_2 injection technique for IM_3 suppression of nano-scale BD differential amplifier is presented which takes advantage of varactor to produce a proper phase shift of the injected IM_2 signal. The tuning ability brought by the varactor make the design reconfigurable for different applications and robust at process corners. With only 0.08 mW extra power consumption, greater than 7.5 dB IIP_3 improvement can be expected for 1MHz to 10 MHz two-tone spacing range without gain loss and noise penalty.

Index Terms – Amplifier, bulk-driven, IIP_3, linearization, nano-scale CMOS, nonlinearity, Volterra series.

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Implementation of FDTD Metho for Graphene Applications

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Abstract – Graphene is a new material of less electrical resistivity, faster speed of electron transfer and electric conduction, which leads to a huge influences in the field of science. Graphene also has been applied to a broad range of elecrtomagnetic fields. Numerical methods are widely used to research applications of graphene in the area, such as auxilliary differential equation (ADE) and Finite-Difference Time-Domain (FDTD) method. In fact, locally one dimensional (LOD) FDTD method, weakly conditional stable (WCS) FDTD method and alternating direction implicit (ADI) FDTD method are used to simulate different applications of graphene devices. In the past time, I read various papers and materials about graphene for the research. In the following work, I will try to use electromagnetic comutation method to simulate the application of graphene in electromagnetic fields.

Index Terms - Graphene, Auxilliary Differential Equation (ADE), Finite Difference Time Domain (FDTD).