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Proceedings of

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Halifax, N.S. Canada

NSERC CRSNG

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

ECEGC-2013 Chair and Graduate Advisor
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Message from the Chair

The Electrical and Computer Engineering Graduate Conference (ECEGC) is an annual forum where in a one day meeting, the ECE graduate students at Dalhousie University present their research, share ideas and provide constructive criticism of their colleagues' works. The conference is structured in such a way that second and higher year PhD and Masters' students communicate their research through oral and poster presentations, respectively. The first year students learn from their peers on how to deliver high impact presentations. The single-session conference provides an opportunity for students to network with all ECE faculty members in the department without compartmentalizing them into focused research groups. This allows the students to see more expanded aspects of their work. The main objective for the ECE Graduate Conference is to have students involved in the academic discourse and learn about the expectations of the academic community.

The proceedings of the conference are published in a Book of Abstracts. This year we have seventy (70) abstracts separated into sixteen (16) oral presentations and fifty four (54) posters. We expect 90 graduate students from ECE Department to attend this event. As in the last year, the work produced by our graduate students is very impressive and covers a wide range of subjects. Considering the different stages of the graduate students' research, the depth and breadth of different works varies. Overall, however, contributions and the scope of research areas covered in a relatively small department like ours are incredible. The conference starts with the Keynote Presentation by Dr. Jeffrey Dahn from the Physics & Atmospheric Science Department here at Dalhousie University.

Any conference requires an enormous amount of effort and the expertise of many committed people. This particular conference is organized for graduate students by graduate students where students get involved in all logistical activities. We are grateful to the student conference committee members as listed on the following pages.

Ultimately and above all, the praise for a successful conference belongs to the graduate students presenting their research summarized in the form of abstracts herein.

Jacek Ilow
ECE Graduate Advisor
Professor of Electrical & Computer Engineering
Dalhousie University

ABSTRACTS

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Signal Extrapolation Using Bandlimited Prolate Spheroidal Wave Functions

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Abstract – A remarkable discovery was made about half a century ago 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.

Optimistic are our hopes to carry out extrapolations on random signals like piece of speech or 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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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, we will use microcontroller EKK-LM3S9D92 to match the frequency of the signal received by the photodiode using embedded C programming language and it will send serial data to the printer to get printed out. Nowadays, LEDs are more widely used over the other light sources such as fluorescent lamps. 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 EKK-LM3S9D92 evaluation kit is used to match the input frequency equal to the frequency required by the printer.

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

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FOREX PREDICTION USING PARTCILE SWARM OPTIMIZATION

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Abstract – 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. Researchers all over the globe have been trying to develop tools and algorithms to statistically evaluate the randomness in various engineering process so that we could explain their existence, study their pattern, control the process and avoid any consequences. Thus understanding the randomness involved in various fields of research is given high importance. 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.

This research attempts to use the features of evolutionary optimization algorithm Particle Swarm Optimization (PSO) to explain the randomness in optical electronics. PSO has its roots from the unpredictable and highly intelligent behavior of birds and insects in nature categorized as swarm intelligence. 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; FORE

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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 rate 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, it is to be determined what result does the 360^{o} rotation of the fringe pattern yield.

Index Terms – Digital Micromirror Device, Structured Illumination Microscopy

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Linear and Nonlinear Optical Response of Planar and Nanostructured Thin Metal Films

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Abstract – To date, there has been a great deal of interest in the near and far-field optical properties of planar and nanostructured metal thin films. Both linear and nonlinear optical properties of these films have been studied extensively, but there remains a lot of interesting optical effects to be explored in either spectral or temporal domain both theoretically and experimentally.

In this talk, I introduce several basic concepts of plasmonics, including surface second harmonic generation, extraordinary optical transmission, and near-field scanning optical microscopy. The different linear and nonlinear optical effects, which can be observed in both the near and far field by coupling light into plasmons through nanostructure, are also presented. To study these effects experimentally, we had to choose a metal thin film with a significant non-linear susceptibility. This was achieved by studying many potential candidates. I discuss the technique and results of the optical characterization of the second harmonic generation of the different metal thin films.

Since the metal nanostructures are essential for coupling light into surface plasmons, possible geometries for these nanostructures are reviewed. The technique for fabricating these nanostructures and scanning electron microscope (SEM) images of some structures are also discussed.

Preliminary results of the optical effects observed as a result of focusing of 1550 nm femto-second laser light onto these nanostructures are presented, alongside some future work and potential applications.

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

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Effect of the Losses for Semiconductor Optical Plasmons Model

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Abstract – The main contribution of this work is the derivation of a generalized dispersion relation for semiconductors, with help of the Drude-Lorentz model. The fundamental optical excitation that is confined to a metal/dielectric interface is the Surface Plasmon Polariton (SPP). The term SPP comes from coupled modes, which can be used to confine light and increase the electromagnetic fields at an interface between two media, of which at least one is conducting. Plasmonics in a semiconductor are taking an increasingly prominent role in the design of future silicon-based optoelectronic chips.

Our goal is to develop a theoretical treatment to find a suitable model for the dielectric function of semiconductors. Starting with the Drude model, which is commonly used to describe the dielectric function of metals, we seek to modify and adapt it for semiconductors by adding the Lorentz model.

Theoretical solutions are obtained for the propagation of electromagnetic waves at optical frequencies along a semiconductor/dielectric interface when losses are taken into account in the form of a complex dielectric function. A combination method for the dielectric function, comprised of the best features of the Drude and Lorentz models, is herein proposed. By including the loss term in both models, we were able to obtain numerical solutions for the plasma dispersion curve of the semiconductor/dielectric interface. The surface plasmon waves, when excited, become short wavelength waves in the optical frequency or THz region. A silicon/air structure was used as our semiconductor/dielectric material combination, and comparisons were made to optical plasmons generated without losses. Our initial numerical calculation results show enormous potential for use in several applications.

A brief review of the basic model theory was presented. We have shown that the inclusion of losses reduces the surface plasmon frequency. We have also proposed the Drude-Lorentz model as a model for the dielectric function of semiconductors, due to its ability to describe both free electron and bound systems simultaneously. The numerical results of the plasmon dispersion for a silicon/air interface were presented using the proposed model and were compared to the Drude model.

Index Terms – Semiconductor optical plasmons, surface plasmon polaritons, optical plasmon, Drude-Lorentz model, plasma dispersion.

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Particle Swarm Optimization (PSO) with Stochastic Data

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Abstract – In photonics, numerous phenomena display stochastic behavior for example phase noise in LASERS or speckle in imaging. The study on stochastic data remains as a strong subject of interest. Evolutionary computational techniques serve as a vehicle for understanding and analyzing such chaotic environments. In this work PSO algorithm, a popular evolutionary computational technique is extended to handle one such stochastic data. Numerical experiments were performed to analyze and predict the behavior of the stochastic datasets. PSO algorithm is used along with a combination of Technical Indicators to investigate the stochastic patterns exhibited in foreign exchange (forex) market. Main Contribution of the research is applying PSO as an independent tool for designing and developing a profitable trading strategy and exploring the possibilities of using PSO as a bridge to understand and comprehend chaotic environments for further research.

Index Terms – PSO, Forex Market, Stochastic, Technical Indicators, Artificial Intelligence, Evolutionary Computation, Random nature

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

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

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

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

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

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

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Automatic Gain Control Design for Differential Code-Shifted Reference Impulse-Radio Ultra-Wideband Receiver

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Abstract – The objective of the poster is to present a design of an automatic gain control for the recently emerging differential code-shifted reference (DCSR) impulse-radio ultra-wideband (IR-UWB) receiver.

IR-UWB is a wireless system which sends information data with impulse that has rapid rising and falling time and very short duration of nanosecond or less. In a wireless system, due to varying communication channel conditions, amplitude of a received signal cannot maintain at a constant level. Therefore, automatic gain control (AGC) is required to equalize the impact of variations of the channel conditions.

In this work, we propose an AGC for uses in the DCSR receiver that uses the feed-forward technique at baseband stage. It consists of a variable gain amplifier, a peak detector and a control voltage generator. The simulation results show that stable amplitude can be obtained around 500mV at the current design. The proposed design presents an AGC for impulse-based transceiver systems which is not often addressed in the literature.

Index Terms – differential code-shifted reference, IR-UWB, automatic gain control.

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Design Optimization & Performance Improvement of DCSR UWB Transmitter

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

In spite of simplicity, the implemented DCSR UWB transmitter faces several design and performance challenges. The first challenge was changes in the ratio of amplitudes of pulses before and after mixing the gated pulse at 4.44 GHz due to nonlinearity of the mixer. For instance, before passing through gated pulse stage, the ratio between "high" and "low" pulses was 4:1, which is acceptable. However, after mixing RF, the ratio changes to less than 2:1. As for the DCSR to work properly without any performance degradation, it is necessary to achieve minimal pulse ratio of 3:1 between "high" and "low" pulses at the transmitter output. To achieve this pulse ratio, in this work, we present necessary changes and optimization in different parts of the transmitter.

The second challenge is that power spectrum of UWB signal from transmitter consists of spectral lines at every 20 MHz due to repetition of UWB pulses, which results in reduction of performance of the transmitter. Previously work has been successfully done to eliminate these spectral lines. However, recent changes at the pulse generation stage in order to get the desired pulse ratio slightly varied the previous spectral suppression results. In this work, we present necessary changes needed at the pseudo random pulse polarity generator to get the desirable results by distribution of spectral lines' energy over the UWB bandwidth.

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

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Ultra-Wideband Planar Antenna for Ground Penetration Radar Applications

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Abstract – In this poster three different designs of ultra-wideband (UWB) antennas are optimized and are presented for ground penetrating radar (GPR) applications. The numerical simulations of scattering and radiation properties of the antennas are performed with a time-domain electromagnetic solver. Due to their simplicity, compactness and ease of fabrication; micro-strip antennas, printed monopole antennas and planar bow-tie antennas were studied. The return loss, the late-time ringing effects, the gain, the directivity, the efficiency and the radiation pattern are investigated.

In our work, we consider the bandwidth in the range 200 MHz to a few GHz with the center frequency range from 0.5 to 1.5GHz. The simulation results show the micro-strip antenna is compatible of operating from 0.7 to 3.3GHz whereas the monopole antenna runs from 0.4 to 3GHz and the bow-tie antenna works from 0.74 to 4GHz with the voltage standing wave ratio (VSWR) less than 2.

Index Terms – Ultra-wideband (UWB) planar antennas, ground penetrating radar (GPR) antennas, late-time ringing effects, cavity-backed antennas.

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High-Speed Engineering Computation with GPU Programming and Compute Unified Device Architecture

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Abstract – Graphics Processing Units (GPU) programming techniques have been applied to a broad range of scientific and engineering computations. In computation electromagnetics, uses of the GPU technique have dramatically increased since the release of NVidia's Compute Unified Device Architecture (CUDA), a powerful and simple-to-use programmer environment that renders GPU computing easy accessibility to developers not specialized in computer graphics. In this work we will present the implementation of CUDA for acceleration of computations for engineering problems. We will demonstrate the speed-up through a few simulations with an off-the-shelf, inexpensive GPU. The comparisons are then made between serial and parallel algorithms, and between the computations with and without GPU and CUDA.

Index Terms – Parallel processing; parallel programming; general purpose graphics processing unit (GPU); Compute Unified Device Architecture (CUDA).

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Intersymbol Interference (ISI) Mitigation Schemes in IR-UWB Systems Employing Energy Detection Receiver

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Abstract – Ultra-Wideband (UWB) is an emerging wireless technology that has attracted many applications in modern day communications. Its ability to provide high data rates at very low complexity makes the system attractive for many indoor high-speed wireless communications. UWB signal can be transmitted by either impulse radio (IR) or multicarrier techniques. Impulse radio technique in particular, is a carrier less technology using pulses in the range of nanoseconds or less providing a low complexity, low power and low interference susceptible wireless system. These features motivate the usage of energy detection based receiver structures that operates at very low power.

With the recent developments in UWB technology, a promising feature of this system is to provide high data rate with transceivers operating at very low power. High data rate on the other hand can be achieved only by using a complex modulation schemes that requires more transmitted power. As a limitation in the spectral emission associated with UWB, only low-level modulation technology can be used in UWB systems. Hence, in order to achieve high data rates using low-level modulation schemes, the Inter-symbol interference (ISI) becomes unavoidable.

Decision feedback equalization (DFE) is one of the signal process techniques that can be used to mitigate the effects of ISI. This thesis proposes an energy subtraction algorithm combining with the principles of DFE to mitigate the effects of ISI in an impulse radio UWB system employing energy detection receiver. Computer simulations have been performed to verify the operation of the new proposed algorithm under UWB channel characteristics and relevant comparisons have been made with the basic energy detection receiver. Simulation results show that the ISI can be effectively mitigated with low system complexity.

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A Planar CPW-fed Ultra Wideband Antenna with Dual Notch Band Characteristics

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Abstract – A communication system is said to be ultra wideband (UWB) if the instantaneous spectral occupancy of the system is more than 500MHz or fractional bandwidth is more than 20%. It has become one of the future technologies for low-cost, low-complexity, and short-range wireless systems. They are capable of high or low data rate transmission as well as accurate locating and positioning. As a result, UWB systems can find applications such as sensor networks, health monitoring and RFID tracking and location. In these applications, design of an appropriate UWB antenna becomes very challenging in order to satisfy the important electrical specifications such as ultra-wide bandwidth, omni-directional radiation pattern, low dispersion and small size. In addition, for practical applications, there is necessity of notch bands within the passband of UWB in order to avoid interference with the existence wireless communication systems.

In this research, a novel ultra wideband antenna has been designed and fabricated. The antenna is designed to work on 1.6mm Fr4 substrate with dual notch bands of Wimax(3.3-3.8GHz) and WLAN(5.1-5.9GHz). The measured return loss and radiation pattern show close agreement with the simulated results.

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Wireless Power Transfer for Charging Small Electronic Devices using Magnetic Resonance Coupling

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Abstract – Efficient and compact wireless energy transfer systems are proposed and designed for recharging small electronic devices. They use the magnetic resonance coupling scheme to transfer power over a relatively large distance. The receiver resonator coil and the load loop are designed in correspondence to the size restriction of small electronic devices such as wireless phone charger. The dimensions of the coils are optimized and effective values of the lumped capacitors are determined and fine-tuned for efficiency enhancement. Three designs, each consisting of two coils for the transmitting side and two coils for the receiving side, are made and fabricated. The transfer efficiency is measured with different transmission distances and with different orientation angles of the receiving coils. Transmission efficiency of more than 50% has been retrieved in all the three designs at 10 cm transmission distance. The measurement results show good agreements with the simulations and illustrate that the proposed wireless transfer systems exhibit nearly omnidirectional performance.

Index Terms –Wireless Power Transmission (WPT), Magnetic resonance coupling, Small electronic devices

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Modelling and Measurement of UWB CIR

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Abstract – Ultra Wide Band (UWB) technology has gained a lot of interest in the recent past because it provides solution to the problem of the limited bandwidth in wireless communication. The UWB signal experiences different propagation impairments than traditional "narrowband" signals. Hence, there is a need of an innovative channel model, which can capture the uniqueness of UWB signals. The channel measurements can be done in frequency and time domain. In the frequency domain the measurements are carried by sweeping the band of interest by a Vector Network Analyzer (VNA), which sends a tone through the channel and records the S-parameters of the channel. In the time domain the channel is sounded by a carrier signal, modulated by specially chosen waveform, which makes it easy to analyze the effects of multipath environment on the received signal. In this technique, the received signal is stored on the Digital Sampling Oscilloscope (DSO) for analyzing.

Estimating an accurate channel impulse response (CIR) is the first step in creating a channel model. If the transmitted signal is *(x(t))*, and the received signal is *(y(t))* the CIR *h(t)* can be estimated by using deconvolution. The deconvolution can be performed in the frequency and the time domain. The CIR of a UWB channel in this work is estimated by using a time domain deconvolution technique known as the CLEAN algorithm. To test the CLEAN algorithm a line of sight (LOS) UWB pulse *(x(t))* with pulse duration of 1ns is generated in MATLAB. The channel model (CM) proposed by UWB channel modeling committee, and the additive white Gaussian noise (AWGN) channel are used for testing the CLEAN algorithm. The simulated received signal *y(t)* is generated by convoluting the LOS pulse *x(t)* with CIR *h(t)* of the CM channel model. Thereafter, the CLEAN algorithm is used to estimate CIR $h_e(t)$ from the received signal *y(t)*. After comparing the $h_e(t)$ with *h(t)* it was observed that the cross correlation coefficient between them is around 0.98, which is a satisfactory result. In order to study the effects of noise on the CLEAN algorithm, the AWGN was added to *y(t)* for creating the received signal with signal to noise ratio (SNR) ranging from 20 to 50 dB. The CLEAN algorithm gave satisfactory results for the SNR ranges of 35 to 50dB.The performance of the CLEAN algorithm was improved in the lower ranges SNR by using the signal averaging technique.

Index Terms – CLEAN algorithm, Ultra-wideband, channel impulse response (CIR), IEEE 802.15.4a

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Frequency Selective Surfaces and Adaptive Radar Absorbing Materials

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Abstract – Nowadays, Frequency Selective Surfaces (FSSs) have been widely studied for their applications in spatial microwave and optical filters. They are being used as polarized filters, and sub reflectors. Interest in applying FSS for radar absorbing materials (RAMs) have also been increased.

The FSSs are usually proposed with periodically arranged metallic patches of arbitrary geometries or their complimentary geometry having aperture elements similar to patches within a metallic screen. They are working as a reflectors or transmitters, for the patches and apertures respectively. RAMs have also been intensively investigated in order to achieve good absorption performance over a wide frequency range. The purpose of the wideband RAMs are the reduction of a target RCS (Radar Cross Section) that is a measure of power scattered in a given direction when a target is illuminated by an incident wave and is an exclusive characteristic of the target

In this presentation, the feasibility of designing and developing of FSS structures are presented and a reconfigurable FSS by changing the electrical properties has been studied. Then a novel design of thin wideband RAMs and Adaptive RAMs are presented.

Index Terms – Frequency Selective Surfaces (FSSs), Radar Absorbing Materials (RAMs), Radomes, Tunable structures.

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Kurtosis Nonlinear Detection for UWB Impulse Radios

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Abstract – Energy detection (ED) based impulse radio (IR) ultra-wideband (IR-UWB) receivers have been considered as a promising technology for low-power and low-complexity applications. However, because the energy detector cannot distinguish interferences and noise from the desired UWB signals, the ED-based receivers are more vulnerable to noise and interferences than the coherent receivers. Meanwhile, due to its huge transmission bandwidth, IR-UWB systems have to coexist with many narrowband communication systems, for example, IEEE 802.11a WLAN. Therefore, narrowband interference (NBI) mitigation technologies must be applied in conjunction with the ED-based receivers.

Many research efforts have been undertaken to develop NBI mitigation technologies for ED-based UWB receivers. Applying analog notch filter bank to remove NBIs present in the received IR UWB signals is a traditional NBI mitigation approach; however, the optimal adaptable notch filtering for NBI mitigation is not feasible because of its high complexity. Although NBI estimation approaches could be done with preambles, the use of preambles leads to loss of information transmission efficiency.

To achieve dynamic NBI mitigation, a nonlinear and non-coherent detector, denoted as modified kurtosis detector (MKD), is proposed in this paper. In a MKD-based receiver, the conventional square law device of ED-based receiver is replaced by a nonlinear kurtosis operator, which allows MKD-based receivers to achieve much better BER performance when strong NBIs are present.

The effects of NBI on the performance of the proposed MKD-based receiver are assessed through computer simulations. The simulation results confirm that the proposed MKD receiver has an inherently robustness against NBIs. Furthermore, it does not require high sampling rates and there is only a slight increase in receiver complexity as compared to conventional ED-based receivers. Therefore, the MKD-based receiver can be a preferred detection technology for IR UWB systems.

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

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High Voltage Direct Current Load on Power Flow Methods in Electrical Networks

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***Abstract*-** The objective of this work is to develop an enhanced version of the Second-Order, Newton Raphson and Fast Decoupled Power Flow methods in rectangular coordinates HVDC Power Flow. The point of departure for this decoupling procedure is based on the Second-Order Power Flow method, which is decoupled by suitable manipulations. Power flow problems are solved for an economic and efficient operation, and an effective and stable control of the power system. Although several methods are available to solve these problems, new ones are developed with a view to enhance the computational efficiency and convergence stability. Three enhanced methods for the HVDC Power flow are developed and experimented with in this thesis. These methods are based on formulating AC, DC and HVDC (interface) performance equations in the rectangular form. Most of these equations are completely expressible in the Taylor series containing terms up to the second order derivatives with the other higher order terms being zero.

In order to evaluate the performance and reliability of this proposed method, a comparison with the Newton Raphson, Second Order and Fast Decoupled Power Flow (FDLF) methods is presented and discussed. Numerical results have been obtained on a Mat lab computer. Simulations have been performed on the IEEE-14 bus system, IEEE-30 bus system and IEEE-57 bus system reliability test system. The tests consider several ill-conditioned cases with high R/X ratio and different load conditions.

Index Terms- HVDC, power flow, second-order, newton raphson, fast decoupled methods.

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Modified PSO technique for Harmonic State Estimation Including Distributed Generation – Solar Panels and Farms

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Abstract **-** Recent developments in Saudi Arabian Energy policy indicate that the country is planning to build large solar farms in the near future. The realization of the fact that the country's domestic consumption of crude oil have reached 30% of its production along with the ample solar radiations levels and long sunshine hours have made policy makers to utilize this enormous potential. As a result Saudi Arabia has announced its intention to invest $ 109 billion to develop the solar energy sector and want to generate one third of its electricity from solar sources by 2032. Following this Saudi Arabia has become a major market for solar systems which require expertise and research for knowing the possible effects of introducing Distributed Generators (DGs) like Solar farms into its grid. The Distributed Harmonic State Estimation has been recently used for Wind Turbine systems along with proposed techniques like Honey Bee Mating Optimization (HBMO) and Modified Particle Swarm Optimization (MPSO) to estimate the harmonic state variables in order to improve the Power Quality of the system. My thesis is intended to use these methods and evaluate the inclusion of solar systems into Saudi Arabian grid. The objective is to apply these methods on a different kind of a system and observe the results. The study will simultaneously address the issues related to management of outages and economical concern related to the grid. The study of recent solar farm project of 3.5 megawatts capacity feeding the grid with 5800 megawatt hours yearly will be of keen interest. Furthermore I propose to carry out the study using MATLAB, HOMER and ETAP software.

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Solar Energy Forecasting Using Artificial Neural Networks in Saudi Arabia, a Case Study

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Abstract – In the midst of decaying fossil fuel resources, their international relation complexities, and the risks associated with nuclear power; there has been an increased demand for alternative energy sources. Moreover, these sources, which are non-renewable, through their combustion cause harm to the environment. For these reasons, renewable energy sources offer good solutions to these challenges.

The forecasting of solar energy has been growing in the past decade. Forecasting of solar energy is useful in many aspects such as photovoltaic (PV) system design, load balance in hybrid system, and projecting potential future PV system feasibility.

Artificial neural networks (ANN) have been successfully used for solar energy forecasting. Our work will use meteorological factors such as air temperature, cloud cover, humidity, wind speed/direction, and date to predict the solar radiation in Saudi Arabia by using ANN. A new approach will find the relationship between humidity, cloud cover, and wind speed/direction. From these relationships, the proposed system will use 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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Modeling Simulation and Optimization of Residential and Commercial Energy Systems

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

In recent years, however, the rate of energy demand has increased rapidly throughout the world while the price of energy has been fluctuating. To find the solution for such problems, REMS establishes the optimal daily operation of home appliances. Numerous methods for REMS are used; this study analyzes many candidate scenarios during peak and off peak load periods comparing to the tariff of the residential sector to reduce the usage and its associated costs. It presents simulated results of proposed REMS to provide automated least cost demand response. The main approach will be to ensure the satisfaction of the requirements with constraints on efficient use of energy. In this research, multiphasic system behavior and an individual set of components simulation of Domestic Electric Water Heater (DEWH) in residential and commercial energy systems with a realistic manner are proposed.

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

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Optimal Distributed Generation Sizing and Placement via Multi-Objective Optimization Approach

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Abstract – Distributed Generation (DG) refers to a relatively small source of electric power generation, typically ranging from less than one kW to tens of MW, that is not part of a large central power source, DG is located close to consumers or to a distribution system's load site and has recently started to play a significant role in the power distribution sector due to numerous advantages attained by integrating DG in distribution systems. These advantages include decreasing power losses, improving voltage profiles and power quality, and reducing emission impacts. Such benefits can be achieved and enhanced if the DG units are optimally sized and located in the systems.

In this work, the optimal DG placement and sizing problem in distribution networks is investigated using multi-objective optimization techniques. The optimization problem considers two objectives including minimizing the total real power losses of the network and minimizing the overall DGs installation cost. This problem is formulated as one of constrained nonlinear optimization and solved using the Sequential Quadratic Programming (SQP) deterministic method. A weighted sum method and a fuzzy decision-making method are presented to generate the Pareto optimal front and also to obtain the best compromise solution. The proposed method is tested in a 15-bus radial distribution system to demonstrate the effectiveness of the proposed methods. Single and multiple DG installation cases are studied and compared to a case without DG, and the program was simulated using MATLAB software.

Index Terms – Distributed Generation (DG), Radial distributed network, Optimal location, Optimal size, Power loss minimization, DG installation cost.

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ENERGY SAVING FOR FIXED SPEED MOTORS

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Abstract **-** The high level of energy demand, the limitation of finding alternative energy sources, and the decrease in oil stock all result in an increase in energy consumption research. This follows that the need of finding different ways to reduce the energy consumption is a must. The purpose of this research is to show how energy could be saved by reducing the amount of waste energy which is dissipated as heat to the motor. This is possible because most of the motors are operating at a higher energy input than the work output required and in return the difference between the input and output energy is wasted.

Induction motors are one of the most commonly used motors in different environmental applications and specifically in the industrial field. Several methods of controlling the consumed energy by the motors may be applied. First, the 'soft start' method could be used where the applied less voltage to the motor through the use of variable resistors, or through changing the motor's speed (by controlling its power supply frequency) which saves a portion of the consumed energy. Such method allow for a decrease in the energy consumption of a system but still does not save the energy wasted as heat which has a negative impact on the environment. Finding a solution to maintain this unused energy will yield a better energy efficient system.

Our research will save energy by supplying the motor with the required amount of energy based on the actual motor shaft load (torque) and not the motor rated power. In doing so, sensors must be installed to track any change in load that is occurring and supply the right amount of energy accordingly. Using Thyristors/ Traic to control the amount of voltage (rms) and the current consumed by the motor (while keeping it at a fixed speed), will control the torque demand.

An analysis was done to test the reliability of the proposed solution. The angle between the voltage and current was monitored and consequently allowed for the monitoring of the shaft load (torque). As a result, the voltage and current was increased or reduced accordingly. It is worth noting that providing the motor with the required amount of energy based on its load will save energy, increase the motor's life (there's less thermal stress due to temperature drop) and thus will reduce the break down time. Due to these positive impacts, it is worth continuing the research to see what other factors could be manipulated to save the greatest amount of energy possible.

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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 activities without which we can't imagine our life. According to BP Energy Outlook 2030 report 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, total population growth of world is also increasing energy demand. Following the study of World Energy Outlook 2011 world's total population will increase by 26% in 2035. Establishing new power station requires longer time and huge investment along with increasing possibility of emitting greenhouse gases. Therefore optimal consumption of energy resources is an interesting area of research to mitigate potential blackouts in power distribution network.

DSM techniques such as load priority techniques, direct load control, peak clipping, valley filling and differential tariff are widely used by utility companies. Load priority techniques assign importance to the load as per interruptible and non interruptible load and during peak hour interruptible loads or non vital loads are switched off to avoid outage. In direct load control utilities can turn off the appliances such as water heater, air conditioners etc during peak hour with remote appliance controller. Peak clipping and valley filling are used to flatten the load consumption curve by consuming power during light load period without implementing additional generation. Differential tariffs offer low pricing rate during off peak hour or in other words it encourages customer to consume energy during valley periods. The objective of the DSM technique is achieved by utilizing the same amount of generated energy for serving number of loads efficiently by shifting energy consumption periods.

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 customers site can play an important role. DG is the process of generating power in distribution network. But distribution network is usually a loop design network where power flow is one directional with no or very little redundancy compare to mesh designed transmission network. However low voltage distribution network has higher resistance than high voltage transmission lines which causes significant voltage drop along lines. Hence the connection of DG can have influence on local voltage level. Thus a fuzzy logic controller is proposed in this study to integrate DG with distribution network by observing the supply and demand gap of energy consumption to maintain expected voltage level.

Index Terms – Demand Side Management, Fuzzy Logic Controller, Distributed Generation

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Simulation of Wind Turbine Energy Conversion Systems with Harmonics Filters

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Abstract – The growth in energy demand has become an issue around the world; and renewable energy is an attractive source. Wind is a popular option of these sources. In this thesis, a Permanent Magnet Synchronous Generator (PMSG) Wind Energy Conversion System (WECS) connected to a three phase load, through a full converter (AC/DC/AC), is simulated using Simulink/Matlab and the results are analyzed. The converter system causes current and voltage harmonics. The thesis uses the Fast Fourier Transform (FFT) to determine the harmonics and proposes using a three phase active filter to compensate for the harmonics in the WECS SG generator output. The active filter is divided into two types, which are High Pass Filter (HPF) and Band – Pass filter (BPF). Improvements in Total Harmonic Distortion (THD) are reported.

Index Terms – wind turbine, PMSG, filters, harmonics analysis, Total Harmonics Distortion.

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Applying a PV Grid-Tied System as Alternative Source in Industrial Sector with Economic and Payback study: case study in KSA.

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Abstract - The key to creating clean energy is to use renewable energy sources. Saudi Arabia has an abundance of solar radiation due to its geographical location; therefore, solar energy applications have excellent opportunities in the region. Since 1960, Saudi Arabia has been researching potential photovoltaic applications; however, the progress towards solar systems is not yet sufficient. In Saudi Arabia, the industrial sector consumes a large portion of the power load demand. The biggest industrial cities in Saudi Arabia are Dammam, Al-Jubile, Jeddah, and Riyadh. This study examines the potential application of solar energy through a PV system in the Saudi Arabian industrial sector. The study seeks to examine whether a PV system combined with a grid system could be efficiently applied in the country. To examine this, a typical energy consumption daily profile is assumed. The study uses a current factory in the city of Jeddah for simulation. HOMER and Microsoft Excel are used to conduct the study. Furthermore, the economic reliability and feasibility of the examined results will be included. Finally the ways to reduce the payback time was investigated and a cost effective system is recommended.

Index Terms – Industrial area, Saudi Arabia, Solar system, PV system, Renewable energy.

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Residential Load Optimization with Available Renewable Generation

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Abstract – Demand Side Management (DSM) and real-time pricing (RTP) are methods by which the consumer can participate in the electricity market and reduce electricity expenditures. By having more active consumers in the electricity market, DSM and RTP have many economic and environmental advantages over many current market structures. By allowing users to participate in the market, a more elastic relationship between supply and demand is achieved. An elastic market reduces the volatility of prices for consumers and generating companies alike. Furthermore, many customers are now introducing renewable sources to their homes in an attempt to reduce their current electricity bill. This can be analyzed as a coupled problem with the existing DSM scheme by imposing new constraints to further minimize the cost to consumers and utilities (both generation and distribution).

The current problem facing DSM and RTP schemes are the customers' inability to participate directly in the market by reducing loads when needed and increasing load during times of lower prices, either due to lack of knowledge or inability to react to prices changes. The proposed thesis is to tackle the current problem of price optimization for the consumer with the constraints of home renewable availability. This design requires: an optimization process to be automatic with user defined time constraints for each appliance, day ahead pricing for each time block, day ahead forecasted renewable availability and user defined "must be on" loads with their corresponding time frames. Using dynamic programming and Lagrangian relaxation techniques, an automatic optimal scheduling horizon can be obtained for each consumer appliance, reducing the price of electricity and maintaining acceptable consumer comfort levels. With the introduction of renewable availability, loads can be shifted times of most convenience regardless of price, assuming renewable generation levels are adequate to result in lower price to the consumer. The result is a price optimized scheduling horizon favoring utilities and consumers. This scheduling horizon benefits utilities due to the high operation costs incurred due to undesirable forecasted load profiles. In optimizing price for the consumers, loads are shifted or reduced at times of high prices to times with lower prices creating a more desirable load profile.

Index Terms – Demand Side Management, Lagrange Relaxation, Renewables

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A Proposed Universal Joint for Wind Turbine

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Abstract – Wind energy is one of the most common and rapidly growing renewable energy sources. A small change in wind speed can lead to a great difference in the power output. This research proposes adjusting wind turbine energy output by mounting the wind turbine rotor on a universal joint. This allows the rotor to adjust the wind turbine rotor in rotational, vertical and horizontal directions. This adjustment determines the accuracy of inflow angle predictions and gives availability to obtain larger amount of wind by facing the wind turbine rotor into the wind, hence increasing the amount of output energy. The proposed change will lead to improving the performance of the wind turbine. Matlab code is used for building up and simulating the whole model. As a way of validating the model a practical simple model will be used to compare the result of wind turbine output before and after using the proposed joint.

Index Terms – Wind turbine, Universal Joint, Rotor yaw actuation, Rotor angular deflection actuation, Power output, Optimization

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Modeling and Simulation of Solar Tower power Plant &Parabolic Trough Power Plant Performance in Southern Region of Libya

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Abstract – Using fossil fuels as the world's main energy source is one of the biggest key factors driving global warming. Therefore, the use of renewable energy resources to meet the electrical energy demand of our world has become very important nowadays. Presently, among the most environmentally friendly energy sources available and viable is solar energy. The idea of concentrating solar power (CSP) technology uses mirrors to concentrate the sun's rays to achieve a high temperature through thermal concentration, and then produce steam that can be used in a conventional generator set. The most commonly used CSP technology is the parabolic troughs and the solar tower systems.

In order to provide reliable electricity at reasonable costs in a specific geographical region, a suitable solar resource is greatly required. In fact, the detailed studies of regional resources are extremely important to accurately assess the solar energy potential of that specific region. Therefore, in my research, modeling and simulation of solar tower and parabolic trough power plant performance in southern region of Libya case study:

- Optimal location and utilization of CSP for rural applications guide for Libya.
- Design of CSP solar field for future solar thermal power plant in Libya.
- Impact of CSP (MW) on steady state and transient performance of Libya transmission systems.
- Design of smart grid management system.
- The main objective is to achieve a minimal-cost objective that can serve as a technical criterion to guide in design of economic incentives for CSP plant.

The main future challenge for Libya is to realize the self-sufficiency from solar electricity and its exportation. Libya is located on the Sun Belt and is exposed to the sun's rays throughout the year with long hours during the day, which makes it a great place to harvest solar energy. According to the irradiation maps, the total annual direct normal irradiation (DNI) ranges from 2740 to over 2818(kWh/m²/y) for the best site in the south, and it is accounted among the best-insolated areas in the world. According to GECOL, Libya's electrical demand is growing rapidly at 8% annual rate. Now Libya puts renewable energy on the table of its energetic and economic politics. The objective of this presentation is to review the renewable energy in Libya (potentials& current situation and future work).

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Integration of Photovoltaic Sources in Electrical Power Systems

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Abstract – Significant advances in power-electronic technology continue to play a vital role in the smooth integration of renewable energy sources into electrical power grids. This technology should introduce means of reducing harmonic distortion in the power supply ata minimal cost. The present research is focused on examining available renewable energy integration models, evaluating their shortcomings, and evaluating their validity to improve the performance of a power grid with renewable energy integration.

Specifically this work will focus on photovoltaic power as a renewable source of energy both at the large scale farm level and single-dwelling small scale applications. Three problems are faced when considering the use of this type of energy, namely: harmonics, cost, and power fluctuations. Much research has been done on harmonic reduction and filters which are used to reduce their impact.

The work will be focussed on harmonics elimination because the harmonics affect the overall cost of renewable integration, quality of service, efficiency, life expectancy, and security of the modern electric power system.

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

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Robust Decentralized Area Control of Power Systems

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Abstract –In this study, we propose appropriate control techniques and improve the area control of large electric power systems. We begin by analyzing the dynamic stability of power systems, and then describe control techniques for achieving better overall system performance. The main outcomes of this study are optimal and robust control theories. System modeling, formulated as a set of coupled differential and algebraic equations (DAEs), reflects the complex behavior of power systems. We solve the DAEs using some numerical methods and obtain the state space representation of the power system model. One of our objectives is to verify whether the overall system is stable or not. In addition, we enhance to the power system performance with some controllable devices. These controllable devices are power system stabilizers (PSSs), flexible AC transmission system (FACTS) controllers, and HVDC links.

In order to maintain the stability of the power systems, the appropriate control scheme has played important role. The type of control scheme in this study is twofold. First, our control scheme depends on a *decentralized* scheme where we first define the local subsystems (regions) that represent an area. This means that the large electric power systems is decomposed into relatively smaller individual areas and associate with ties-lines. These individual areas are implemented autonomously based on measurements from each area. In other words, an independent local control is available for each area. Second, the control is *robust.* The robust control identifies the class of all uncertain systems and enhances the stability of a system to guarantee desired performance over a range of operating conditions. We first check whether the areas are robustly stable. Then, we choose the allowable states and input-output variables for control purposes. Load-frequency, electrical-mechanical powers, and tie-line flows are essential states and input-output variables for the each area control. We also build some worse-case scenarios such as time delays and input-output uncertainties to control a more realistic system.

The methodology is based on Linear Matrix Inequalities (LMIs) framework, which allows for the inclusion of a wider class of nonlinearities of power system. The solutions have been obtained by using MATLAB optimization toolbox and the aid of LMI toolbox. The IEEE 50 generators, 162-bus system are used to demonstrate our study. This test system has two strongly coupled areas.

Index Terms: Robust decentralized control, area control, linear matrix inequality

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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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A Low Power Comparator-Based Switched-Capacitor For Biological ΔΣ Modulator

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Abstract **-** Microelectronics circuits for biomedical applications operate at low supply voltage. Hence, op amps (which is a hungry for power device) should be avoided. Comparator-based switched-capacitor (CBSC) is a new design that replaces op-amp in switched-capacitor circuits with a threshold detection comparator and a current source. Thus forcing the virtual ground condition for the complete charge transfer. 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 lower the power consumption and to avoid various trade-offs occurred by op-amp circuits.

In this work, low power consumption is considered which is the major requirement in the biomedical applications. To save power, one approach is to turn off the comparator and current source when they are in idle state. In order to restrict the harmful turn-on transient behaviors, an advanced clock may be used to turn them on at correct intervals. Other approach is to produce the constant ramp generation at lower supply voltage where a cascade current source can no longer be used. CBSC is applied to delta-sigma modulator ADC originally based on op-amp's and output can be evaluated. Using CBSC, some architectural changes are required for the original modulator. To reduce non-linearity, we could produce multiple ramps to the circuit or to apply a comparator with a fixed delay. By using the offset compensation technique we can reduce the offset to a considerable extent.

As a conclusion, if we could use a CBSC with low supply voltage ramp generator, then low power consumption of the circuit can be achieved. We can implement it in many Biomedical applications such as pipelined ADC, delta-sigma modulator ADC.

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

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A Fully Integrated Sensor Circuit Based on OFET's for Bio-Medical Applications

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Abstract **-** Current sensing technology requires microelectrodes be placed on the surface with a wire connected to each electrode, which are not suitable for biological or biomedical applications. Organic thin film transistors (OTFTs) are gaining attention as new technology that enables electronic circuits to be fabricated using ***low-cost*** and ***simple processes*** on mechanically ***flexible*** and ***light*** substrates**,** compared to common inorganic devices. Organic semiconductors are inherently sensitive to specific molecules, making organic transistors greatly suited for biological sensors. The flexible plastic substrate employed allows for a sensor that uses flexible electrodes. Basically, the biosensors are defined as biological component in close contact with a transducer. Biological elements (enzymes, anti bodies, nucleic acids) are used as recognition event and transducers convert the specific "bio-recognition event" into an easily assessable and meaningful signal. This biological recognition event may cause variation in optical, thermal, mass or electrical properties proportional to the amount of analyte in the sample and is converted into measurable electrical signal by transducer.

This research work deals with design of a biological sensor circuit which contains sensor array and interface circuit. Sensor array is composed of different sensors like DNA sensor, PH sensor, Temperature, Humidity, Gas sensors. For these sensors different organic semi-conductors have been used in OTFT for sensing applications such as pentacene, polyaniline, polypyrrole. The sensitivity of the device is dependent on the type of analyte and organic semiconductors, the adhesion and the homogeneity of the analyte onto the organic semiconductor. We will develop different deposition technique to improve the adhesion and the homogeneity between the analyte and the organic semiconductor. To unify the supply voltage and implement low operating voltage for the system, we also give our attention to ultrathin gate dielectric layer, which can be incorporated in the fabrication of OTFTs with very low operating voltage (3~5V). The resultant output electrical signal of this sensor array is applied to interface circuit, which composes of a low noise amplifier. We are going to design an interface circuit according to the electrical signal produced by sensor array.
As a conclusion**,** the sensitivity, stability, and architecture of the devices can be optimized by choosing more suitable fabrication techniques and materials for both the active layers and the electrodes of the devices.

Index terms - Organic thin film transistors (OTFTs), biological sensors, sensor array.

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Inverter Based Gain Enhanced Switched - Capacitor Integrator

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Abstract– Op-amp is a key building block in analog microelectronics which is used in wide range of applications . A good dynamic range is required for any audio and video processing application. Evolution in CMOS technology forced the supply voltage to become lower . This would have an adverse effect on the performance of the op amp such as lower dynamic range. Since, supply voltage of the op-amp is tied directly to the dynamic range. Another problem is limited voltage headroom where it is hard to operate all transistors in saturation region.

A number of design techniques have been proposed to operate op-amps in low supply voltages. However, each of these techniques has its own drawback. Some of these techniques are, body driven OTAs (poor noise performance), digitally assisted op-amps (require additional power consumption for digital circuits), and also few other techniques have been proposed to replace op-amps such as, comparator- based (difficulties with low supply voltage), charge- domain (additional supply voltage for clock generation), time-based (accuracy being affected by device mismatches).

Recently, inverter- based switched - capacitor integrator has been proposed where inverter serves the purpose of an op-amp. This circuit offers offset compensation technique, however gain error has to be taken into account to maximize the performance. The proposed technique is based on finite gain error correction of an op-amp. Analysis and simulation results prove the enhancement in gain compared to the previous works.

Index Terms– Op-amp , Switched-Capacitor circuits, Inverter, Finite-Gain error.

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A New Transient and DC Simulation Model of Floating Gate Transistors in Sub 100nm Technologies

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Abstract – In CMOS circuits, the gate direct tunnelling (DT) current is a growing issue that affects the power dissipation and also degrades the MOS performance. Many studies reported the gate DT current impact on MOS performance however; the effect of this current on floating gate MOS (FGMOS) devices in analog circuits is still not studied yet.

In this research , the impact of the direct tunnelling gate leakage current on floating gate circuits in sub 100nm technologies (where the gate oxide thickness less than 3nm) is investigated. SPICE simulations and bench measurements for (FGMOS) implemented with TSMC 90nm technology are presented to illustrate the problem of gate DT current on FGMOS.

A new simulation model for floating gate circuits is developed for technologies that suffer from gate leakage and to be used for transient and DC simulation. The new model can be used with sub100nm technologies and with minimal changes to the model parameters.

As a pilot test, a simple FG cascade current mirror has been simulated and the impact of gate current on (FGMOS) behavior has been analyzed. It is shown from the simulating results for FG current mirror that the circuit functionality is not compromised (within the considered technology) however*;* non-negligible influence on circuit performance has been observed.

Index Terms –FGMOS, direct tunneling gate current, gate leakage , sub 100nm technologies

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A Methodology to Design Bulk-driven Mixer with Harmonic Mixing Rejection

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Abstract – The scaling-down of feature size of CMOS technology prompts the development of low-voltage and low-power (LVLP), radio frequency (RF) analog circuits. As an indispensable element of wireless transceiver, mixer has to be modified to adapt to the LVLP design. Several bulk-driven (BD) mixers have been reported in recent years. They are based on the traditional switching-type mixer whereas applying the RF signal and the local oscillator (LO) signal into the same transistor stage. Thus BD mixer can perform frequency conversion with a much smaller supply voltage by eliminating the stacked stage.

Meanwhile wideband applications are popular in wireless communication. For instance, the bandwidth of software-defined wireless receiver could be from 850MHz to 6GHz. In such wideband applications, the harmonics of one channel could be another in-band signal which cannot be attenuated by antenna or low noise amplifier (LNA). For switching-type mixer, the wideband RF input will be multiplied with a square wave alternating between $+1$ and -1; as a result any interferences near the odd-order harmonics of the LO will be down-converted to the intermediate frequency (IF) band. It is desirable that mixer itself is able to reject the harmonic mixing rather than add extra circuits.

It should be noted that a multiplier can avoid the harmonic mixing issue; however, comparing with the switching-type mixer, its performance is inferior, especially the noise performance. In this research, a comprehensive analysis of the 'mixing' mechanism of bulk-driven (BD) mixer is presented. Further, based on the theoretical analysis, a design methodology to enable BD mixer in nanoscale CMOS technology with harmonic mixing rejection (HMR) is proposed, i.e. an optimal gate bias voltage is determined to improve HMR of BD mixer. Three BD mixers of different structures are designed in TSMC 65nm technology to verify this design methodology. Simulation proves that HMR performance is improved for different mixer structures by following the methodology. The broadband HMR is robust under the variation of process, temperature, bias and LO amplitude. Moreover, it is achieved without sacrificing other performances. These proposed mixers offer conversion gain above 4.1dB, -0.5dB 11.5dB, respectively, covering frequency from 850MHz to 6GHz. The simulated IIP_3 are 14.51dBm, 16.82dBm and 4.96dBm respectively. Power consumptions are 0.96mW, 1.2mW and 0.33mW.

Index Terms – Broadband, bulk-driven, harmonic mixing rejection, low voltage low power, mixer

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Stochastic ADC with Random U-quadratic Distributed Reference Voltages to Uniformly Distribute Comparators Trip Point

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

A Stochastic Flash ADC uses comparator's random offset as the trip point while all the comparators have the same reference voltages. Since the offset of a basic comparator depends on number of independent random variables, the offset will follow randomly distributed Gaussian function and this can be verified by performing the Monte Carlo analysis of a dynamic comparator. Since the offset is random signal instead of deterministic values, we have to use more than 2^n-1 comparators. The random Gaussian function of dynamic comparator implemented using 90nm CMOS technology has a standard deviation of 153mV and the cumulative distribution of the Gaussian curve will be linear between ±153mV. It means that a Stochastic Flash ADC implemented using this comparator will have an input dynamic range of ±153mV. In this research work it is shown, by adding voltages that follow random U-quadratic distribution to the comparator's reference inputs, their trip points will shape into uniform distribution, and 80% of them will lie within the useful input range. With the proposed technique, the input dynamic range of a stochastic flash ADC can be increased from ±153mV to ±400mV with also increase in resolution with the same number of comparators.

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

Index Terms – Input referred offset voltage, Dynamic comparator, Monte Carlo analysis, stochastic signal, Gaussian signal, U-quadratic distribution, cumulative distribution and Resolution.

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Temperature And Process Compensation In ZTC Bias Point Using LMS Adaptive Filter 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 unique ZTC point in which biasing doesn't change with temperature variation. But because of process variation it is not possible to find the exact ZTC point through manufacturing process.

To bias a typical MOSFET in exact ZTC point and compensate process variations, two different techniques are introduced. In first technique, internal transistor temperature variation is used to determine if ΔV_{GS} varies same direction or opposite direction of temperature. Based on the sign of ΔV_{GS} it is applied as the input of LMS adaptive filter adjusting bias current in order to close bias point to the exact ZTC point. This loop is repeated as long as bias point gets close to the exact one with an acceptable error. Feedback loop can be removed afterward or bias point will wobble around ZTC point of transistor. In second technique, ZTC point dependency to MOSFET channel width is getting used. Based on CMOS characteristics, if V_{ZTC} is fixed, I_{ZTC} can change by varying MOSFET channel Width. In this method, fixed V_{ZTC} obtained from a typical transistor is used as the LMS adaptive filter reference. Due to process variation, transistor ZTC voltage is different than reference voltage. Thus, this voltage is used as the loop input. Based on the difference between V_{ZTC} and V_{Ref}, adaptive filter will increase or decrease MOSFET channel width in order to change I_D. In this way, V_{ZTC} is eventually getting close to V_{Ref}. In order to have a variable channel width, switched parallel transistors connected to the output of an ADC are used and the current passes through some of them based on the LMS adaptive filter output.

Conclusion is that by using any of these techniques, process variation is being compensated and thus, MOSFET will operate in its ZTC point. Now that bias point is temperature independent, both temperature and process variations are compensated and this transistor can be used as a very reliable reference in any analog or digital application.

Index Terms – Temperature Compensation, Process Compensation, Zero Temperature Coefficient, LMS Adaptive Filter, ZTC Point, Variable Channel Width.

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Time Difference Amplifier Using Closed Loop Fractional Gain control

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Abstract– In recent CMOS technology, it is getting complicated challenge to design analog and mixed signal integrated circuits in acceptable specifications and features. The main reasons are due to limits of Voltage resolutions, high leakage current and lowered power supply. To overcome these problems, some works have introduced processing the signal in time domain which has greater benefit from the technology scaling of CMOS due to enhanced time resolution.

To add , the time Difference Measurement has become an area of interest to many authors as it is used in wide range of applications like Time to Digital Converters ,Time and Distance Measurement ,Testing of IC's and Telecommunications . A mutual Execlusive Ciruits and Closed loop Gain control time amplifiers are good examples of processing signal in time resolution ,However each of it has some limitations such as open loop gain is sensitive to PVT Variations, sensitive to dynamic supply noise, narrow tunning range ,high Power Consumption ,large circuit size and non-Linearity.

The objective of this work is to design a Time Difference Amplifier using DLL- like closed loop with Pseudo Differential Delay element and Fraction Delay element with Monotic Digital Control by Delta Sigma A/D conversion signal processing .This work has been designed and simulated using 65nm CMOS process at 1.2V supply voltage and a clear variable fractional range with a very wide dynamic linearity have been achieved . Moreover, the noise performance is improved by taking advantage of Pseudo differential delay element.

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A Highly Linear Voltage Controlled Current Starved Inverter Delay Element with the Compensatated Circuits Using 1/X Circuit and Pass Transitor Logic

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Abstract:- Low power, high resolution and high speed have become important objectives in designing mixed signal integrated circuits using CMOS technology. In order to achieve these objectives, we need a high linear delay element . Delay elements play an important role in many digital circuits including digital phase lock loops (DPLL), digitally controlled oscillators (DCO), self-timer circuits, and sensors . Delay elements are the key building blocks in all of these applications. The overall performance of digital circuits can be directly affected by small and precise changes in the delay element.

Delay elements are divided into two categories digitally controlled delay elements (DCDE) and voltage controlled delay elements(VCDE). In DCDE the delay is obtained in a digital manner in which the voltage is controlled digitally and a fixed and quantized delay can be obtained. In VCDE the delay is obtained by controlling the voltage continuously. In most of the applications we need a delay element in a continuous manner. Current starved inverters are used as delay elements in most CMOS circuits due to their longer delay time and high performance in static power consumption

This work presents a simple and an effective concept of using a current starved inverter to linearize a delay element where the input control voltage is converted into desired delay which is linearized with the help of a 1/x circuit, a source degeneration transistor and a pass transistor logic in 90nm technology. This technique helps to achieve a 10% improvement in linearity up to 300mV and a moderate improvement in linearity up to 400mV by using a clock frequency of 385MHz for a 5 bit resolution output which gives SNDR of 36.5dB and ENOB of 5.78 bits. In 500MHz clock frequency, a high linearity limited to 300mV with a 6 bit resolution was obtained which gives the SNDR of 41.9 dB and ENOB of 6.66 bits. The future work of this research work is to prove these linear delay in terms of analytical expressions.

Index Terms- Delay element, current starved inverter, 1/x circuit, pass transistor logic, source degeneration transistor, high resolution, low power

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

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

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

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Design and Testing of Electronic Stethoscope Capable of Separating Heart-Murmur Sound without Affecting the Frequency Components

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Abstract – The sound of heart and murmur are composed of frequencies between 1 Hz and 1 KHz. Humans have little or no sensitivity to some of these frequencies, particularly those below 20 Hz. In addition, the use of personal music devices and earbuds can lead to various levels of industrial deafness, further limiting frequency response. Further, the human threshold of audibility to sound intensity varies from the low end (i.e. 20 Hz) to high end (i.e. 1 KHz) of frequency spectrum. As a result, physicians' diagnostic performance during auscultation tends to be more subjective than objective due to their different levels of experience. This has led to the increased use of expensive high-tech instruments such as the echocardiograph and to the decrease in use of the 'art of auscultation'.

Recently designed electronic stethoscope's algorithm relies on time-frequency analysis or neural network methods which are beneficial for signal localization and visualization. Other methods are by segmenting the mixture of heart and murmur sounds using band-pass filtering or an Independent Component Analysis (ICA).

ICA is of particular interest in that it is capable of separating two or more mixed signals into their additive components without affecting their overlapped frequency spectra. Filtering strategies cannot do this. However, ICA cannot determine the variance and sequence of independent components, a problem raised when further signal processing is required to identify health from a disease state.

The aim of the project is to build an easy used, low cost electronic stethoscope that addresses the differences of human threshold of audibility by allowing the user to amplify each signal disproportionally while listening for the sound. One approach is to use an ICA algorithm and another algorithm to keep the independent components of heart and murmur signal in a fixed sequence in order to find their correct variances using a Fourier Transform approach. The final signal components are scaled independently, so that the user can vary their relative amplitudes, and are then summed and sent to the audio output.
The overall design will be tested by simulation to verify that it addresses the problem. If the design is shown to be effective and practical, the results of the work may be useful for primary care facilities and other health care in remote areas.

Index Terms – Heart auscultation, Independent Component Analysis, Electronic Stethoscope, Segmentation of heart murmur, Phonocardiography

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Impedance Control and its Implementation on Bilateral Teleoperated Robotic Arm

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

For video broadcasting purposes, a H.264/AVC encoder is developed using Intel IPP which uses latest multicore capabilities of new processors and can encode and transmit high definition videos over internet in real time. Encoder uses a modified idea of video-on-plane, where the area of interest is extracted and encoded at a different frame rate than rest of the frame. Using video-on-plane has been proven to decrease the file size and give better compression. Our modified algorithm uses user input as well as motion detection of individual pixels to define area of interest. This scheme gives better results than existing algorithms for slow moving objects. Encoder is designed to be used for video with slow moving objects for cases like surgical procedures. Use of Intel IPP provides better compression ratio, shorter encoding time and improved PSNR than existing video encoders. The results of our compression algorithm have been verified using PSNR analysis and human perception survey. PSNR and human perception survey results of our H.264/AVC encoder showed better performance than comparable encoders at the same bandwidth. Our approach of using Intel IPP libraries and keeping video encoding separate from control software makes it easier to develop it using two different technologies and also enables it to run on a separate computer than the one which is connected to robot.

Index Terms – Teleoperations, video on plane, impedance control, H.264/AVC, PSNR

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

Yi Pu

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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.

As a new project, we have finished the literature review and patent search on existing electromagnetic dampers, and have done the body design of the linear permanent generator and fabrication recently. Now we are working on the electrical and electronic development for the suspension system.

Index Terms – Regenerative; Electromagnetic Dampers; Energy harvesting

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Tracking LV Endocardium with Biomechanical Model and FEM

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Abstract– A Finite Element Method is used to detect the endocardium of the left ventricular (LV) through 2D echocardiography image sequence. The deformation of the LV is estimated from the biomechanical constitutive equations. Two strain energy functions are used for the passive and active cardiac cycle phases. The ABAQUS FEM is used to solve the Biomechanical model equations. The pressure during heart contraction and relaxation is simulated and applied at each frame of the cardiac cycle. The input file of the ABAQUS is prepared by MATLAB. The ABAQUS and MATLAB are linked by using Python program to transfer data and reading the output results. The experimental results conducted and found very promising.

Index Terms– FEM, left ventricular, ABAQUS, echocardiography, biomechanical model.

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Mathematical Modeling of the PA-10 robotic Manipulator

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Abstract – PA10-7C robot arm is an open kinematic structured chain with 7-Degrees of freedom, widely used for industry, research. The PA-10 is ideal for precise manipulation tasks due to the back drivability, precise positioning capabilities, and zero backlash afforded by its harmonic drive transmission.

Kinematic modeling of PA10-7C robot arm involves forward kinematics and inverse kinematics. In the paper, the forward kinematics of PA10-7C robot arm is calculated efficiently based on the D-H model. Then the Kinematic model is derived to describe the robot motion with respect to a fixed reference Cartesian frame by ignoring the forces and moments that cause motion of the structure. The inverse kinematics of PA10-7C robot arm is calculated efficiently. Jacobian matrix for PA10-7C robot arm is derived to describe the relationship between joint angular velocities in the joint space and the end effector's velocities in Cartesian space.

The results of simulation of the robotic manipulator PA10-7C are presented. They confirm efficiency of the proposed method. Software architecture was also developed which uses the concept of device drivers to achieve modularity in a real-time subsystem environment. The proposed Torque /position control approach has been simulated on the dynamic model of PA10-7C. Simulation results are discussed and the control algorithm for the manipulator is approved.

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

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

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

To address this problem, a visualization tool has been developed to represent a jurisdiction's energy system. The tool allows the effects of changing energy policies on energy security to be analysed. A case study using real-time wind data from the City of Summerside has been implemented to demonstrate the capabilities of the tool.

This presentation will elaborate on the methods and implementation of the visualization tool and explain the results obtained from the analysis of the Summerside project.

Index Terms — Energy system, Energy policy, Energy security, Visualization tool

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Legacy Appliance Profile Generator

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Abstract – People are in need of more home automation devices to upgrade their living spaces and enjoy a high-tech life because it makes their life convenient as well as secured. Hence smart appliances are becoming very popular today due to their characteristic of being operated automatically. Therefore, what is a smart appliance? Traditionally, a smart appliance is a device that responds to a pricing signal and decides when it is most economical to operate, something that cannot be done by a legacy or non-smart device or appliance. In order to address this deficiency, we propose a Legacy Appliance Profile Generator that creates profile of a legacy device to be operated smartly by constantly monitoring and recording the constituents like voltage (V), active power (P), reactive power (Q) and current (I).

A profile of an appliance can be defined as a measurable parameter of a load that gives information about the nature and operating status of an appliance, so that the user could understand and monitor the pattern of energy consumption and how much energy the device is consuming. The proposed Legacy Appliance Profile Generator contains sensors and RFID reader that extracts features to generate the profile of a legacy device connected to it by measuring parameters such as voltage, current, power and recognizes the attached electrical device by sensing the RFID tag mounted on device's plug which identifies the electrical appliance. The generated profiles along with the appliance ID from the tag are stored in a data base as unique appliance finger print/signature for that device.

The proposed Legacy Appliance Profile Generator contains a socket into which the plug of a legacy device will be inserted; RFID reader to read the RFID tag mounted on the plug to identify the appliance, voltage sensor circuit to record the instantaneous voltage (V) and current sensor circuit to sense the current flow (I). The plug of the legacy device contains a passive RFID tag that identifies itself to the reader whether if it is a fan, lamp or any other electrical appliance. The collected information (Appliance ID, V, I) from the tag and two sensors are then transferred through a communication interface like USB to a host computer system where the data is stored in a data base. The active power (P) and reactive power (Q) is extracted and stored in the data base using the respective equations that utilizes voltage and current as inputs and software that is programmed in the host computer to implement the equation. Therefore five parameters- Appliance ID, Voltage (V), Current (I), Active Power (P) and Reactive Power (Q) are considered as constituents for generating and storing profile of the connected appliance in the data base of the computer.

Index Terms – Smart Outlet Box, Appliance Signature, Legacy Appliance Profiling, RFID

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A Novel Method for Determining Energy-Security Diversity

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Abstract – Energy plays an essential role in any jurisdiction, affecting its society, economy, and environment. All jurisdictions are associated with an energy system which is responsible for meeting the energy demands of its different energy services such as heating and cooling, electricity, and transportation. Not surprisingly, energy systems differ from jurisdiction to jurisdiction, with a wide-range of processes and energy flows all contributing to the improvement or deterioration of its energy security.

Energy diversity, defined as the reliance on a variety of mutually disparate suppliers and their energy supplies, is seen by many as a proxy for energy security. Although diversity of supply is important, by focusing on suppliers and supplies alone—omitting the internal structure of the system and its energy services—is a narrow and potentially misleading view of diversity.

The International Energy Agency's (IEA) definition of energy security, "the uninterrupted physical availability at a price which is affordable, while respecting environment concerns'' can be parsed into three generic energy security indicators: availability ("uninterrupted physical availability"), affordability ("a price which is affordable"), and acceptability ("respecting environment concerns"). The jurisdiction's energy security can be affected when the system and its sources, internal structures, and services are subject to events, such as extreme weather events, grid failures, and new energy sources. An event is any external or internal action or activity that causes an entity (i.e., a source, process, or service) to deliver a measurable change to at least one of its flows.

This presentation describes a novel, generic method to determine energy-security diversity of an energy system, its processes, and flows using graph theory and linear algebra. Energy diversity is measured in terms of the three energy security indicators—availability, affordability, and acceptability—derived from the IEA's definition of energy security, affected by the event related stresses, and represented as energy-security indexes (ESI). This view of energy-security diversity provides a better appreciation of the relationship between the events, both external and internal, and the components of the system leading to a more systematic, transparent, and complete way to articulate diversity perspectives and approaches to the stakeholders of any jurisdiction's energy system.

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

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Implementation of a Subsidiary System to Control a Model Train System Employing the Cortex-M3

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Abstract – The discipline of Computer Engineering (CE) may be described as the combination of Computer Science (CS) and Electrical Engineering (EE). CE brings together the science and technology of design and implementation of software and hardware components in modern computing systems to serve industries that vary from aerospace to VLSI. One of the foundational curricula of CE is the study of Real-time Systems (RTS). Hughes defines an RTS as a computer system employed in an environment where a number of events, usually external to the computer system, that must be accepted and handled within a short period or within certain deadlines.

At the Electrical and Computer Engineering Department at Dalhousie University, a course named "ECED 4402: Real-time Systems" aims to teach students the fundamentals of design in a real-time system through a model train-set, complete with track sensors, switches, and variable speed ability. This course previously employed an Intel x86 architecture to reach its educational goals. Since the introduction of the course to the ECE curriculum, significant advancements have taken place in the microprocessor and embedded market. Because of this evolution, it has been deemed that the Intel technology no longer serves to provide students with up-to-date knowledge on the subject. This resulted in the migration of ECED 4402's syllabus to a new, more modern processor. Within the last year the course has undergone a face-lift to apply ARM's popular and effective embedded processor, the Cortex-M3. To make this migration from architectures happen, a new subsidiary system had to be created to facilitate the conversion process.

A subsidiary system that serves as the middle-man between the track-layout electronics and the Cortex-M3 had to be designed. This system currently employs three Atmel 644PA's, coupled with the Serial Peripheral Interface (SPI) serving as the communication link between the Cortex, and a communication protocol to help exchange commands between the two sides in an effective fashion.

In the setup, the Cortex serves as the Master while the Atmels work as the Slaves. The target Atmel receives a five-byte frame which contains the information required to have the desired effect on the train-set. As each Atmel has a different function (e.g. sensor read, change track speed, or change switch direction) it is necessary to "talk" to each Atmel separately. The Cortex achieves this by using 3 different Slave-Select lines and only sends information to the desired recipient. The correct return codes for the five-packet frame are echoed back to the Cortex, confirming execution of the issued command has taken place.

Index Terms – Real-time systems, ARM, Cortex-M3, Serial Peripheral Interface

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Unequal Error Protection of SPIHT Coded Image Transmission Using Joint Source-Channel Coding

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Abstract – Reliable image and video communications over noisy channels has been a great challenge especially for the transmission of large volume of data over unreliable and bandwidth limited channels. One obvious technique is to deal with this problem involves taking an existing image encoder and then protect the bits using appropriate channel coding method - separate source channel coding schemes. But channel coding techniques add redundant bits at the source resulting in an increase in the required bandwidth.

A combined source-channel coding scheme using Hierarchical Quadrature Amplitude Modulation (HQAM) provides alternative means of error protection, without the need of increasing bandwidth. For source coding, Set Partitioning in Hierarchical Trees (SPIHT) is used, which is an efficient wavelet based progressive image compression technique, designed in this work to minimize the Mean Square Error (MSE) between original and decoded imagery. SPIHT coding generates different types of embedded bit streams that have different degrees of vulnerability to errors. Since wireless channels suffer from significant bit error rates, some mechanism to protect the encoded image sub-stream is required. Without such a mechanism, the channel bit errors will prevent acceptable decoding of the image.

An important approach to obtain such a mechanism is by combining image coding with channel coding and modulation scheme design which is called Joint Source-Channel Coding (JSCC). In this work, JSCC is achieved by combining SPIHT coded bits with Unequal Error Protection (UEP) using HQAM. Different bits with different levels of priority, according to the SPIHT encoder are transmitted using different levels of error protection through different separation of symbols, without increasing the bandwidth and bit power budget. The work will prove that JSCC scheme can reduced sensitive bit error rates when using SPIHT image transmission. The performance of SPIHT coded image transmission is evaluated using gray test images and for different values of the modulation parameter and different levels of compression rates.

Index Terms – UEP, HQAM, SPIHT image coding, image compression, joint source-channel coding.

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Enhancing the Performance of Wireless Relay Networks Using Interference Alignment

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Abstract – As wireless communications technology evolves, many techniques are developed to address the various challenges that face this technology such as the limited resources and fading channels. With more users and higher bit rate services, the major difficulty in this area is how to accommodate more information-bearing signals within the finite bandwidth. A promising approach to address this problem is a technique called interference alignment, which improves the utilization of communications resources by multiplexing more signals in each channel use from devices using multiple transmit and multiple receive antennas. Specifically, while transmitting at the same time and in the same frequency band, users allocate part of their signaling dimensions to overlap the interfering signals in a controllable fashion and they exploit the rest of their signaling dimensions to communicate their information free of multiple access interference.

This work attempts to apply the concept of interference alignment to enhance the performance of wireless networks with relays. Interference alignment has already been used as a tool in analog network coding to reduce the average number of time slots to exchange data via relay. Instead of using two time slots to relay the messages from a transmitter to a receiver in the conventional relaying system, the average number of time slots can be reduced when the transmitter sends a first group of its messages to a subset of the relay nodes in the first time slot and then sends the second group to the other part of the relay nodes in the second time slot. At the same time when the transmitter sends to one group of the relaying system, the other group relays the previous set of messages to the receiver. In this scenario, the expectation is that if the relay nodes perform interference alignment to avoid the interference caused by the other nodes during the relaying process performance improvements in terms of throughput can be obtained.

Index Terms – Interference Alignment (IA), Signal dimensions, Analog Network Coding (ANC), Relaying network, Multiple antennas, Degree of Freedom (DoF)

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Random Access MIMO in Wireless Networks

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Abstract – In recent years, multiple-input multiple-output (MIMO) techniques have been deployed in a wireless link design to increase the bandwidth utilization and to improve link reliability. New developments in this area consider the multi user MIMO (MU-MIMO) operation to allow simultaneous transmissions between multiple hosts and a base station by controlling the level of multiple access interference (MAI) in a deterministic fashion. In particular, IEEE 802.11ac wireless local area network (WLAN) standardization effort considers this approach on a downlink from the base station to the hosts because of feasible implementation of channel estimation and accessibility of channel state information from the base station to any of the hosts. However, designing the random medium access control (RMAC) for the MU-MIMO on the uplink is still an open problem and is the focus of this work.

All the conventional RMAC currently used in practice are designed for single-input single-output (SISO) systems and when applied in MIMO systems they offer suboptimum performance. There are already some preliminary investigations into RMAC for MU-MIMO systems assigning pre- and post-processed data streams to multiple transmit and multiple receive antennas on different hosts, such as applying interference alignment or taking advantage of the spatial adjustment. But there is still much more that can be gained in this area. For example, most of these approaches do not take full advantage of WLAN protocol capabilities like database distribution, beacon frames while others address the problem partially by focusing on single aspects of a much bigger system.

This research focuses first on the physical layer issue in MU-MIMO by proposing an uplink approach that shows a less complex design with an acceptable performance compared to others. This is done by assuming that the channel state information (CSI) is only required at the base station. Second, a suitable RMAC scheme for the proposed uplink transmission is considered in a cross layer fashion, and it is compared with a centralized medium access control and a conventional RMAC from the perspective of the transmission throughput and the collision ratio as determined by stochastically controllable amount of MAI.

Index Terms – Multi user multiple-input multiple-output (MU-MIMO), spatial adjustment, wireless local area network (WLAN), cross layer protocol, multiple access interference (MAI), random medium access control (RMAC), throughput, collision ratio

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Beam Angle Channel Modulation

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Abstract - The demand for increased throughput in wireless communication systems is driving research into the development of more advanced transmission schemes with ever increasing bandwidth efficiencies. Multiple input-multiple output (MIMO) systems is one example of recent developments in this area that allowed significant performance improvements and is already deployed in many wireless communication standards. While a lot of new results have been reported in the area of multiple-antenna techniques there is still a lot of opportunities for innovation, especially when trading performance and bandwidth efficiency for system complexity and cost.

Our investigations are falling into the general areas of antenna array design with the purpose of improving bandwidth efficiency and they are encompassing the design of both MIMO and Space Modulation signal processing algorithms. MIMO is a powerful performance-enhancing technique that uses an array for: gain, spatial diversity, spatial multiplexing, interference reduction and noise robustness. SM uses an array, for mapping information bits in the spatial positions of the transmitting antenna in the array. The modulation techniques researched in our work integrate the elements from both MIMO and SM domains.

In order to increase the spectral efficiency of wireless communication systems, a concatenated modulation scheme is proposed that uses an antenna array to encode the information bits into the channel response. In this scheme referred to as beam forming channel encoding, an antenna array is engaged to transmit the data bits in such a way that received beam, or rather estimated channel, conveys the information about spatially encoded data. Specifically, the new technique uses antenna beam-forming to encode data into dynamically controlled beam directions resulting in diverse channel responses used at the receiver in the detection processed. This scheme is called in our work Beam Angle Channel Modulation (BACM).

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

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Implementation of Filtering Beamforming Algorithms for Sonar Devices Using GPU

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

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

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

We used INVIDIA GTX 690 Graphics Card with 4GB Ram and CUDA as a programming language. CUDA is a parallel computing platform and programming model invented by NVIDIA. It enables dramatic increases in computing performance by harnessing the power of the GPU.

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

Advantages of GPU computing:

1- Improve performance and solve problems more quickly by implementing parallel processing.

2- With CUDA, you can send C, C++ and Fortran code straight to GPU, no assembly language required.

3- No need to design an expensive hardware.

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

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Proposed Power Electronics Course

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Abstract – This course covers the principles of semiconductor switching devices and their applications to the design and operation of various power electronics circuits such as ac-to-ac, ac-to-dc, dc-to-ac, and dc-to-dc converters. The course will engage students using a combination of lectures, interactive learning tools, and computer-based simulation techniques. The objective is to introduce the principles of power electronics to fourth-year undergraduate electrical engineering students. Although laboratory hardware is not available at Dalhousie University, course participants will use computer programming software such as MATLAB, PSpice, or PSIM to simulate and design various power electronic circuits.

The course is designed to create an effective learning environment. It will be taught both in-class and on-line. Distance education students will have access to all course resources, such as lectures, research papers, text books, and lab software. The assessment of this course will be a combination of on-line and in-person techniques. To provide high-quality online education and diminish cheating and plagiarism, several strategies have been included in the course design.

Index Terms – Power Electronics, Online Courses, Teaching and Learning.

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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 micromirror is attracting more and more attention for fiber optic switch, projection display, and confocal microscopy. In recent years, MEMS mirrors with large scanning angles have found great application potential in the fields of biomedical imaging and interferometer systems. For many biomedical applications MEMS mirrors with a controllable curvature are desired. MEMS technology holds the greatest promise to deliver a deformable mirror that meets these specific requirements. For this project, a MEMS micromirror with controllable curvature will be designed and fabricated.

There are several actuation principles available in literature but electrostatic actuation has been chosen by many research groups for its inherent design simplicity, fast response and low power consumption. For this project 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 bottom electrodes underneath for electrostatic actuation. On the basis of the theory of materials strength, the deformation of the plate can be parabolic only if bending moments are applied at the anchoring ends with the electrodes which are beneath the mirror plate. The static and dynamic characteristics of the device are studied using mathematical software MATLAB. The structural performances and analysis are carried out using the Finite Element Analysis (FEA) tool.

The proposed deformable MEMS micromirror will be fabricated using surface micromachining processes SOI and POLYMUMPS through CMC microsystems. The performances of the device will be characterized and the experimental results will be available in future.

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

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Design, Fabrication and Control of MEMS Based Micromirrors for High-Resolution Imaging of the Ear

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Abstract – For more than two decades, micromirrors fabricated using Micro-Electro-Mechanical-Systems (MEMS) technology has been used as a key building block for optical networks and beam scanning systems. A number of research groups and commercial manufacturers have successfully used MEMS based micromirrors for optical wavelength-selective switches, configurable optical add-drop multiplexers and optical cross-connects. In recent years MEMS based micromirrors are finding their way into biomedical imaging applications.

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

This project reports design, fabrication and control of 1D and 2D MEMS micromirrors. Electrostatic actuation is choosen to actuate the micromirrors because of its simpler structural geometry, flexible operation, and low power consumption. To increase the stability and controllability of the micromirror devices, a multi-loop proportional, integral and derivative (PID) controller has been designed and implemented. Traditionally, 2D electrostatic MEMS micromirrors have been designed with a gimbal surrounding the mirror plate and four square electrodes underneath. The main disadvantage of this type of design is the X-Y tilts are extensively coupled, which makes design of a control system difficult. In this work, triangular shaped electrodes have been used to achieve relative decoupling. Simulation results show that decoupling for small tilt angles has been achieved and the controller can achieve a larger controllable tilting angle than the pull-in angle resulting in significantly enhanced device performance and functionality.

Several test structures have been fabricated using commercially available micromachining processes and primary experimental results are presented in this work. Future work of this project involves calibration of the fabricated devices, control system testing, and in-lab post-processing of the fabricated micromirrors using the facilities of Dr. Yuan Ma and fabrication facilities of Dr. Rob Adamson.

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Plasmon-Enhanced Spectral Changes in Surface Sum-Frequency Generation with Polychromatic Light

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Abstract – The field of plasmonics has lately experienced a truly explosive growth. Much research in plasmonics has so far been focused on linear light-matter interaction modalities, owning largely to the success of plasmonic-based sensors as a powerful tool for probing surfaces. However, resonantly enhanced local electric fields bring about pronounced enhancement of nonlinear responses of plasmonic materials as well: second- and third-order nonlinear processes are surface sensitive at the molecular level, rendering them highly attractive for nonlinear microscopy. Although the vast majority of work in plasmonics deals with quasi-monochromatic light, there has been growing interest in spectral signatures of plasmon enhanced electromagnetic fields. In particular, the *linear* optical response of homogenous and inhomogeneous–periodic or random–plasmonic nanostructures, probed with broadband light beams, has been recently examined. Nevertheless, to the best of our knowledge, plasmon-enhanced *nonlinear* optical processes, excited by polychromatic light sources, have not yet been studied. In this context, it is especially instructive to learn whether plasmons, excited on the surface of a conducting material or nanostructure, leave any signatures in the far-field spectra of generated second-order nonlinear waves. The affirmative answer to this question can trigger new developments in surface nonlinear spectroscopy, microscopy, and surface morphology studies.

In this work, we investigate the spectral behavior of the fundamental and sum-frequency waves in the surface SFG from a thin metal film with the polychromatic incident light. We assume that the source field is well collimated such that it can be treated as a plane wave. The wide bandwidth of the source makes it possible to realize SFG with a single source: any pair of monochromatic components within the source spectrum gives rise to a sum-frequency component through the surface SFG process. For symmetric source spectra, one would expect the SFG spectrum to peak at half the carrier wavelength of the source. We show, however, that at the incidence angle corresponding to light coupling to the surface plasmon, the reflected sum-frequency wave (SFW) spectrum gets blue-shifted from the expected maximum whereas the reflected FW has a spectral hole at the carrier frequency. We further demonstrate that the magnitude of the effect depends on the bandwidth of the source spectrum and the incidence angle: the shifts of SFW spectra become more pronounced as the source bandwidth increases, while at a certain angle a spectral switch is observed. Also, as the incidence angle deviates from the switch angle, all spectral anomalies disappear. The appearance of a spectral switch of SFWs can serve as an unambiguous plasmon signature in nonlinear surface spectroscopy.

Index Terms – Surface plasmons, spectra, nonlinear optics at surfaces.

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Spectral Coherence Anomalies in Statistical Optics

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Abstract – The field of singular optics is concerned with the behavior of electromagnetic fields in close proximity to the regions of perfect destructive interference where field amplitudes vanish and, by implication, phases are indeterminate (singular). Until recently, singular optics dealt, for the most part, with monochromatic, fully spatially coherent scalar or vector fields. In recent years, however, the spectral behavior of focused coherent, polychromatic wave fields in the vicinity of phase singularities was explored and pronounced spectral anomalies were theoretically discovered and experimentally verified. This research was followed by the examination of spectral anomalies in Fraunhofer and Fresnel diffraction of fully coherent light by hard apertures. The discovered spectral anomalies were shown to be generic of fully spatially coherent, polychromatic fields.

Concurrently, the behavior of partially spatially coherent, quasi-monochromatic wavefields near phase singularities was also studied, both theoretically and experimentally, and self-similar or non-shape preserving evolution of partially coherent singular beams was revealed. Moreover, heuristic arguments were advanced showing that while phase singularities of field amplitudes are generic to fully spatially coherent fields, so are the correlation function phase singularities to partially spatially coherent fields.

However, it appears that only the anomalous behavior of the spectral intensities of optical fields near their phase singularities has been explored to date. In this work, we show that the second-order correlation functions of partially spatially coherent, polychromatic fields also exhibit anomalous spectral features in the vicinity of their phase singularities. We term the novel spectral anomalies the spectral coherence anomalies to distinguish them from the previously discussed anomalies of spectral intensities. We note that many realistic light sources, ranging from multi-mode lasers to light-emitting diodes, are partially spatially coherent and polychromatic because they operate at several transverse (spatial) and longitudinal (temporal) modes. Therefore, spectral coherence anomalies are expected to be generic to the fields generated by such sources. We describe the structure of spectral coherence anomalies using a simple, yet illustrative, example. We also demonstrate how the parameters of the system can be adjusted to engineer a partially coherent source with spectral anomalies.

Index Terms – Coherence and statistical optics, diffraction.

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Ultrashort Pulse Coherence Properties in Linear Resonant Amplifiers

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Abstract **-** The statistical properties of ultrashort pulses are of great interest because of their crucial effect on the accuracy and performance of the optical communication devices. Up to now, a widespread exploration has been done on defining and modeling statistical properties of stationary random pulses. In addition, statistical properties of partially coherent pulses far from any internal resonance upon propagation in fiber optics, linear and nonlinear dispersive media have been studied. In near-resonance regime, the influence of statistical properties of self-similar pulses on their propagation in linear absorbers was derived. Further, second-order coherence properties and the general area-correlation theorem of generic partially coherent pulses in resonant linear absorbers were explored. However, exploring the coherence properties of ultrashort partially coherent pulses upon propagation in linear resonant amplifiers is quite a novel idea which has not been studied yet.

Here, we explore the statistical properties of intrinsically stationary pulses while propagating in coherent linear amplifiers. As a generic statistical pulse model, we consider Gaussian-Schell model (GSM) pulses which can be generated by a temporal modulation of a statistically stationary source with a Gaussian spectrum. As the first consequence, we demonstrate how the partially coherent pulses with symmetric initial intensity lose their symmetry on propagation in the media. Moreover, we show that over a sufficiently long propagation distance, the coherence properties of GSM pulse becomes almost uniform across its temporal profile. As the second consequence, we show that the level of coherence of the partially coherent pulses progressively increase upon propagation in amplifier media regardless of the initial pulse being rather incoherent or fully coherent. Consequently, not only the media amplify and reshape the pulses, but they reduce the noise associated with source fluctuations. These properties can have relevant applications in short-range optical communication systems using ultrashort pulses.

Key words: Statistical optics, ultrashort pulses, resonant regime, linear optics and amplifiers.