

## **M.TECH. THESIS ABSTRACT 2009**

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*Title* : *Single Phase PLL For Variable Frequency Applications*  
*Author(s)* : *Ragaja SR*  
*Roll No* : *Y7104063*  
*Supervisor(s)* : *Sensarma Partha Sarathi*

***Abstract:***

The objective of this thesis is to implement a single phase PLL which can lock to a wide range of power supply frequencies. In this thesis, a new single phase PLL is presented. A variable delay block is used to generate the orthogonal signal to the input signal. A chain of filters is used to filter out the harmonics from input signal after transforming it to dq domain. The proposed structure has the advantage that it gives undistorted output for input signal having distortions like harmonics and dc offset. The performance of the proposed PLL is validated through simulation of the same with various test signals at steady state and transient conditions.

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***Title*** : ***Design Of Synchronous Buck Converter For Power Management Applications***  
***Author(s)*** : ***Venkateswara Reddy Mula***  
***Roll No*** : ***Y7104084***  
***Supervisor(s)*** : ***JoshiAvinash&Mishra SantanuKumar***

***Abstract:***

Rapid development in computation and communication integrated circuits (ICs) demands development of better power supplies to satisfy their load demand. These power supplies are required to be small, low profile, and possess good steady state and dynamic response. This thesis presents the design aspects of these power supplies. The steady state efficiency of the power supply is studied at various switching frequency. As the switching frequency reduces the efficiency of the power supply improves at the expense of larger footprint for the overall system and slower dynamics. The small signal modeling and large signal performance of the converter are also described and validated using PSpice simulation. A 1.27 V /10.5 V-20 A prototype is used to verify the steady state design equations and the small signal characteristics. The prototype achieves more than 80 % efficiency with a 200 kHz switching frequency. All the experimental results show good correlation with the predictions.

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*Title* : *Synchronization And Operation Of Parallel Inverters Using Droop Control Method*  
*Author(s)* : *Saho Lalit Kumar*  
*Roll No* : *Y7104040*  
*Supervisor(s)* : *Sensarma Partha Sarathi*

***Abstract:***

At present, there is acute shortage of conventional energy resources. Continuous power supply systems have become increasingly important, especially for applications with sensitive and critical loads. A common practice to obtain a continuous power supply is to use a centralized supply system. This, however is inflexible and can be unreliable for distributed generations. Distributed Generation(DG) is emerging as a new paradigm to produce onsite highly reliable and good quality electrical power. DG becomes a viable alternative when renewable energy resources are available. These resources can be connected to local low-voltage electric power networks, also called mini- or micro-grids, through power conditioning ac units, i.e. inverters or AC-AC converters, which can operate either in grid-connected mode or in island mode. The reliability as well as the power capability of the supply system can be increased by replacing a single UPS unit with multiple, smaller units in parallel, resulting in a so-called distributed power system(DPS). A DPS has many desirable features such as expandability, modularity, maintainability, redundancy, and increased reliability. The technically challenging aspect of the DPS, however, is the synchronization of inverters and load sharing among the parallel connected inverters. There is a need of control strategy to strictly hold the amplitude, phase and frequency of output voltages of inverters to avoid circulating currents through inverter. In this work, a control method is proposed and implemented for synchronization and parallel operation of three phase inverters which enables to share the load power equally in steady state. The synchronization is maintained between the inverters and with grid as well. The design issues for voltage control loop are analysed at length with the discussion of active damping and relative stability of the system. Droop control method has been used for equal power sharing, and design of power control loop and its stability is analysed. A current control is designed and analysed to provide proper synchronization between the inverters. FPGAs can be used to control power electronic systems. They have advantages like high speed, parallel processing capability, and rich digital I/O interface. In this thesis, basic modules required for development of controllers for power electronic systems are developed and tested with standard signals. The proposed control scheme for synchronization and parallel operation is implemented for two 3-phase inverters using this FPGA platform

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*Title* : *Design And Implementation Of Multiband Shunt Hybrid Active Filter With DC Bus Control*  
*Author(s)* : *Rai Kapil*  
*Roll No* : *Y7104035*  
*Supervisor(s)* : *Sensarma Partha Sarathi*

### ***Abstract***

Proliferation of three phase diode and thyristor bridge rectifiers for dc power supplies and as front-end rectifiers for inverter based applications such as adjustable speed drives(ASD) and UPS, has result in serious harmonic, reactive power, flicker and resonance problems in industrial applications and in transmission / distribution systems. Voltage distortion due to current harmonics is a major problem for utilities at transmission and distribution levels. To alleviate harmonic related problems utilities are beginning to implement IEEE 519 recommended harmonic standards on the maximum harmonic current drawn by the industrial and domestic loads. Passive filters have been mostly used to eliminate the harmonics in utilities due to their low cost and high efficiency. However, passive filters characteristics are strongly influenced by source impedance and are susceptible to undesirable series and parallel resonances with source and loads. Later Active filters have been introduced to overcome drawbacks of the passive filters, which provide effective solution for small non-linear loads. But these are not feasible and cost effective for large non-linear loads due to high VA rating requirement of inverter. Combining the advantages of passive filter and active filter, hybrid active filter topologies have been developed which enable the use of significantly small rated active filter compared to pure active filter solution. But in case of hybrid active filter no fundamental voltage is being generated by the active filter and also it exhibit finite impedance at fundamental frequency, so a small fundamental current will always be flowing through the filter. Also real power flows into the inverter due to the product of the harmonic voltage generated and the corresponding harmonic current in the filter branch. This causes charging/discharging of inverter resulting in change in dc bus voltage of the inverter which greatly effects the filter performance. Thus, dc bus need to be made constant for proper functioning of the hybrid active filters. In this thesis, two Multiband Shunt Hybrid Active Filters are used for selective harmonic compensation, both connected in parallel at the Point of Common Coupling. One of the filter has passive branches tuned at 5th & 7th harmonic frequencies and other one has passive branches tuned at 11th & 13th harmonic frequencies. Two methods has been discussed in this thesis to solve the above mentioned problem of dc bus voltage variations. One of the method is to use an additional converter to maintain the dc link voltage while in the other the same inverter is used to perform both the tasks. The analytical investigation of each of these cases are provided. Simulation is carried out to develop control methods. Hybrid active filter with 5th & 7th harmonic tuned passive branch along with Active Front End Rectifier is tested experimentally with a diode rectifier load. The complete control scheme is implemented using FPGA platform. The experimental observations are recorded and it shows remarkable reduction in harmonic component of current drawn from the source with the dc bus voltage being maintained at a constant reference.

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*Title* : *Visual Motor Co-ordination Of A6 DOF IRB140 Manipulator Using Eye-In-Hand Camera Configuration*  
*Author(s)* : *Tanala Subrahmanyam*  
*Roll No* : *Y7104074*  
*Supervisor(s)* : *Behera Laximidhar & Venkatesh KS*

***Abstract:***

This thesis primarily focuses on setting up an experimental test bed for carrying out visual guidance of a 6 DOF ABB IRB 140 manipulator. The task is to automate the entire control process thereby eliminating the need of a human supervisor. This necessitates setting up a PC-based control loop for the manipulator. In this system, the PC (computer) should be able to communicate with the robot controller for exchanging data as well as status information. In our setup, the main communication mode based on RPC protocol is not working. Thus, this thesis aims at finding an alternative approach to establish communication between the robot controller and an external PC. Towards this direction, we accomplish the following: • We establish an alternative communication system between the PC and the robot controller. It uses FTP protocol for data transfer and digital I/O signals for handshaking. • Eye-in-hand camera configuration is used for tracking a target in the manipulator workspace. Fuzzy logic is used to estimate the target position in 3-dimensional Cartesian space. This, in turn, necessitates the robot forward kinematic model which is derived from its link geometry using D-H parameters. • The entire experiment is implemented on a 6 DOF IRB 140 robot manipulator in real-time and experimental results are analyzed. It is shown that the visual controller achieves zero tracking error in steady state.

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*Title* : *Analysis Of Common Mode Voltage And ITS Effects InA Five Level SVPWM Inverter*  
*Author(s)* : *Marisarla Dhanunjayarao*  
*Roll No* : *Y7104018*  
*Supervisor(s)* : *Joshi Avinash*

***Abstract:***

The space vector pulse width modulation(SVPWM) technique can be implemented for any three phase inverter. The SVPWM of a multilevel Inverter results in low total harmonic distortion(THD) and better fundamental voltage as compared to that of a two-level inverter. Multilevel inverter modulation is very complicated and cumbersome due to the increased number of space vectors in every sector. The selection of space vectors to synthesize the reference voltage vector at every sampling time ( $T_s$ ) is not straight forward in case of a multilevel inverter. The new modulation strategy based on two level SVPWM is used to solve this problem. This method of modulation strategy has been implemented for three-level and five level inverters. Common mode voltage exists in the case of any three leg voltage source inverter(VSI) with generally used modulation strategies. This voltage may cause induction motor bearing currents and conducted electro magnetic interference(EMI). Complete elimination of common mode voltage is possible using a modified SVPWM for any odd level inverter supplying a balanced load. The effect of common mode voltage elimination on the performance of inverter is studied. The reduction in common mode voltage may reduce the detrimental effects of pulse width modulation like EMI and induction motor bearing currents. The common mode conducted EMI which is due to the common mode noise flowing through ground or chassis of the inverter will reduce considerably by reducing common mode voltage. The common mode EMI spectrum and differential mode EMI spectrum have been presented for a five-level and three-level inverters with and without the elimination of common mode voltage.

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*Title* : *A PIC-MCC Model For Dusty Plasma Simulation*  
*Author(s)* : *Gupta Swati*  
*Roll No* : *Y4177447*  
*Supervisor(s)* : *Gupta Nandini*

***Abstract:***

Dust particles may occur in RF (radio- Frequency) discharges for a host of reasons; these include gas-phase nucleation and Coagulation within the plasma itself and trapping of dust particles from sputtering and etching of wall materials and other external sources. The dust particles are most often negatively charged due to electron capture from the plasma. When the amount of dust accumulation is sufficiently large, it modifies the plasma evolution and the discharge characteristics. In this work, we develop a PIC-MCC based two dimensional model to study the behaviour of a dusty radio frequency discharge in Argon. The simulation model effectively includes not only the ion and electron interaction with each other and the neutral gas molecules but also charged-particle interactions with the dust. The evolution of the discharge Parameters are traced under the dynamically changing dust content. The effect of various parameters like gas pressure and initial dust loading are studied. The evolution of the charge on the dust plasma and the corresponding change in discharge parameter is traced. Effect of mobile and immobile dust particles are understood separately. The dust particles charge content grow due to capture of electron or positive ions and other processes like ionization, excitation etc. Scattering interactions are also modeled. Electrostatic and Gravitational forces on the dust particles are involved in the modeling.

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*Title* : *A Matrix Converter-Fed Synchronous Motor Drive Control*  
*Author(s)* : *Prasanna Kumar B L*  
*Supervisor(s)* : *Das Shyama Prasad*  
*Roll No* : *Y7104039*

***Abstract:***

Matrix Converter (MC) is a direct ac-to-ac power converter, without any dc link. In this thesis, a 3x3 matrix converter is simulated using two modulating schemes viz., Venturini algorithm, and Space Vector Modulation (SVM). The simulation results are presented. The major problem to implement matrix converter in hardware is identified as commutation. Traditional commutation schemes like four step current based and voltage based commutation are studied and their merits and demerits are discussed. A new improved commutation scheme to operate matrix converter as a VSI is proposed. Initially, it is simulated in software, and its feasibility is confirmed. Then, it is implemented in hardware. The commutation scheme is verified experimentally by using an inductive load. Subsequently, a matrix converter fed synchronous motor (SM) drive is simulated for two control schemes, namely, self synchronous control (scalar control) and vector control. The MC fed SM drive with self synchronous control is implemented in the laboratory. The improved commutation technique is implemented with the drive system successfully. The typical simulation results are validated by the results from the experimental setup. The developed MC fed SM drive can be used for fan/ pump type of applications.

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*Title* : *Software Development And System Fabrication Of An Embedded Controller For AVR Applications*  
*Author(s)* : *Bhadra Dinesh Kumar*  
*Supervisor(s)* : *Sensarma Partha Sarathi*  
*Roll No* : *Y7104017*

***Abstract:***

TMS320F2812 DSP, a Texas Instruments based Digital Signal Processor, has been utilised to implement the controller part of Synchronous Generator Excitation control system. Flash programming feature of this device finds wide application in embedded systems. In this thesis, the Flash memory of the device has been encoded so that when the device is turned on, it executes the code without the initiation of any external signal or computer. This feature of DSP has been used to implement the controller part of excitation system. The Serial Communication Interface module of this DSP has been extensively used to communicate with devices like Human Machine Interface. In this thesis, the controller parameter values are transmitted to DSP by Human Machine Interface, thus, facilitating an online change of such values to suit the controller requirement.

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**Title** : *Recurrent Neural Network Based Control Of An Exoskeleton For Rehabilitation*  
**Author(s)** : *Akolkar Himanshu Vinod*  
**Roll No** : *Y7104027*  
**Supervisor(s)** : *Behera Laxmidhar & Dutta Ashish (MechEngg)*

***Abstract:***

Music scene description is an interesting field, one that requires AI techniques to replicate the human perception and capability. The definite connection between music and the emergence of human intelligence has been speculated for a long time. Exploring its realms would therefore rightfully give it the much needed attention it deserves in unravelling the complexity of the human mind. Towards this end an attempt to replace human musical accompaniers with intelligent systems is considered to be an interesting challenge in the AI community and this thesis is an effort to contribute in that direction. A new strategy for extraction of tempo from a polyphonic music track is suggested which exploits the fact that the tempo of music is preserved even when the track is played reversed but peaks related to the melody, chord and other parameters are however misplaced. This indicates that when superimposed with the original track the repetitive beats will stand out prominently thus eliminating the ambiguity in peak picking and the in thresholding during tempo extraction. The track is first processed through a gamma-tone filter and the best bandwidth is chosen dynamically to improve the accuracy of the algorithm. Further rectangular fuzzy numbers are used to capture the uncertainties in the location of the peaks. Based on the tempo and the inter-beat interval the chord recognition and automatic labelling is carried out with a 36 bin chroma vector as the feature and Hidden Markov Model (HMM) as the classifier. The information thus obtained can be used to direct and conduct the musical accompaniment in an interactive manner.

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**Title** : *8051 Microcontroller Based Human Machine Interface For A Digital Excitation Control System*  
**Author(s)** : *Thota Karthik*  
**Roll No** : *Y7104036*  
**Supervisor(s)** : *Potluri Ramprasad*

***Abstract:***

This thesis presents the design and development of a human machine interface (HMI) for a digital excitation control system (DECS). The values of parameters (such as  $K_p$ ,  $K_d$ ,  $K_i$ ) and variables (such as voltages, currents, power factors) are displayed as well as modified on the 128x64 pixel graphical LCD of the HMI using a set of push buttons that are on the HMI. A microcontroller P89C51RD2BN from Philips is the backbone of the HMI. The microcontroller communicates with the DSP (around which the DECS is implemented) using UART protocol, and displays information on the graphical LCD based on the input from the pushbuttons

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*Title* : *Development Of Electric Braking System For Aircraft*  
*Author(s)* : *Ik kurti Hanumath Prasad*  
*Supervisor(s)* : *Das Shyama Prasad*  
*Roll No* : *Y7104025*

***Abstract:***

Traditionally aircrafts have been using hydraulic systems for the generation of braking force on the wheels. But electrically actuated braking systems is a better choice because of the inherent advantages like fast control, modular nature of electronics, light weight and reduced maintenance. In this thesis the development of an “electric actuator (EA)”, for electric braking system of an aircraft is taken up. The project reported here involves a brief literature survey of the available braking systems, selection of appropriate motor and its ratings, and design of mechanism for its torque control. Brushless dc (BLDC) motor is selected because of its advantages like less maintenance, availability of permanent magnet rotor (which eliminates the requirement of secondary supply to the rotor through brushes), simplicity of control and its commercial availability at low powers. Thermal modeling of BLDC machine is made and the temperature rise corresponding to different loadings is analyzed. Torque control of BLDC motor is very simple and can be done using the hysteresis control of dc link current. For the present thesis, a synchronous motor with constant field current is used to simulate a BLDC motor. An incremental encoder is used to detect the position and accordingly switch the control between different phases. Above simulations are done in MATLAB® SIMULINK. Experimental evaluation of control strategy is also done and the results are compared with simulation results..

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*Title* : *Control Of Power Flow Using Interline Power Compensating Devices*  
*Author(s)* : *Adda Ravindraath*  
*Roll No* : *Y7104065*  
*Supervisor(s)* : *Joshi Avinash*

***Abstract:***

Voltage sags and outages can cause significant disruptions to modern industrial processes. This has generated greater awareness to mitigate the effect of such voltage disturbances. Two different custom power devices called Distribution Static Compensator (DSTATCOM) operating in voltage control mode and Dynamic Voltage Restorer (DVR) have been developed to solve these problems. In practice these devices are realized by a voltage source inverter supplied by a DC Capacitor. The amount of energy that can be stored in the DC Capacitor limits the duration and the depth of the voltage sag that can be mitigated using these devices. This problem can be solved by replenishing the energy required to mitigate the voltage sags and outages from other healthy feeders in the same distribution system. This is possible by interconnecting different feeders in a distribution system using Interline power compensating devices. Three different structures of interline power compensating devices are available in the literature. They are Interline Dynamic Voltage Restorer (IDVR), Interline Unified Power Quality Conditioner (IUPQC), and Interline Voltage Controller (IVOLCON). They can be connected between any of the two feeders of a distribution system. The control strategy followed for IDVR is complex. In case of IUPQC and IVOLCON, the voltage sags and outages in one of the two feeders, say Feeder-2 can only be mitigated by drawing the required real power from the healthy feeder, say Feeder-1. But it is not possible to draw the real power required to mitigate the voltage sags and outages in Feeder-1 from Feeder-2. In this thesis it is explained how to control the real power exchanged between the two feeders of a distribution system which are interconnected using either an IDVR or IUPQC or IVOLCON in steady state. A control strategy is also proposed to share the total load demand between the available feeders in a distribution system. The control strategy is modified such that various power system disturbances occurring in either one of the two feeders can be mitigated by drawing the required real power from healthy feeder. The power system disturbances considered in this thesis are short duration and permanent voltage sags on any of the two feeders, and Feeder outages due to three-phase to ground fault on any of the two feeders. The PSCAD/EMTDC simulation results presented in the thesis prove the efficacy of the proposed control strategy.

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**Title** : *Performance Analysis of Hybrid Wind/Fuel Cell System  
Connecteto High Voltage Grid*  
**Author(s)** : *Neradhala Nagaraj*  
**Roll No** : *Y7104050*  
**Supervisor(s)** : *Singh Sri Niwas*

***Abstract:***

Distributed generation is attracting more attention as a viable alternative to large centralized generation plants, driven by the rapidly evolving liberalization and deregulation environments. This interest is also motivated by the need for eliminating the unnecessary transmission and distribution costs, reducing the greenhouse gas emissions, deferring capital costs and improving the availability and reliability of electrical networks. This thesis focuses on the dynamic simulation and performance analysis of hybrid fuel cells-wind turbines system. The objective of this thesis is to put emphasis on the following aspects, Since fuel cell units represent new promising sources, the research ascribes special consideration to developing models that describe their dynamic behavior, the fuel cell model responses are studied under both constant fuel flow and constant fuel utilization operating modes and a fuel cell system has been interfaced through a set of power electronic devices to deliver desired real and reactive power. The modeling of doubly-fed induction generator (DFIG)wind turbines and its rotor and grid side converter controller structures have been presented. Small signal analysis of grid connected conventional DFIG has been performed. A general medium-scale centralized DC-bus grid connected hybrid wind-fuel cell power system (GCHWFCPS) configuration, which is connected via a three-phase pulse-width modulated voltage source inverter (PWM-VSI) to a high voltage (HV) distribution grid, is proposed for the integration hybrid wind-fuel cell system, as the proposed GCHWFCPS configuration to simultaneously achieve four practical objectives.

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*Title* : *Intelligent Moving Target Tracking Schemes For Mobile Robot Navigation*  
*Author(s)* : *Thokala Naveen Kumar*  
*Roll No* : *Y7104078*  
*Supervisor(s)* : *Behera Laxmidhar & Venkatesh KS*

***Abstract:***

The main focus of the thesis is devising the vision based target tracking algorithms for the mobile robot. In addition to the target tracking algorithms, sonar based obstacle avoidance algorithm has also been developed. This obstacle avoidance algorithm can be used in conjunction with the target tracking algorithm to make the robot to navigate in a cluttered environment. The contributions of this thesis may be enumerated as follows: • We presented novel control strategies for tracking an object with a mobile robot similar to human being. It is shown through experimentation that the classical PD controllers are not suitable for tracking a moving target like a human being and is slow and frequently misses the target. To overcome these limitations, Fuzzy based PD control strategies are proposed such that the robot mimics a human motion while tracking a target in efficient manner. The velocity of the robot is computed directly from the image feature instead of pose space. The proposed control schemes are successfully implemented on a mobile robot (PatrolBot). • We proposed a novel method of object tracking in cluttered environment for mobile robots using T-S fuzzy models. The modeling of uncertain and dynamic environment is an important and challenging problem in mobile robotics. Nonlinear dynamic systems can be represented as Takagi-Sugeno (T-S) fuzzy models, with linear or affine consequence. We developed two separate T-S fuzzy controllers for target tracking and obstacle avoidance. The model has been tested on a PatrolBot which tracks a ball using a camera and avoids obstacles using six sonars

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*Title* : *Fault Diagnosis Of Internal Combustion Engines Using Empirical Mode Decomposition And Neural Networks*  
*Author(s)* : *Nidadavolu S V P Sankar*  
*Roll No* : *Y7104069*  
*Supervisor(s)* : *Kalra Prem Kumar*

***Abstract:***

Condition Monitoring is the process of monitoring a parameter of condition in machinery, such that a significant change is indicative of a developing failure. The use of conditional monitoring allows maintenance to be scheduled, or other actions to be taken to avoid the consequences of failure, before the failure occurs. Many automobile industries in our country use condition monitoring as a quality control mechanism. Online condition monitoring increases the reliability of the process. Fault diagnosis is at the heart of the condition monitoring procedure. This idea leads to the research in the area of fault diagnosis of internal combustion engines using empirical mode decomposition and neural networks. With the rapid development of signal-processing technique, the sound emitted from an internal combustion engine can be used in condition monitoring and fault diagnosis because they always carry the dynamic information of the machine. This process of fault diagnosis using acoustic signatures involves five main stages: Capturing the audio signatures of the healthy as well as faulty engines, decomposing the captured audio signals into many single monotonic functions called intrinsic mode functions, removing the noise content from the selected intrinsic mode function-also called pre-processing the data, extracting features from the pre-processed data using several frequency domain and time-frequency domain techniques, and finally using the feature data set for training and testing the neural network classifiers. Wavelet analysis technique, an important time-frequency analysis technique, and Fast Fourier Transform (FFT), an important frequency analysis technique, have been used for extracting the feature data set. Feed-forward neural network classification techniques, back-propagation and radial basis function networks, are used as neural network classifiers in this fault diagnosis procedure.

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*Title* : *Electromagnetic Analysis Of Induction Motor Drive System With Field Oriented Control*  
*Author(s)* : *Gutlapalli Chiranjeevi*  
*Roll No* : *Y7104016*  
*Supervisor(s)* : *Das Shyama Prasad & Gupta Nandini*

***Abstract:***

Induction motors are commonly used in industrial applications because of their high torque-to-weight ratio and robustness. The optimal design of a three-phase induction motor must pass through the stage of manufacturing tests that enable a reliable check of their basic characteristics. This requires additional investment and time. The expenses can be significantly reduced if during the design process, through advanced level simulation methods to assess the performance of the motor. In the context, a detailed electromagnetic analysis of the machine could be performed at the design stage. The finite element method currently represents the state of the art in the numerical magnetic field computation relating to electrical machine. In the present work 2D and 3D transient analysis of an induction motor is done using Maxwell simulation software and results are observed. Subsequently, a voltage source inverter-fed induction motor drive under field oriented control (also known as ‘vector control’) is simulated. System level simulation is performed on the induction motor drive. The aim of this simulation is to provide a combined simulation environment capable of modeling and analyzing the interaction between induction motor and the control circuit. For that purpose the drive circuit is implemented for induction motor with rotor flux oriented indirect vector control and the interaction analysis done using Simpler in conjunction with Maxwell. Field and circuit equations are solved by indirect coupling technique. Simulation is carried out both without and with load and results are observed. The simulation results are found to be satisfactory.

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**Title** : *Statistical Methods Based Classification In Condition Based Monitoring Of Internal Combustion Engine*  
**Author(s)** : *Shah Brijeshkumar Jayeshkumar*  
**Roll No** : *Y7104071*  
**Supervisor(s)** : *Kalra Prem Kumar*

***Abstract:***

Internal Combustion Engine (IC engine) being a rotating machine emanates noise which is mixture of various frequency component generated by rotation of various engine parts. Any defect in this engine parts give rise to different noise signature. On the similar way it is true for vibration. These are the two major indicators of presence of fault in engine. Fault in engine part may have occurred during manufacturing time or during regular running because of wear and tear. Some automobile industries and service stations use human expertise to identify the health of IC engine, which is subjective to human error. If this process is automated, losses due to error and labor cost can be reduced. As a part of automation of the process of identifying faults this thesis proposes a Condition Based Monitoring for health monitoring of IC engine. Six major faults were considered for this purpose and the seventh type is good engine naturally. Data Collection was done at M/s TVS Motors Pvt. Ltd. and Electrical Department workshop, IIT Kanpur, with Integrated Electronic Piezoelectric enabled unidirectional Industrial Microphone and uniaxial accelerometers. Collected data than preprocessed and clipped for suitable number of sample in each signature. Classification methods are purely statistical methods i.e. Linear Discriminant Analysis, Principle Component Analysis and Auto/Cross Correlation based methods. Results achieved are satisfactory for collected data; however it is found that accuracy of the algorithm is dependent on surrounding conditions of the engine testing area.

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***Title*** : ***Fault Diagnosis Of Internal Combustion Engines For Manufacturing Automation***  
***Author(s)*** : ***Chinnam Ravi Sankar***  
***Roll No*** : ***Y7104015***  
***Supervisor(s)*** : ***Kalra Prem Kumar***

***Abstract:***

Condition monitoring of IC engines is an important stage in the manufacturing process of any automobile industry. It improves quality, productivity and hence, profit to the industry. Condition monitoring applications deploying the usage of impact acoustic techniques are mostly done intuitively by skilled personnel. But to make the process more robust, accurate and reliable, there is a need to automate such intuitive human skills. This leads to the research in the area of intelligent fault diagnosis. An intelligent fault diagnosis process involves three stages primarily: Data acquisition, feature extraction and classification. As a part of data acquisition process, the sound emanating from different faulty engines (including normal) and vibrations induced due to defectiveness are captured and measured using different sensors and Data acquisition system. The preprocessed acoustic signatures were analyzed in time-domain, frequencydomain and time-frequency domain for extracting different features from the signals. Different feature sets analyzed and extracted from different domains were passed to the classifiers. The classifiers were implemented based on Adaptive Resonance Theory (ART) using both unsupervised ART & supervised ART networks. Results for different features, different sensors & their positions and different classification techniques were evaluated and compared.

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**Title** : *Finite Element Analysis (FEA) Application For Induction Moto(IM) And Brush-Less DC Motor (BLDCM)*  
**Author(s)** : *Gudivada S R Naga Rajesh*  
**Roll No** : *Y7104068*  
**Supervisor(s)** : *Das Shyama Prasad &Gupta Nandini*

***Abstract:***

The finite element analysis (FEA) method is a numerical technique that can be applied for electromagnetic analysis of complex geometrical electrical machine structures. In this thesis, 2D transient finite element analysis and 3D transient finite element analysis are applied to induction motor (IM) and brush less DC motor (BLDCM) and the performances of both the machine are simulated using Maxwell. Initially, transient analysis is performed for IM and BLDCM. The main problem in 3D transient analysis is optimized initial mesh generation, which plays a prominent role in reducing computational time without affecting accuracy. A hybrid magneto static coupled initial mesh generation method is proposed. Both manual mesh refinement method and hybrid magneto static coupled method are applied to 3D transient analysis of BLDCM. An indirect procedure to couple transient finite element simulation with circuit simulation is proposed. The procedure is based on extracting lumped parameters from the field simulation and Norton equivalents from the circuit simulation. This is implemented by using Maxwell and SIMPLORER, and applied to V/f controlled IM drive and BLDCM. To reduce computational time in system level simulations, indirect interaction analysis method is used. By creating equivalent circuit models for electromechanical devices, and by using electrical analogs for mechanical subsystems, it is possible to perform accurate parametric design studies. This is implemented by using Maxwell and SIMPLORER, and applied to rotational actuator and BLDCM

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*Title* : *Transmission Cost Allocation Using Power Flow Tracing Method*  
*Author(s)* : *Gupta Pratibha*  
*Roll No* : *Y7104062*  
*Supervisor(s)* : *Singh Sri Niwas & Srivastava S C*

***Abstract:***

With the increasing trends of restructuring in electricity industry, a competitive market is being created to provide cheap power and offer more choices to the customers. An ideal competitive market should, in theory, allow any generator to supply any customer and should place no constraints on the transaction. In the deregulated countries, regulators are continuously striving to achieve the goal of providing an efficient, reliable and economic electricity service. Fair competition among producers can be achieved, if the transmission of electrical energy treated as a separate business. In deregulated environment, the pricing of the use of transmission system, which is satisfactorily allocated among the involved parties, has become one of the major issue. Several strategies for transmission pricing have been proposed but there is no clear evidence on which one is better in providing adequate economic signal to the different utilities. In this thesis, different transmission pricing methodologies and international experience of the transmission pricing are discussed. In the last section of work, power flow tracing method to trace the path of power flow, operating and embedded cost allocation using this tracing method have been carried out. Locational marginal prices of the buses also calculated using tracing method. Locational marginal prices are used to calculate operating costs. Postage stamp and MW-mile method are used to calculate embedded costs of the lines. The methods discussed have been successfully simulated on 39-bus, 10-machine, New England system.

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*Title* : *Application Of Artificial Intelligence In Designing An Auto Accompaniment For Guitarists*  
*Author(s)* : *Kumar PJanand*  
*Roll No* : *Y7104056*  
*Supervisor(s)* : *Kalra Prem Kumar*

***Abstract:***

Music scene description is an interesting field, one that requires AI techniques to replicate the human perception and capability. The definite connection between music and the emergence of human intelligence has been speculated for a long time. Exploring its realms would therefore rightfully give it the much needed attention it deserves in unravelling the complexity of the human mind. Towards this end an attempt to replace human musical accompaniers with intelligent systems is considered to be an interesting challenge in the AI community and this thesis is an effort to contribute in that direction. A new strategy for extraction of tempo from a polyphonic music track is suggested which exploits the fact that the tempo of music is preserved even when the track is played reversed but peaks related to the melody, chord and other parameters are however misplaced. This indicates that when superimposed with the original track the repetitive beats will stand out prominently thus eliminating the ambiguity in peak picking and the in thresholding during tempo extraction. The track is first processed through a gamma-tone filter and the best bandwidth is chosen dynamically to improve the accuracy of the algorithm. Further rectangular fuzzy numbers are used to capture the uncertainties in the location of the peaks. Based on the tempo and the inter-beat interval the chord recognition and automatic labelling is carried out with a 36 bin chroma vector as the feature and Hidden Markov Model (HMM) as the classifier. The information thus obtained can be used to direct and conduct the musical accompaniment in an interactive manner.

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**Title** : *Loss Minimization In Electrical Distribution Systems Through Optimal Network Reconfiguration And Allocation Of Distributed Generation*  
**Author(s)** : *K Udaya andrika*  
**Roll No** : *Y7104033*  
**Supervisor(s)** : *Srivastava S C & Singh Sri Niwas*

**Abstract:**

Electric power utilities have recently become more concerned towards reducing the network losses, specifically at distribution level. One of the effective operational measures to reduce the distribution system losses is through network reconfiguration. The optimal Distribution Network Reconfiguration (DNR) is formulated to minimize the network losses under system constraints, which is a complex nonlinear optimization problem. This thesis has applied four versions of Particle Swarm Optimization (PSO) technique to solve the DNR problem, which include the Normal PSO (NPSO), Constriction Factor Approach (CFA) based PSO, PSO with Time Varying Acceleration Coefficients (PSO\_TVAC), and Crazy PSO (CPSO). There has been an increasing trend to install Distributed Generators (DGs) in the distribution networks. However, to gain the benefits of the DGs, these must be installed at optimal locations and of optimal sizes. This thesis has suggested five different sensitivity factors to rank the buses and have utilized Analytic Hierarchy Process (AHP) based method to find the overall ranking of the buses for the optimal placement of DGs. A PSO based method has been suggested to determine optimal size of DGs, considering their different penetration levels. The optimal DNR results are also obtained with the optimally placed DGs. The effectiveness of all the above methods have been established on 16-bus and 33-bus distribution test systems. Considerable reduction in loss and improvement in voltage profile have been observed through optimal DNR and placement of DGs. Out of the four PSO methods applied to the DNR, the CPSO is found to be the most effective.

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**Title** : *Modeling And Control Of Grid-Connected Photovoltaic System Using PSCAD/EMTDC*  
**Author(s)** : *Sakamuri Jayachandra Naidu*  
**Roll No** : *Y7104067*  
**Supervisor(s)** : *Singh Sri Niwas & Srivastava S C*

### **Abstract:**

In recent years, lack of adequate transmission capacity, limitations in constructing new transmission lines, growing concern to the environment and emerging electricity market structure have led to the increased use of Distributed Generation (DG), in the form of smaller size generators installed at the power distribution level close to the end users. Many DG systems employ renewable resources for electricity generation and, thus, help in mitigation of the adverse environmental impacts, being experienced due to the fossil fuelbased centralized generating plants. Among the renewable DG systems, Photo-Voltaic (PV) solar systems have attracted considerable attention and investment in several countries. The installation of low (<10kW) and medium (<100kW) power PV generation systems is, particularly, increasing at the Low Voltage (LV) distribution networks. Power outputs of PV arrays depend on solar insolation, atmospheric temperature and the voltage level at which it is operating. The process of extracting maximum power from the PV array by adjusting its terminal voltage is called Maximum Power Point Tracking (MPPT). In this thesis, low (5.6kW), and medium power (32.5kW) PV arrays have been considered for integration at the 1-Phase and 3-Phase lines of the LV system, respectively, using two-stage (DC-DC boost converter and DC-AC voltage source inverter) configuration of the PV system. The DC-DC boost converter is responsible for boosting the voltage and ensuring MPPT of the PV array. The Voltage Source Inverter (VSI) controls its output current to remain in phase with the grid voltage to supply power at unity power factor. The controllers for Grid-Connected Photovoltaic System (GCPS) have been designed using PI and K factor methods to achieve the unity power factor operation. With the K factor control, one can select phase margin of the controller to get the desired transient response. The GCPS transient response to grid faults, voltage swells/sags and varying atmospheric conditions have been studied in this thesis. The simulation results are obtained using PSCAD/EMTDC, which is industry standard power system simulation software.

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***Title*** : ***Wind,Thermal And Hydro Unit Commitment Using Advanced Particle Swarm Optimization Techniques***  
***Author(s)*** : ***Yadagiri Jinijirala***  
***Roll No*** : ***Y7104029***  
***Supervisor(s)*** : ***Singh Sri Niwas***

***Abstract:***

Wind power is popular form of the renewable energy sources and has been proved as potential source of electricity generation with minimal environmental effects. Modern wind farms can produce a sustainable amount of power, which can supplement the base power generated by thermal, nuclear or hydro power plants, when they are integrated into the grid. However, the intermittency and unpredictability of wind power generation creates difficulty in control of frequency and scheduling of generation. It can be expected that many problems will arise in the renewable-energy based hybrid power system, particularly in system operation and ancillary services. With increasing wind power penetrations in power systems, scheduling of additional emergency reserve will be needed to maintain an adequate level of supply security. Apart from the up spinning reserve requirements, there are strong demand for enough down spinning reserve requirements. Development of better wind, thermal and hydro coordination algorithm is necessary to determine the optimal proportion of wind, hydro and thermal generator capacity that can be integrated into the system. In this work, four versions of Particle Swarm Optimization (PSO) techniques are proposed for solving wind, thermal and hydro coordination problem. A pseudo code based algorithm is suggested to deal with the equality constraints of the problem for accelerating the optimization process. The simulation results show that the proposed PSO method was indeed capable of obtaining higher quality solutions efficiently in wind, thermal and hydro coordination problems.

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*Title* : *Strategies For CO2 Mitigation From Power Sector*  
*Author(s)* : *Bhesaniya Mukeshkumar Mohanbhai*  
*Roll No* : *Y7104048*  
*Supervisor(s)* : *Kalra Prem Kumar*

***Abstract:***

Climate change is currently one of the most pressing environmental issue facing the international community and individual governments. India as a developing country doesn't have any binding obligations to reduce CO2 emission but as India develops, its energy usage is bound to increase and therefore carbon emissions will rise in the years to come. Much of the current policy focus in Indian power sector is related to the nature and impact of on-going electricity restructuring and reforms. While these are important issues, there has been less attention paid to attract sufficient investment in renewable and high efficiency generation technologies for CO2 mitigation. One emerging question faced by power sector is how to reduce CO2 emission at a low/affordable cost. Obviously, internal actions such as improving energy efficiency and applying new technologies might play an important role in the short term. However, it is really not easy and also unrealistic to meet the targets by solely relying on their own efforts as, simply speaking, the abatement cost after certain level is very high. The main objective of this thesis work is to find out the possibilities to reduce CO2 emission with a lower mitigation cost in India such that the effect of CO2 reduction on power pricing is minimized. Three CO2 mitigation options in the electricity sector are accessed. These encompass the pricing model aiming at efficiency improvement, carbon trading scheme and Carbon Capture & Sequestration (CCS) of emitted CO2. Further the carbon trading model was combined with conventional Economic Dispatch and analyzed the performance of the system. The results show that it is possible to reduce the CO2 emissions from power sector at lower cost through carbon trading schemes. However, it is important to preserve the competitiveness of power industry. Therefore, internal abatement should also be encouraged since they can further improve the efficiency and promote the discovery of new technologies for creating a more sustainable energy supply both from an economic and an environmental point of view.

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*Title* : *Harmonic And Reactive Power Compensator For Alternator In ADiesel Locomotive*  
*Author(s)* : *P Vinay Ranganath*  
*Roll No* : *Y7104057*  
*Supervisor(s)* : *Das Shyama Prasad*

***Abstract:***

In a diesel-electric locomotive, the diesel engine drives an alternator whose output provides power to the traction motors through a three phase diode bridge rectifier. The supply current of the alternator feeding a rectifier load has several harmonics. As a result, losses in the alternator increase leading to heating of its windings and hence reducing its life. In this thesis, two level and three level active filters are designed for the alternator to eliminate these unwanted harmonics and to compensate the reactive power of the load. It is made sure that the source current is sinusoidal and is in phase with the induced emf of the alternator. Different modes of operation of the three phase diode bridge rectifier are analyzed and their effect on alternator's terminal voltage and current are discussed. The alternator is simulated with both linear and non-linear loads. Active filters are designed with two level and three level hysteresis current controllers and the advantages of three level active filter over two level active filter are studied. Further, an adaptive hysteresis current controller is designed for both two level and three level active filters, which makes the switching frequency constant. This provides predictability of the converter input harmonics and thus makes the filter design task easy.

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***Title*** : ***Multilayered Background Models Of Static Camera Data For Summarization, Compression And 2.5D Analysis***  
***Author(s)*** : ***Kethineedi Durga Prasad***  
***Roll No*** : ***Y7104031***  
***Supervisor(s)*** : ***Venkatesh K S***

***Abstract:***

The aim of surveillance video summarization is to automatically identify high-value information events in a video stream and to present them to a user. Video information is invariably extremely heavy and hence time consuming to view and summarize as well as space consuming to store. We utilize the particular properties of static camera-captured surveillance videos to develop efficient techniques for summarization, compression and high level analysis. By extracting the foreground objects in static camera video, we develop a method by which the entire video can be viewed in much lesser time without losing a feel of continuity. Besides the summarization, to process huge volume of data efficiently in video surveillance system, it is very necessary and important to find out advanced video compression techniques. Here we present an improved video compression algorithm, which eliminates the redundancy in the frames before processing through any standard video encoder. This process reduces enormously the storage space required for the raw video. It is achieved by updating the background based on the stationarity of the foreground objects from which multi-layered background models are prepared. The thesis also includes a 2.5D analysis of the static camera video with the help of the extracted stationary foreground objects and processing these objects with different morphological operations.

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***Title*** : ***Design Of A Near Lossless Video Codec Using Implicit Motion Model And Spatiotemporal Regularity Flow***  
***Author(s)*** : ***Marathe Manohar Anandrao***  
***Roll No*** : ***Y7104046***  
***Supervisor(s)*** : ***Gupta Sumana***

***Abstract:***

The importance of implicit motion model and spatiotemporal regularity ow (SPREF) are well established in recent times. In view of the difficulties with existing explicit motion estimation and segmentation paradigm, we have proposed an alternative framework for video coding based on implicit motion model and SPREF. The implicit motion model, when used in backward adaptive fashion, is the most efficient tool for exploiting redundancies in video data. However, this model is effective only for slow motion and its performance degrades with motion contents in a video. The spatiotemporal adaptation is an effective tool to improve the capability of implicit motion model where the parameters are adaptively selected from the motion properties of a video. The spatiotemporal feature SPREF has ability to model the motion well; it has the advantage of computational simplicity and compact representation as desired in video coding applications. In the propose framework, we achieve spatiotemporal adaptation using the motion dependent T-SPREF (i.e. xy-parallel SPREF). We have designed a video codec based on this new framework. Experimental results are presented which demonstrate the effectiveness of the proposed codec for lossless/near lossless video compression. At low bit rates, however, the efficiency of proposed codec degrades fast due to susceptibility of backward adaptive approaches to quantization noise

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*Title* : *Design Of An Efficient Space Time Video Completion  
Algorithm For Grey Scale And Color Videos*  
*Author(s)* : *Tiwari Aditya*  
*Roll No* : *Y4177036*  
*Supervisor(s)* : *Gupta Sumana*

***Abstract:***

Many important events of the past that are of historic, political and cultural significance have been recorded in media which are susceptible to degradation. The quality of the stored films media gets is reduced after repeated usage. Re-using of these old film and video material is however only feasible if the visual quality meets the standards of today. Most of the old video materials are grey scale videos. In this thesis in this Space-Time Completion algorithm for grey scale videos is presented. An efficient completion method is also proposed which can be used for both color and grey scale videos. It reduces the computation time of the Space time algorithm to a great extent. In Space-Time Video Completion Algorithm the missing portions (holes) are filled in by sampling of spatio-temporal patches from the available parts of the video, while enforcing global spatio-temporal consistency between all patches in and around the hole. This algorithm is very effective in restoring the video artifacts but the Time Complexity is large and this has not been implemented for grey scale videos. We propose a Space-Time Video Completion for Grey Scale Videos. In this algorithm two spatial (in x & y directions) and one temporal (in t direction) gradients of the intensity are used along with the intensity value to obtain 4 dimensional pixel value representation for a pixel. The missing portion is filled in by sampling of spatio-temporal patches from the available parts of the video, which are the best similar space-time patches considered around the missing pixel. The 4D pixel representation is used to get the perceptually best similar space time patch for a given space time patch. We also propose an efficient Space-Time video completion Algorithm to reduce the time complexity of the existing Space-Time video completion algorithm. In the proposed algorithm, instead of considering all the space time patches containing the corrupt pixel during the search process, we search for a lesser number of space time patches around the centre pixel and around the boundary points of the centre space time patch. In this way we reduce the number of searches and hence the number of computations

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*Title* : *Design Of Error Correcting Codes For Deep Space Optical Communications*  
*Author(s)* : *Joshi Nikhil Anil*  
*Roll No* : *Y7104030*  
*Supervisor(s)* : *Banerjee Adrish*

***Abstract:***

The deep space channel is characterized by constraints on transmitter weight and transmit power. Power efficient modulation schemes like pulse position modulation (PPM) are used to overcome the average power constraint. For intensity modulated (IM) direct detection (DD) scheme, optical channel can be modeled as a Poisson point process. Bit interleaved coded modulation techniques are devised to achieve high performance for deep space optical links. The serial concatenation of a convolutional code with an accumulator-PPM (SCPPM) and the serial concatenation of turbo code with an accumulator-PPM (TAPPM) are the two bit interleaved coded modulation techniques that outperform previously proposed schemes like LDPC-APPM and RS-PPM. 'Accumulator+PPM' acts as an inner code while convolutional/turbo code acts as an outer code. At the receiver end joint demodulation and decoding is performed iteratively by soft input soft output (SISO) demapper and SISO MAP decoder for convolutional/turbo codes. In case of TAPPM local turbo iterations between two constituent decoders are performed in addition to the iterations between the inner and the outer decoders. In this work, extrinsic information transfer(EXIT) charts are used as a framework for the analysis of SCPPM and TAPPM schemes. EXIT charts characterize mutual information transfer characteristics for a decoder. Convergence behavior of the SCPPM and TAPPM schemes is explained with help of EXIT charts, also the signal-to-noise ratio (SNR) threshold beyond which these iterative decoder will fail to converge is calculated. The convergence analysis is carried out for different convolutional/turbo codes used in SCPPM/TAPPM schemes to calculate their SNR thresholds. We propose a new convolutional encoder for SCPPM scheme. The resulting scheme outperforms the existing SCPPM and TAPPM schemes. We also studied the effect of choice of different constituent encoders on the performance of TAPPM scheme. Finally the effect of the ratio of local turbo iterations to inner-outer iterations for TAPPM scheme is studied using decoding trajectory as a tool. It's found that as we increase the iterations ratio between the outer and inner decoder, TAPPM decoder converges at lower SNR value.

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*Title* : *Application Of Turbo Codes For Geosynchronous Satcom*  
*Author(s)* : *Sahu Yugal Kishor*  
*Roll No* : *Y7104090*  
*Supervisor(s)* : *Vasudevan Kasturi*

***Abstract:***

Turbo codes have been a revolution in the coding theory domain. It is the coding technique which comes very close to the information capacity limit given by Claude Shannon. In this work we have applied this exciting coding technique for designing a communication system for geosynchronous satcom channel. Geosynchronous satellites are very far away from the surface of the earth and onboard power available is limited. Hence signal-to-noise ratio (SNR) received at the earth station is very low. So we need to design a communication system that can work effectively at these low SNR values. This thesis work is a part of above project. Basic communication system, with non-ideal conditions of random timing, random phase and frequency offset on additive white Gaussian noise (AWGN) channel has already been designed. The task of this work is to implement turbo codes on the basic communication system and obtain overall performance. The calculations of forward and backward recursions have been done in logarithmic domain which is simpler than probability domain version. The performances in both domains are almost comparable with logarithmic domain version showing error floor at higher SNRs due to approximations involved. Performance of turbo codes greatly depends upon the type of interleaver used. We have observed the performance of turbo code under different type of interleavers of different lengths. Encoder termination is also important. We have studied some encoder termination techniques and observed their performance. Overall performance of turbo code is sensitive to timing and frequency offsets. With the help of simulations, this dependency has been shown

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***Title*** : ***Mathematical Modeling Of Optical Burst Switch Network Protocol Alongwith Performance Analysis Of Contention Resolution Algorithm***  
***Author(s)*** : ***Tiwari Brijesh Singh***  
***Roll No*** : ***Y7104012***  
***Supervisor(s)*** : ***Singh Yatindra Nath***

***Abstract:***

Optical burst switching (OBS) is a technology positioned between wavelength routing and optical packet switching that does not require optical buffering or packet-level parsing, and it is more efficient than circuit switching when the sustained traffic volume does not consume a full wavelength. A simplified mathematical model for evaluating the performance of optical burst switching networks is proposed. This model is described using a detailed state diagram. A performance measure, viz, average blocking probability, is derived based on the equilibrium point analysis technique. The effects of several design parameters on the above performance measures have been examined with simulations. Although the simulator is verified with the aid of numerical results obtained from mathematical analysis. OBS is an effective technology to handle large number of packets with less processing at nodes. Although it has issues such as contention resolution without optical buffering, which are critical to its performance. Deflection routing is an approach for resolving contention by routing a contending burst to an output port other than the intended output port. In OBS networks, when contention between two bursts cannot be resolved through deflection routing, one of the bursts will be dropped. However, this scheme doesn't take advantage of all the available resources in resolving contentions. Due to this, the performance of existing deflection routing scheme is not satisfactory. In this thesis, we propose and evaluate a new strategy which aims at resolving contention. The performance of our scheme and of those proposed in the literature is studied through simulation. The parameter considered in evaluating these schemes is blocking probability. The results obtained show that our scheme performs significantly better than their standard counterparts

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*Title* : *Modification Of Congestion Control Protocol Based On Delay Parameters For Layered Multicast Communication For Variable Packet Size*  
*Author(s)* : *Surya Rao Amballa*  
*Roll No* : *Y7104005*  
*Supervisor(s)* : *SinghYatindra Nath*

***Abstract:***

Multi-Rate Multicast Congestion Control (MR-MCC) is most suitable protocol to tackle the multicast congestion control problem in huge and heterogeneous networks. The design of MR-MCC with responsiveness, efficiency of network utilization, low packet loss, scalability and fairness including intra-protocol fairness, inter-protocol fairness as well as feasible implementation is very important. This thesis is concerned with the Modification of Congestion Control Protocol Based on Delay Parameters for Layered multicast Communication for variable packet size. The general multimedia application may not have the property of equal packet size. So, the modified congestion control protocol is implemented with variable packet size by estimating the available bandwidth using One-Way Delay trend by sending the probes periodically. It is implemented in Drop-tail queuing, which is most commonly used queuing scheme. Modified congestion control protocol is simulated in network simulator (ns-2). Simulations shows, the protocol is TCP-friendly, stable, scalable and intra-protocol fair..

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*Title* : *Gain Dynamics Of EDFA In Loop Buffer Switch*  
*Author(s)* : *Gupta Vinamra*  
*Roll No* : *Y7104086*  
*Supervisor(s)* : *SinghYatindra Nath*

***Abstract:***

Tremendous growth of communication technology had been seen in the past century. This growth gives rise to hunger of more and more bandwidth which further fuels the growth of communications. At the beginning of 21st century we are facing the challenges of not only increasing the bandwidth but also using it efficiently. The backbone traffic can be effectively managed by using Optical Fibers and Dense Wavelength Division Multiplexing (DWDM). But for further increase in the bandwidth there is a need of all-new Optical Networks. The Photonic Packet Switching (PPS) is the first step in the evolution of such networks and optical packet switching architecture are integral part of PPS. In these OPS architectures physical loss is compensated by Erbium Doped Fiber Amplifier (EDFA). This thesis investigates the effect of EDFA gain dynamics on packet recirculation in the recirculating loop buffer of Broadcast-and- Select Type packet switch. The effect of EDFA gain dynamics is observed for ATM and KEOPS packet formats. A Simulink model has been developed to simulate the behaviour of EDFA.

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*Title* : *Study Of Removal Of Loopback In p Cycles For Dynamic Traffic*  
*Author(s)* : *Umair Mohammad*  
*Roll No* : *Y7104047*  
*Supervisor(s)* : *SinghYatindra Nath*

***Abstract:***

Optical networks have seen an unprecedented growth since their inception owing to the large bandwidth and low loss offered by them. Today they are carrying enormous traffic including voice, data and various other real time applications. In this scenario the survivability of optical networks is of critical importance. Various schemes have been proposed to provide protection and restoration of these networks. One of the techniques, p-cycles, has successfully combined the advantages of restoration speed and capacity efficiency and hence is widely used. However p-cycles suffer from longer restored path lengths which can be possibly reduced by the removal of loops. Earlier work has considered removal of loopbacks in static traffic. In this thesis, we have implemented the loopback removal algorithm for dynamic traffic scenario and analyzed the impact of reduction in path-length on the protection performance. A simulator has been developed and the modified algorithm has been simulated for COST239 and NSF networks. The results show significant reduction in the length of the restored paths. This also reduces the capacity used up in restoration

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*Title* : *Discrete Time Implementation Of MSK*  
*Author(s)* : *Dubey Sumit Kumar*  
*Roll No* : *Y7104075*  
*Supervisor(s)* : *Vasudevan Kasturi*

***Abstract:***

Digital communication system are gaining a popularity because of the need for information transfer and information processing in the present day world. The ever increasing demand for digital transmission channel for radio frequency (RF) band presents a potentially serious problem of spectral congestion and is likely to cause severe adjacent and co-channel interference problem. There are wide variety of techniques for solving the problem of spectral congestion. 1. better management of existing allocation; 2. the use of frequency reuse techniques; 3. the use of efficient source encoding techniques and 4. the use of spectrally efficient modulation techniques. This thesis we consider last approach and analyse the modulation scheme known as minimum shift keying(MSK). Though Gaussian Minimum Shift Keying is spectrally more efficient, we consider only MSK because of its implementation simplicity. Among the various method for bandwidth conservation and the efficient use of the available bandwidth, we have the minimum shift keyed modulation technique, which has the advantage of a compact bandwidth associated with constant carrier amplitude and continuous phase modulated signal. In this report bit error rate (BER) performance of the minimum shift keying (MSK) system for both the coherent and non coherent communication is given.

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*Title* : *Timing And CFO Estimation In Multiuser MIMO-OFDM Systems*  
*Author(s)* : *Routhu Uma Maheshwara Rao*  
*Roll No* : *Y7104066*  
*Supervisor(s)* : *Chaturvedi Ajit Kumar*

***Abstract:***

The problem of data aided timing and carrier frequency offsets (CFO) estimation in multiuser multiple-input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) systems is considered. Optimal training sequences for CFO estimation are proposed. Closed form Cramer Rao Bounds (CRB) for joint estimation of timing, CFO and channel are derived. Asymptotic Cramer Rao Bound (ACRB) for CFO estimation is derived and minimized to get the optimal training sequence with the goal of achieving minimum estimation mean square error. Joint Maximum Likelihood (ML) estimator and a low complexity estimator based on space-alternating generalized expectation-maximization (SAGE) algorithm are proposed for the estimation of timing, CFO and channel response. Fractional timing offset is also considered in this work. Closed form expressions for bit error rate (BER) of SISO OFDM systems in the presence of both fractional timing offset and CFO are derived in additive white gaussian noise (AWGN), Rayleigh flat fading and frequency selective Rayleigh fading channels for BPSK modulation scheme. Our simulation results illustrate the accuracy of the theoretical analysis

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*Title* : *Semi Blind Channel Estimation In Of Dm Systems*  
*Author(s)* : *Munagala Rakesh*  
*Roll No* : *Y7104049*  
*Supervisor(s)* : *Vasudevan Kasturi*

***Abstract:***

With the rapid growth of digital communication in recent years, the need for high speed data transmission is increased. Moreover, future wireless systems are expected to support a wide range of services which includes video, data and voice. Orthogonal frequency division multiplexing(OFDM) is a promising candidate for achieving high data rates in mobile environment, due to its resistance to ISI, which is a common problem found in high speed data communication Channel estimation using pilots is commonly used in OFDM systems, where pilots are usually time division multiplexed with information sequence. However pilots introduce overhead and reduce bandwidth efficiency. It is shown that bandwidth efficiency can be preserved at an expense of increase in the transmitted power. The additional transmitted power is used to send a known pilot sequence hidden in the information sequence. Pilots are arithmetically added to the output of OFDM modulator. Receiver uses the hidden pilots to get accurate estimate of the channel. The pilots are removed after the channel estimation

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*Title* : *Performance Analysis And Improvement In Receive Diversity As A Function Of Dwell Time*  
*Author(s)* : *Agarwal Pratibh*  
*Roll No* : *Y4177302*  
*Supervisor(s)* : *Chaturvedi Ajit Kumar*

***Abstract:***

The performance of DPSK modulation is analyzed for a time-varying channel in the presence of an imperfect antenna selection at the receiver. The performance is analyzed as a function of Dwell Time, the time between consecutive selections. A new scheme is introduced for retaining the selected channel for different Dwell Times depending upon the magnitude of the channel at the time of selection. The new scheme improves the performance without any increment in the switching rate.

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*Title* : *On Variations Of Sliding Window Lempel-Ziv Compression Algorithm And Their Redundancy Rates*  
*Author(s)* : *Jain Ankit*  
*Roll No* : *Y4177070*  
*Supervisor(s)* : *Bansal Rakesh K*

***Abstract:***

Lempel-Ziv codes are probably the most widely studied class of weakly universal codes. They appear in almost all data compression packages which in turn , have widespread applications. A brief theoretical survey on the universality and redundancy rate of various versions of the Sliding Window Lempel-Ziv(SWLZ) data compression algorithm has been documented and presented. We articulate few open problems in this context and attempt to arrive at a partial answer and present the theoretical insights developed in the process. An empirical study on six different versions from this family of codes is conducted to establish the validity of theoretical claims in practical applications.

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*Title* : *Serially Concatenated Turbo Codes Over The AWGN Channel*  
*Author(s)* : *Kodi Deepthi*  
*Roll No* : *Y7104037*  
*Supervisor(s)* : *Vasudevan Kasturi*

***Abstract:***

In this thesis, the Bit Error Rate (BER) performance of a turbo receiver for serially concatenated turbo codes transmitted through the AWGN channel is studied, with an emphasis on the basic ideas and some of the practical details. According to the Shannon's theorem on the channel capacity of an ideal band-limited Gaussian channel, bit error rates as small as desired can be achieved as long as the transmission rate (R) through the channel (in bits/second) is smaller than the channel capacity(C). This can be achieved by using an appropriate encoding and decoding operation. For very low bit error rates, concatenated coding have become very popular. In this thesis, we use serial concatenation in which the FEC(Forward Error Correction) codec is broken up into an inner and an outer code. Inner and outer codes both are considered for encoding the input data stream. Both inner and outer codes are assumed to be rate-1/2 recursive systematic convolutional (RSC) codes that perform the channel error correction. The optimum turbo receiver consists of an inner maximum a posteriori (MAP) decoder and a MAP decoder for the outer code. The inner and outer MAP decoder operates on the trellis for the inner and the outer error-correcting code respectively. Each MAP decoder is implemented as a forward/backward algorithm operating on observations and soft inputs from the constituent MAP algorithm to produce a posteriori probabilities(APPs). The forward/backward algorithm is implemented efficiently and iteratively in calculating the branch metrics and hence the extrinsic information. Calculation of APPs is carried out in exponential domain and the individual bit/symbol probabilities are exchanged between the decoder pair. An algorithmic description and intuitive explanation of each of the steps involved in designing such a communication system is presented. Influence of various iterations on the system performance is examined through the simulation results. Performance comparison between PCTC (Parallely Concatenated Turbo Codes) and SCTC (serially Concatenated Turbo Codes) for same code rate i.e.1/4 is also studied in the simulation results.

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*Title* : *Optimum Detection Of Signals In Coloured Noise*  
*Author(s)* : *Ghunawat Rahul Kumar*  
*Roll No* : *Y4177320*  
*Supervisor(s)* : *Vasudevan Kasturi*

***Abstract:***

For uncoded signalling, symbol-by-symbol detector is optimum for white noise. It gives the best possible bit-error-rate performance for a given channel. Although most of the current literature deals with signal detection in additive white Gaussian noise (AWGN), in many practical situations, the noise is correlated. This correlation is usually due to the non-ideal nature of the receiver filters. Symbol-by-symbol detection proves to be a suboptimal technique in presence of such correlated noise. Optimum detectors for both uncoded and coded signalling in additive coloured Gaussian noise have been proposed earlier in the literature. In this thesis, we apply the proposed technique to specific examples and demonstrate the performance improvement over symbol-by-symbol detection. Whitening property of the prediction error filters is the basis of the proposed technique. Simulations are carried out for BPSK signalling in which the coloured noise is obtained by passing white noise through a filter. The computational complexity of PVA increases for higher order prediction filters and for bigger constellations. The improvement in performance by using the proposed method is demonstrated through SNR vs BER plots obtained using computer simulations.

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**Title** : *Multi-Mode And Dual-Mode Zero-Forcing Beamforming For MIMO Broadcast Channels With Limited Feedback*  
**Author(s)** : *Kadhe Swanand Ravindra*  
**Roll No** : *Y7104034*  
**Supervisor(s)** : *Chaturvedi Ajit Kumar*

***Abstract:***

We consider multiple-input multiple-output (MIMO) broadcast (BC) channels with limited channel knowledge at the transmitter due to quantized feedback. When transmitting to multiple users simultaneously, sum-rate of the limited feedback schemes is upper bounded even if the transmit power is increased, due to inter-user interference. In this thesis we propose a multimode scheme that optimally selects the users so that the sum-rate is maximized. Expressions for the signal-to-interference-plus-noise-ratio (SINR) distribution and the sum-rate are derived, and it is shown that the proposed scheme asymptotically achieves unbounded capacity growth when increasing the transmit power or when increasing the number of users, without requiring extra feedback bits. We also present an enhanced version of the multimode scheme which achieves higher sum-rate at the expense of little increase in complexity. Lastly, a simple dual mode scheme, which switches between the single user and multiuser modes, is proposed. We see that the dual mode scheme requires less feedback than multimode scheme and still performs comparably. We analytically determine the asymptotically preferable mode as the number of users and/or the transmit power increases. Simulation results are presented to verify the analysis.

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***Title*** : ***Estimation Of Carrier Frequency Offset And Fractional Timing Offset In OFDMA Systems***  
***Author(s)*** : ***Adhikary Ansuman***  
***Roll No*** : ***Y7104007***  
***Supervisor(s)*** : ***Chaturvedi Ajit Kuma***

***Abstract:***

We focus on the estimation of frequency offsets, sampling timing offsets and channel impulse responses in OFDMA uplink. ML estimation is done through SAGE (space alternating generalized expectation-maximization) method. Simultaneous estimation of frequency and timing offsets through a two dimensional search is broken down into two one dimensional searches and the MSEs of both the methods are compared. In addition, a closed form approximation for both the timing offset estimator as well as the frequency offset estimator is also obtained. It is shown that the estimators achieve a performance close to the Cramer Rao Bounds. The problem of designing optimum pulses for improving timing offset estimation is also addressed.

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*Title* : *Modeling Of Video Frames For Object Extracti Using Spatial Correlation*  
*Author(s)* : *Ray Vinayak*  
*Roll No* : *Y7104087*  
*Supervisor(s)* : *Sircar Pradip*

***Abstract:***

Object extraction forms a critical part of the object-based video processing. However, most of the techniques available concentrate only on surveillance and tracking. Normal video sequence does not have steady background and hence these techniques cannot be applied to them. In our work we propose an elegant method to model background and foreground based on histogram data. We use 2D continuous wavelet transform to spatially localize object and create object mask to approximate silhouette. With available histogram for object-pixels and background-pixels, we obtain probability density function by normalizing the area under histogram. In order to retain smoothness in our density function we use curve-fitting techniques to approximate the probability density function.

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*Title* : *Feature Tagged Incidence Graphs For Speech Processing*  
*Author(s)* : *A Srinivas*  
*Roll No* : *Y7104002*  
*Supervisor(s)* : *Rajesh Hegde*

***Abstract:***

A pattern classification task consists of identifying sub patterns some of which are more confusable than others. Feature Tagged Incidence Graphs(FIGs) are based on the intuition that humans examine more closely only those sub patterns that are most confusable in a very selective fashion. Although several techniques including CART analysis and Discriminative modeling, work on a similar principle, FIGs follow a two stage classification approach where the selective discrimination is done on only the most confusable patterns in the second stage. The design procedure for FIGs uses thresholds computed from normalized confusion matrices corresponding to a pattern classification task. Metrics used to compute the threshold include the conventional L1, L2 distance, KL divergence and also a new technique based on Dempster-Shafer Theory. These thresholds are used to group the most confusable patterns into subgroups which are further represented by an incidence graph. The most discriminative features for each such group are then calculated based on the Bhattacharya distance. These features are tagged to the Incidence graphs obtained in the previous stage to derive what are called the FIGs. In the testing stage we use a two stage identification process where the mapping of the classes is done to one of the FIGs, followed by a more closer examination within each group using only the selected features as tagged to the FIGs. Feature Tagged Incidence Graphs approach works with smaller dimensional features at each stage, as opposed to a single large feature vector. The proposed FIGs are applied to Speaker and Language identification tasks using the N-TIMIT and OGIMLTS databases respectively. Significant improvements in identification performance are noted.

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*Title* : *A New Color Video Compression Technique Using Key Frame Based Color Transfer*  
*Author(s)* : *Gude VaraPrasad*  
*Roll No* : *Y7104082*  
*Supervisor(s)* : *Gupta Sumana*

***Abstract:***

We propose a novel method for color video compression using keyframe based color transfer. In this method we achieve compression by discarding the color information of all the frames except that of selected frames, referred to as keyframes. We do preprocessing on the video to select the keyframes and enhance the compression capability of the codec. At the decoder, we restore the color of the luminance-only frames by transferring the color from the keyframes using color transfer technique. Both compression and color transfer is done in YCrCb space. In existing technique, every eighth frame is selected as a reference frame. As a result, for slow motion and fast motion videos, the number of reference frames selected is either too many or too less respectively. In this paper we have used the keyframe concept based on spatio-temporal color distribution. In the existing technique, the original standard encoder is modified to remove the color of the non-intra blocks, but the proposed method is completely independent of the codec used. The compression capability of a standard codec is improved by 20% to 50%, depending on the motion activity within the video. The PSNR is comparable to that obtained by standard codec. In the post-processing stage, we need to estimate the motion vectors for color transfer..

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*Title* : *Angle Of Arrival And Time Delay Estimation Of Known Signal In Multiplicative Noise*  
*Author(s)* : *Soni Atul*  
*Roll No* : *Y7104009*  
*Supervisor(s)* : *Sircar Pradip*

***Abstract:***

The problem of angles of arrival (AOA) and time delays (TD) estimation of multiple sources in multiplicative noise using an uniform linear array (ULA) of sensors is addressed. The problem is an example of wireless communication in fast fading channel where we want to localize the mobile station. We present two independent and computationally attractive estimators for each of the parameters, as well as we develop a method to couple these parameters for every source. The TD estimator is based on autocorrelation coefficients obtained from redundancy averaging of frequency sample autocorrelation matrix. Whereas the AOA estimator is based on correlation coefficients of time sample covariance matrix. The Cramer-Rao bounds for all the parameters are derived for the comparison of proposed estimators.

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*Title* : *IPSec-MOBIKE Based Fast Authentication Mechanism For Intra-Domain Handoff Scenario In WLANs*  
*Author(s)* : *Patil Ravikant Jaykumar*  
*Roll No* : *Y7104058*  
*Supervisor(s)* : *Singh Yatindra Nath*

***Abstract:***

Security services offered by Wireless local area networks (WLANs) are gaining constantly increasing importance as WLAN deployment extends to business and government environments. Original 802.11 standards provide Wired Equivalent Privacy (WEP) protocol to support security services. Various flaws were detected in this protocol making it insufficient to satisfy increasing security needs of WLANs. Internet Security protocol (IPSec) based Virtual private networks (VPNs) is one of the most popular overlay solution used over WLAN which provides required security services. Another comparable solution is 802.11i security standards released in 2004 providing layer 2 security in WLANs. 802.1x framework used as authentication mechanism in 802.11i WLANs causes considerable authentication delay hampering delay critical services and quality of service over WLANs. Various solutions such as pre-authentication, neighbor graph technique, proactive key distribution etc. have been proposed till date to reduced this authentication latency. We present IPSec-MOBIKE based solutions to reduce authentication delay in 802.11i WLANs. MOBIKE is a mobility extension to IKEv2- key exchange protocol from IPSec protocol suite. Security Associations (SAs) formed between Wireless stations (STAs) and Authentication server (AS) form a core part of this solution, and are used for verifying authenticity of STAs at the time of handoffs. Simulation results show that considerable improvement over existing solutions is obtained. Average authentication latency and messages sent by AS are the two parameters used for this comparison. Average authentication latency is parameter we want to minimize without causing increased load on the network. Messages sent out by AS give good representation of load on both the network as well as on AS.

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*Title* : *A New Multi-Scale Multi-Directional Filter Bank: Design And Application*  
*Author(s)* : *Satish M*  
*Roll No* : *Y7104042*  
*Supervisor(s)* : *Gupta Sumana*

***Abstract:***

Image is generally made up of smooth regions and locally oriented features like texture and edges. In the frequency plane the oriented structures give directional frequency component. Smoother regions and edges can be captured at different scales. In this thesis we propose a new multi-scale multi-directional non-subsampled filter bank , which can represent directional features of an image at various scales. Due to its non-subsampled structure, the proposed filter bank is translation invariant. We have used McClellan transform to design 2-D filters of the proposed filter bank from existing 1-D filter bank and showed that 2-D filter bank is perfect reconstruction or near perfect reconstruction if 1-D filter bank is either perfect reconstruction or near perfect reconstruction. The proposed filter bank is computationally efficient compared to general 2-D filter bank. In filter bank we decompose the low frequency regions in succeeding stages, but we use a binary tree decomposition in proposed filter bank which bisects both low and high frequency region at each stage. This gives more redundant information of any image. We also proposed a new set of 1-D zero phase FIR filters for near perfect reconstruction filter bank. The proposed filter bank has been applied for image de-noising using a new soft thresholding method. The performance of proposed filter bank is comparable with those obtained by existing de-noising method.

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**Title** : *Comparative Study Of Centralized And Distributed Scheduling In IEEE 802.16J*  
**Author(s)** : *Meena Om Prakash*  
**Roll No** : *Y7104055*  
**Supervisor(s)** : *SinghYatindra Nath*

***Abstract:***

IEEE 802.16j is a relay technology, which is backward compatible to IEEE 802.16e. 802.16j is used to extend the range of OFDMA based WiMAX network (802.16e) and throughput improvement using Relay Stations (RSs). To address the challenges posed by the mobile Non-Line-Of-Sight (NLOS) propagation channels, WiMAX operators will need to increase the density of BSs. Therefore, for rapid and cost-effective deployment of WiMAX network, relay technology can be used, which doesn't require backbone line. For mobile station (MS) registration with WiMAX network supported by IEEE 802.16j, there is centralized and distributed scheduling schemes. In centralized scheduling scheme, the number of messages required and time delay are larger than distributed scheduling scheme. There are three distributed scheduling and CID (Connection Identifier) allocation schemes; among them the "distributed scheduling with local CID allocation" scheme gives the best performance. In centralized scheduling, base station (BS) generates downlink/uplink MAP (DL-/UP-MAP) on behalf of RSs, while in distributed scheduling RSs have capability to generate DL-/UL-MAPs themselves. So the distributed scheduling scheme reduces the DL-/UL-MAP generation computing load on BS, messaging overheads and bandwidth requirement over relay links. In this thesis we are comparing the DL-/UL-MAP generation computing load on BS in centralized and distributed scheduling schemes for 1/3/3 cell design using RSs and Line topology for multihop transmission. We evaluated that using RSs the total cell throughput also improves, which is represented in form of cell capacity improvement

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*Title* : *Image Compression For Resource Constrained Devices*  
*Author(s)* : *Lokanath Malluri*  
*Roll No* : *Y7104041*  
*Supervisor(s)* : *Sharma Govind*

***Abstract:***

Image compression is now considered as an essential tool in applications such as transmission and storage of the image data because it drastically reduces bandwidth requirements for transmission and memory requirements for storage. Although earlier standards for image compression were based on the Discrete Cosine Transform (DCT), a recently developed mathematical technique, called Discrete Wavelet Transform (DWT), has been found to be more efficient for image coding. The memory requirement of the wavelet transform may seriously affect memory-constrained devices that deal with digital images, such as digital cameras and personal digital assistants (PDAs). The complexity of the wavelet transform is another issue that affects these devices, since they usually contain DSP or processors with lower computational power than regular desktop workstation processors. Both memory and complexity of the DWT impose severe restrictions on applications running on this kind of device, in terms of required working memory and processing time. In this thesis, algorithms are used to reduce memory usage and complexity in wavelet-based image coding, while preserving compression efficiency in the resource constrained devices. Here, an algorithm to efficiently compute the wavelet transform is presented. This algorithm achieves low memory consumption by using line-by-line processing, and it employs recursion to automatically place the order in which the wavelet transform is computed. The proposed tree based encoder perform in-place processing so that no extra memory is required for the coding process. Furthermore, time-consuming methods (such as iterative algorithms, high-order modeling and bit-plane coding) are avoided to reduce complexity, and we show the importance of grouping coefficients with tree structures as a method to reduce complexity

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**Title** : *MRF Based Texture Synthesis And Image Learning Using Appearance Space*  
**Author(s)** : *Thrinadh Kottana*  
**Roll No** : *Y7104081*  
**Supervisor(s)** : *Gupta Sumana*

***Abstract:***

Texture Synthesis plays an important role in computer graphics, vision and image processing. Many texture synthesis algorithms use Markov Random Field (MRF) to model textures. This is because of its capability to model broad spectrum of textures. The quality and speed of these algorithms mainly depends on the order of neighborhood system used in MRF model. The traditional approach in texture synthesis is to compare pixel color neighborhoods with those of an exemplar. Because each pixel only contributes information at one point, large neighborhoods are often necessary to accurately recreate the original texture structure. Such large neighborhoods are runtime bottleneck, as they require both many memory references and an expensive search process. The new Two stage neighborhood system overcomes these limitations of large neighborhoods. We have tested this neighborhood system by applying it to both Static and Dynamic Textures. To create realtime texture synthesis algorithms, efficient methods for data clustering are needed, so we also made a comparative study of two well known clustering algorithms: K-means and PDDP (Principal Directional Divisive Partitioning). The one shot PDDP provides a reasonable improvement in our synthesis time compared to iterative K-means clustering. Observed gain in synthesis speed, without any compromise in the quality of the output, established the efficacy of the proposed system. In the second part of the thesis, we test the same Two stage neighborhood system to solve a problem called "Learning the arbitrary Image processing Algorithm by example". In this case different linear filters used for Noise removal, Image colorization and Texture-by-numbers are learned through examples. A Coherence search method is proposed for making the results look more natural.

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*Title* : *Power Optimization MAC Protocol In Wireless AD HOC Network*  
*Author(s)* : *Nyayate Mihir Manohar*  
*Roll No* : *Y7104054*  
*Supervisor(s)* : *SinghYatindra Nath*

***Abstract:***

Ad hoc Wireless Networks are or on-the-fly networks are characterized by the lack of infrastructure. Nodes in Adhoc networks are independent and take the routing decisions themselves unlike infrastructure oriented networks. One of the major limitation of Ad hoc network is limited energy resource. Several researchers have proposed simple modifications in IEEE 802.11 to incorporate power control. However we have shown that some schemes degrade the network throughput as well as bring unfairness in the network in order to save energy and to increase the network throughput as compared to the standard protocol. We have proposed two power aware mac protocols based on an RTS-CTS-DATA-ACK handshake in the context of IEEE 802.11. We have worked on above two issues and have shown that the proposed methods give a low energy consumption and better throughput. This increases the battery life of the ad hoc nodes making the system cost effective. Also the proposed schemes bring fairness in the pairwise network throughput.

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*Title* : *Dynamic On-Demand p-Cycle Based Protection In Optical Networks*  
*Author(s)* : *Wadhwa Tarun*  
*Roll No* : *Y4177458*  
*Supervisor(s)* : *Singh Yatindra Nath*

***Abstract:***

Network survivability is becoming increasingly critical in optical networks with the large amount of data being transmitted. Several methods have been proposed for restoration of optical networks like rings, path protection methods like Shared Backup Path Protection. The relatively new concept of p-cycles has gained a lot of popularity in the last few years due to its ability to provide ring like restoration speeds and mesh like capacity efficiency. However, most of the research done on p-cycles has been focussed on static networks where the traffic matrix is known before hand. The methods proposed are not designed for dynamic real time networks where the load on the network is continually changing and we have no information about the traffic matrix before hand. This thesis proposes an algorithm to overcome these problems. The algorithm aims at providing on-demand p-cycle protection whenever a working path setup request arrives at a node. The resources reserved for the working path are removed after it has been serviced and the protection relationships released for future use. The computations are done online and the simple nature of the algorithm makes it easy to implement in real time dynamic networks. A simulator has also been written as the main part of this thesis to simulate a dynamic network and provide p-cycle protection to the network using the proposed algorithm. Dual failure restorability has also been provided in the simulator which is becoming increasingly important in the modern optical networks. The blocking and protection performances of the algorithm have been analyzed for different variables

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*Title* : *Modeling Transient Voiced Phonemes*  
*Author(s)* : *Talasila Jayanth Kumar*  
*Roll No* : *Y7104080*  
*Supervisor(s)* : *Sircar Pradip*

***Abstract:***

An exponential sinusoidal model for the voiced phonemes reconstruction in speech is studied. The main feature of the exponential sinusoidal model (ESM) is that the amplitude of each sinusoidal component is allowed to vary exponentially with time. The estimation of model parameters is carried out by utilizing the accumulated autocorrelation functions (AACFs) of the modeled signal. The model is used in transitional speech segments such as voiced phonemes. Computer simulations with voiced speech phonemes indicate substantial better modeling performance in transitional regions when variable segmentation is applied in separating transients starting at the beginning of the segment. The robustness of the ESM is also tested in the presence of additive white Gaussian noise and found to be suitable even at poor SNRs.

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*Title* : *Efficient Coding Of Image subbands Using Block-Based Modified SPIHT*  
*Author(s)* : *Ramireddy Viswanath Reddy*  
*Roll No* : *Y7104088*  
*Supervisor(s)* : *Sharma Govind*

***Abstract:***

Real time transmission of images through handheld mobile/portable devices require an image coding algorithm that performs best at very low bit rate. A number of very successful wavelet-based image coding algorithms have been proposed in the literature. These algorithms are mainly categorized into zerotree and zeroblock algorithms. Zerotree algorithms makes use of the inter-subband correlations existing among different subbands of an image. Set Partitioning in hierarchical Trees (SPIHT) is one of the popular zerotree algorithms due to its excellent rate-distortion performance. Set Partitioning Embedded Block Coder (SPECK) is the prominent algorithm used in zeroblock approach, because of its simplicity. The SPIHT algorithm does not fully provide the desired features of progressive transmission, spatial scalability and optimal visual quality at very low bit rate coding. The inefficiency of SPECK lies in that it does not take care of the inter-subband correlations existing among different subbands. The proposed BMSPIHT algorithm combines both the features of zerotree and zeroblock algorithms into a single algorithm. It is based on Spatial Orientation Trees (SOT) in which the basic unit is a block of  $m \times n$  coefficients in contrast to a single coefficient in SPIHT algorithm. Each SOT has a root block in the LL-subband with the descendent blocks in the high frequency subbands. Due to this the performance of the proposed method improves when compared to other state-of-the-art coding algorithms. Simulation results show that the proposed BMSPIHT algorithm has a better coding efficiency over SPIHT at very low bit rates.

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*Title* : *Multiple Insertion And Deletion Correcting Codes Using Independent Sets*  
*Author(s)* : *Kapoor Manu*  
*Roll No* : *Y4177218*  
*Supervisor(s)* : *Chaturvedi Ajit Kumar*

***Abstract:***

Codes capable of correcting errors due to multiple deletions of symbols are constructed by representing all possible codewords as nodes of a graph and finding an independent set of this graph. Upper bound on the cardinality of the codebooks are obtained by method of induction. The graphs obtained are solved for maximum independent set by using the bound obtained, properties of graph generated and those of independent sets. The codebooks generated by this method have maximum cardinality and thus give maximum code rate. The errors induced due to insertion of symbols are dealt on similar lines. Algorithms to generate codebooks capable of correcting multiple deletions and insertions are developed. The codebooks thus obtained have cardinalities higher than those formed by number theoretic construction for deletion/insertion correcting codes. By sacrificing the probability of correct detection of codewords, codebooks with higher cardinalities can be obtained. Two possible methods to obtain such codebooks are discussed and their relative performance in terms of cardinality of codebooks obtained are compared.

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*Title* : *Combining Edge And Color Features To Track Partially Occluded Humans*  
*Author(s)* : *Dixit Mandar Dilip*  
*Roll No* : *Y7104045*  
*Supervisor(s)* : *Venkatesh K S*

***Abstract:***

The effectiveness of an approach to tracking is determined by the robustness of the selected features, the nature of the appearance model and the overall implementation strategy. Variations in the target scale or changes in its overall appearance, cluttered background and scene or inter-object occlusion are the major problems that limit the performance of any tracking algorithm. In this thesis, we propose a novel region-feature based approach for tracking humans through partial occlusions. We implement a part based paradigm that employs both color and edge information to accurately localize different parts of a human target. A method is proposed to segment automatically, using projection histograms, any human target into three parts namely, head, torso and legs. Using their non-parametric color probability density estimates, these parts are tracked individually through mean shift. Following the mean shift convergence, the strong local edges present in the mean shift window are matched iteratively with those of the initially learnt edge template. The robust edge matching validates and refines the estimates of the mean shift procedure. An estimate of the edge curvatures and their relative locations, collectively recording the target structure, are used for matching. A unique combination of edge and color features ensures reliable tracking even in the presence of severe occlusions and clutter. We use the CAVIAR Data Set as well as our own IIT Kanpur test data cases demonstrating varying levels of occlusion in daily life situations to evaluate our tracking method..

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*Title* : *3D Reconstruction Techniques From Multiple Fand Terrain*  
*Author(s)* : *Varier Sidharth Ramachandran*  
*Roll No* : *Y7104073*  
*Supervisor(s)* : *Venkatesh K S*

***Abstract:***

Silhouette and laser based techniques have been widely used for 3D object reconstruction. We have a proposed a method of camera calibration using mesh-grid pattern for silhouette based method. Using this method, the real-world dimension measurements of the reconstructed visual hull can be done. This can be very useful for visual metrology. But, there could errors in the silhouette based reconstruction, because of the depth issue. This problem arises when the size of the object is comparable to the depth of the camera optical center from the object center. We have given an elaborate explanation for depth issue. We have also described the laser based reconstruction for rotatory platforms with and without camera calibration. A need for a real-time based system has also led us to devise an algorithm for real-time laser based reconstruction. It is difficult to qualitatively ascertain the accuracy of any reconstruction method. By measuring the various dimensions of the object and comparing them with that of the reconstructed model results in a very tedious process. A novel technique for the error analysis of a reconstruction method, which is closely related to the conventional concept of visual hull, has been introduced in this thesis. A comparison of the silhouette and laser based technique, based on the error analysis is presented which has led us to conclude that the laser based method is more accurate as compared to silhouette based method, when we are dealing with objects without concavities. As a direct application to 3D object reconstruction, a reverse engineering based method for generating the engineering drawings for an object, has been presented. Using OpenGL kit we have been able to design a user interactive interface for examining the engineering drawings of any object. The interface also includes features for calculating the Euclidean distance and the distance along the surface between any two point lying on the surface of the object. A theory for the extension of laser-based reconstruction, towards terrain reconstruction is also presented in this thesis. This kind of vision system can be implemented for planet rovers. This would help the rover for exploration and navigation purposes

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*Title* : *Two-Dimensional Beam Forming And Interference Reduction Using Different Arrays*  
*Author(s)* : *Myneni HarshaVardhan*  
*Roll No* : *Y7104026*  
*Supervisor(s)* : *Sircar Pradip*

***Abstract:***

As the demand for mobile communications constantly increases, the need for better coverage, improved capacity, and higher transmission quality rises. Smart antennas used in code division multiple access(CDMA) systems can effectively maximize capacity and improve reliability and coverage by directing beam patterns towards the desired signals and null-patterns towards the interferers. Although numerous studies on smart antennas have already been conducted, mostly on Uniform linear arrays(ULA), not as much effort has been devoted to other configurations. In this work, with the use of different types of antennas arrays the main issue related to smart antennas, beam forming is studied. A Modified constraint beam forming technique for Uniform planar arrays is proposed and the Bit error rate(BER) performance with co-channel interference in Uniform planar array(UPA) and Uniform circular array(UCA) is examined and compared

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**Title** : *Distributed Group Constructions Using DCF In IEEE 802.11 Networks*  
**Author(s)** : *Pitkar Saurabh Mahendra*  
**Roll No** : *Y7104059*  
**Supervisor(s)** : *SinghYatindra Nath*

***Abstract:***

Throughput performance of the IEEE 802.11 distributed co-ordination function (DCF) is very sensitive to the number of active stations in the network. When the number of active stations is large enough, the system throughput in DCF degrades because of large packet retransmissions. Because of the same, the delay time per packet transmission gets affected the most. In such cases, the delay probability density function will have large delay jitter. The delay pdf will also showcase the phenomena of “channel hogging”. In order to reduce packet retransmissions; and hence the collisions; we propose to create groups of stations in the network in a distributed environment. We allow only one group of stations to operate in the active state while other groups are in the dormant state. We also maintain equal number of stations in all groups, so that the waiting delay experienced by a packet is almost the same for all stations irrespective of their groups. In doing so, our scheme takes the help of kalman estimation to estimate the number of competing stations. Numerical results show an improvement in the throughput performance as compared with the basic access mechanism. Our scheme substantially reduces the jitter in the delay time per packet transmission. Our scheme also succeeds in constraining the variance in the number of successfully transmitted packets by each station, to a small value, thereby achieving fairness.

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*Title* : *Performance Evaluation Of Fiber Optic Loop Buffer Switch Under Prioritized Traffic And Optical Regeneration*  
*Author(s)* : *Tiwari Alok*  
*Roll No* : *Y7104004*  
*Supervisor(s)* : *SinghYatindra Nath*

***Abstract:***

Photonic packet switches are essential in optical packet networks to meet the high bandwidth demand of today's world. This thesis addresses the class of service (CoS) which categorizes the traffic into different classes, as different services requires different QoS. The loop buffer based architecture has been simulated under various classes of services. The service differentiation is important in optical packet switching as all the packets under contention can not be stored due to limited buffering capacity. Circulation limit inside the buffer affects the Quality of Service of the switch severely. Conclusions are drawn about the packet loss performance of the switch for various circulation limits. To remove circulation limits in the buffer, all-optical regenerators are placed inside the buffer. As optical regenerators are costly hence, to minimize the cost of regenerator based switch architecture, number of regenerators should be optimized. This work also shows the performance of the switch in terms of packet loss probability for different number of regenerators for different circulation limits in the buffer

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*Title* : *Improved Block Motion Estimation Using Block Frequency Warping*  
*Author(s)* : *Varunkumar Allagadapa*  
*Roll No* : *Y7104083*  
*Supervisor(s)* : *Sharma Govind*

***Abstract:***

Motion estimation (ME) is one of the most important tasks in the video coding process since it exploits temporal correlation between neighboring frames to enable efficient compression of video. Motion estimation can provide significant compression efficiency by removing temporal redundancy. The compression performance is typically increased with improved prediction capabilities. A typical video encoder such as MPEG-4, H.263 and H.264 uses the discrete cosine transform (DCT) to achieve near optimal compression of individual frames. This is done by decomposing frames into components of different spatial frequencies. The DCT fails to compress much information into low-frequency components if the block of images contains mostly high frequency components. In this dissertation, a motion estimation scheme based on block frequency warping is presented. In the proposed approach, the best candidate block is initially obtained using the classical full search scheme, and then frequency warping is applied to this block to improve the matching accuracy. The proposed method outperforms the conventional matching strategy. Block frequency warping is done by using warped discrete cosine transform (WDCT). The WDCT is cascade connection of conventional DCT and all-pass filter whose parameters can be adjusted to provide frequency warping. Motion estimation is a critical yet computationally intensive task for video encoding, we also propose a method for reducing mean absolute difference (MAD) calculations. This method reduces redundant MAD calculations for best matching block without loss in the frame quality. The proposed block frequency warping method improves the prediction capability with additional complexity, and proposed reduced MAD method reduces the complexity of video coding

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*Title* : *Visual Recognition Of Hand Gestures In ASL*  
*Author(s)* : *Kaushal Jyoti*  
*Roll No* : *Y4177182*  
*Supervisor(s)* : *Venkatesh K S*

***Abstract:***

Sign language recognition has emerged as one of the most important research areas in the field of human-computer interaction. The aim of sign language recognition is to provide an efficient and accurate mechanism to transcribe sign language into text or speech. Existing recognition systems rely heavily on expensive instrumented gloves or markers to determine the signer's manual configuration; this is unnatural and restrictive for the signer. Also these systems have mostly concentrated on finger signing, where the user spells each word with hand signs corresponding to the letters of the alphabet. However, most signing does not involve finger spelling but, instead, gestures which represent whole words. This allows signed conversations to proceed at about the pace of spoken conversation. In our work, we look at recognition of signs representing whole words in ASL rather than finger spelling. We propose a video-based approach for sign recognition which does not require the signer to wear special gloves. We rely on skin segmentation for tracking arms and hands in the sign videos and obtain the skeletal images of the signer for each frame. We propose two intuitive schemes for extracting and storing features for reliable gesture recognition from the sign videos. We then also propose two novel classification schemes employing frame-wise matching and relative weighing of frames based on their order in the video and hence their significance in distinguishing any two signs. For testing our proposed classification approaches, we have created an ASL Repository consisting of 210 videos, in which 6 non-native ASL signers sign 35 signs each under controlled laboratory conditions.

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**Title** : *On Power Loading Algorithms For OFDM Based Cognitive Radio*  
**Author(s)** : *Malik Shakti*  
**Roll No** : *Y4177401*  
**Supervisor(s)** : *Banerjee Adrish*

***Abstract:***

Rapid growth in the wireless communications sector, requires more spectral bandwidth but we have limited spectral resource. So the radio spectrum is becoming exhausted. Moreover measurement studies have shown that in both the time and frequency domains that spectrum is underutilized. The rising demand for spectrum and inefficiency in spectrum usage requires paradigm shift from the conventional exclusive use of frequency resources by the fixed allocation to the dynamic frequency utilization for the future wireless networks. Cognitive radio (CR) technologies has made it possible to use the frequency spectrum efficiently and to dynamically use and release spectrum wherever and whenever they are available. It brings an emerging paradigm of dynamic spectrum access (DSA). The dynamic spectrum access technology can allow unlicensed secondary systems to share the spectrum with the licensed primary systems. By cognition of the radio frequency environment, radio can sense these voids in wireless spectrum (called spectrum holes) and can adaptively use these spectrum holes increasing overall efficiency. While utilizing these spectrum holes for transmitting its own data, CR has to make sure that interference caused to the primary users is below a given threshold. OFDM has been recognized as potential modulation technology for Cognitive radio because of various reasons like its environment adaptiveness, ease in spectrum sensing and spectrum shaping. We proposed a new centralized power allocation technique (PAT) and a new Hybrid PAT. In centralized PAT we tried to maximize overall spectral efficiency. Sub-carriers which are near to primary user (in frequency domain) cause more interference to primary user. So for some sub-carriers which contributes more to interference, data symbols are adaptively spread in time domain to reduce interference to primary user and then we allocate optimal power to each subcarrier. This way we are able to push more power into CR system for same value of interference caused to PU. In hybrid PAT we have a centralized controller which doesn't need information about different CR-CR Instantaneous channel gains but it knows their distributions. Based on the knowledge of just distributions of CR-CR Channel gains centralized controller will allocate powers to different subcarriers this information will be told to different users which will use actual CR-CR channel gains to get more optimal power profile.

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**Title** : *Complete Representation Of Speech Signal Using Fourier Bessel Expansion And AMFM Signal Model*  
**Author(s)** : *Hood Avinash Shrikant*  
**Roll No** : *Y7104010*  
**Supervisor(s)** : *Sircar Pradip*

***Abstract:***

In this thesis work, complete speech signal is parameterized and modeled using Amplitude Modulation Frequency Modulation (AMFM) signal model. Firstly multi component Speech signal is separated using Fourier Bessel expansion. First component or low frequency component is modeled with one set of parameters for complete signal length. Second and third components where AMFM parameters are time varying, are modeled in parts by selecting suitable length where AMFM model is admissible. Itakura Saito distance measure is applied to determine spectral distortion between actual and modeled signal. Results obtained are encouraging and demonstrates suitability of AMFM model for speech signal application.

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*Title* : *Fusion Of SAR And VIR Imagery For Land-Cover Classification*  
*Author(s)* : *Kanakan Bineshkumar*  
*Roll No* : *Y7104011*  
*Supervisor(s)* : *Gupta Sumana*

***Abstract:***

The complementary information provided by images obtained from active Synthetic Aperture Radar (SAR) sensors and sensors operating in the visible/infrared (VIR) region of the electromagnetic spectrum can be synergistically combined by the process of image fusion. The limitations of existing methods for the fusion of SAR and VIR images is basically due to the effect of speckle in SAR images and the limited capabilities of existing methods for controlling the amount of SAR information to be incorporated into the fused product. In this thesis work, three fusion methods are proposed to overcome this problem. These are based on the concepts of Bayesian fusion, matching of local mean and variance information in the input images to that of the fused image and local spatial high pass filtering based fusion. All the proposed methods allow the user to control the amount of SAR information to be transferred to the final fused product while retaining the high spectral information provided by the VIR images. The worthiness of the fused images is investigated in a subsequent classification phase to classify the pixels in the fused image into different land-cover classes. To make use of the enhanced spatial information in the fused images, these images are classified using two different schemes: spectral classification and (spectral + textural) classification using the Gaussian maximum likelihood classifier. The classification results are analyzed using kappa analysis to find whether a particular fusion scheme helps in improving the overall classification accuracy. On the basis of visual interpretation, objective quality measures and classification accuracies obtained, it is seen that proposed fusion schemes give better results compared to existing fusion methods. The results from (spectral + textural) classification are also encouraging and show promise in discriminating certain classes which have similar spectral properties, on the basis of their textural content

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*Title* : *Peak To Average Power Reduction Of MIMO-OFDM*  
*Author(s)* : *Tiwari Abha*  
*Roll No* : *Y6104003*  
*Supervisor(s)* : *Banerjee Adrish*

***Abstract:***

Demands for the capacity in the wireless communications, driven by cellular mobile, Internet and multimedia services have been rapidly increasing worldwide. On the other hand, the available radio spectrum is limited and communication capacity can not be met without a significant increase in communication spectral efficiency. Significant improvement in the spectral efficiency are available through increasing the number of antennas at both the transmitter and receiver end i.e. through Multiple Input Multiple Output communication. MIMO in combination with Orthogonal Frequency Division Multiplexing (OFDM) provides a very good air interface with the advantage of flat fading MIMO channels in the frequency selective multipath environment. But it suffers from the inherent problem of Peak to Average Power Ratio (PAPR) reduction of OFDM based modulation scheme. We have basically focused on the implementation of the MIMO-OFDM system model and PAPR reduction of the same. Space Time Coded OFDM is used for the implementation of two transmit two receive and two transmit one receive MIMO-OFDM system and companding based method of PAPR reduction for OFDM is extended on our system model. Performance is analyzed in terms of Complementary Cumulative Distribution Function (CCDF) curve of PAPR and Bit Error Rate (BER).

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*Title* : *Cooperative Spectrum Sensing Using Double Threshold Energy Detection For Cognitive Radio*  
*Author(s)* : *Srivastava Shishir Kumar*  
*Roll No* : *Y7104072*  
*Supervisor(s)* : *Banerjee Adrish*

***Abstract:***

Cognitive radio has been under active consideration in recent years to deal with the conflict between the steady spectrum demand of unlicensed users (secondary users) and the inefficient spectrum utilization of licensed users (primary users). Dynamic spectrum allocation (DSA) has been proposed to solve this problem. In DSA secondary users are allowed to use licensed band whenever primary user is not using the band. Therefore, spectrum sensing must be performed before the secondary users access the licensed band in order to limit the interference to the primary user. However, due to fading of the channels and the shadowing effects, the sensing performance of single secondary user will be degraded. To enhance the sensing performance, cooperative spectrum sensing has been proposed, which is usually conducted in two successive stages: sensing and reporting. In this thesis a new cooperating sensing method has been described using double threshold energy detection technique. Each secondary cognitive user takes a local decision on spectrum occupancy based on two threshold energy detection and uses one bit information to convey its decision to the fusion center that collects decisions from all cooperating users who are able to detect presence or absence of signal. Fusion center takes a final decision using what we call ‘n-ratio’ logic. It is also shown that OR logic proposed in the literature is a special case of the ‘n-ratio’ logic decision. Expressions for probability of detection and probability of false alarm have been derived for ‘n-ratio’ logic cooperating sensing method for Additive White Gaussian Noise (AWGN), flat fading Rayleigh and Nakagami channels. Finally, some results have been presented for perfect and imperfect reporting channels that shows improvement in spectrum sensing of the proposed method in comparison to OR logic, while keeping network overhead low.

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*Title* : *VHDL Implementation Of Two-State Multiple Turbo Codes*  
*Author(s)* : *BhatiaVikas*  
*Roll No* : *Y7104085*  
*Supervisor(s)* : *Banerjee Adrish*

***Abstract:***

Wireless communication is always encountered with errors in the transmission through the radio channel due to thermal noise and fading. This coupled with ever increasing number of users, interference, service requirements and regulatory restrictions calls for use of efficient error correction schemes that provide the capability to lower bit error rates (BERs) while keeping the transmission power in control. Since their introduction, Turbo Codes have become one of the most popular and powerful error correction schemes because of its good error correction properties. The Turbo Codes perform close to the theoretical Shannon limit. No wonder, Turbo Codes are now a part of the third generation of mobile phone (3G) and the standard IEEE 802.16 (WiMAX) and are planned for upcoming standards. With increasing demands from a communication system to cater to different data rates and services, reconfigurability has now become of prime importance. In recent times, FPGAs have appeared as the best choice. FPGAs provide the flexibility in operation and function by a simple change in their configuration bit streams. Moreover, the user can easily provide additional functionality on the same FPGA device in the leftover device fabric. In fact, this has led to the concept of System on a Chip (SoC) based on an FPGA. Additionally, FPGAs serve as a quick verification and prototyping platform if the design has to subsequently go for an ASIC design thus saving huge Non-Recurrent Engineering (NRE) costs and enabling faster time to market. Advancements in silicon technology have heralded an increase in device densities and consequently higher performance devices. As a result there has been a spurt in the number of vendors offering Turbo Code solutions on FPGAs and ASICs catering to the present communication standards. Off late there has been active research on several approaches to low complexity turbo-like code designs that are based on very simple graph structures or 2-state trellises which result in low decoder complexity. One such approach is based on multiple turbo codes that offer good BER performance and lower implementation complexity and costs when compared to the standard 8-state 3rd Generation Partnership Project (3GPP) Turbo code. In this work we present the VHDL implementation of a 2-State Multiple Turbo Code architecture targeted towards the Xilinx Virtex-5 FPGAs that is much more efficient than the 3GPP Turbo code in terms of hardware complexity and speed.

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*Title* : *Automatic Speaker Verification Using Factor Analysis*  
*Author(s)* : *A Naga Koteswara Rao*  
*Roll No* : *Y7104051*  
*Supervisor(s)* : *Umesh Srinivasan*

***Abstract:***

Automatic speaker verification (ASV) is the task of verifying if a given speech sample belongs to claimed identity or not. This system suffer performance loss due to a number of factors. The two most dominant causes are limited training data and session variability. Although high performance can be obtained in an ASV system by enforcing large data requirements, it is often impractical for system users. The challenge in current database evaluation is to recognize given speaker enrollment data extracted from single recording and test data extracted from other recordings. Estimating a Gaussian Mixture Model(GMM) from a speaker's enrollment data by classical Maximum A Posteriori (MAP) produces a model which is adapted to the enrollment recording conditions as well as to the speaker. Using this GMM to recognize the speaker under different recording conditions is therefore problematic. It seems that collecting training data from multiple sessions for each target speaker is the only way to deal with channel variation. In this thesis, we will indicate how, given a database comprising a large number of speakers in which each speaker is recorded under many different conditions, we can jointly model speaker and channel variability by a probabilistic factor analysis. The speaker factors and the channel factors play different roles in that, for a given speaker, the values of the speaker factors are assumed to be the same for all recordings of the speaker but the channel factors are assumed to vary from one recording to another. The general factor analysis model is constructed by combining the prior for eigenvoice MAP with the priors for classical MAP and eigenchannel MAP. This is expected to improve performance of ASV system.

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*Title* : *Comparative Study Of Speaker Adaptation Techniques For Automatic Speech Recognition*  
*Author(s)* : *KS RajeshKrishna*  
*Roll No* : *Y7104064*  
*Supervisor(s)* : *Umesh Srinivasan*

***Abstract:***

Speaker variability is considered as a major source of performance degradation in speaker independent speech recognition systems, which is caused due to many reasons. To account for such variations, different Speaker Normalization methods have been proposed. Speaker Normalization methods are broadly of two types, viz., Vocal Tract Length Normalization (VTLN) and Speaker Adaptation. In VTLN, the spectrum of speech signal of one speaker is warped to match the spectrum of the another speaker. This is a feature domain approach for speaker normalization. Speaker Adaptation, on contrast is a model domain approach, where the acoustic models of the SI models are changed to match the characteristics of the test speaker. Diagonal covariance structure is assumed for Gaussian components in the model building step, which requires feature vectors to be uncorrelated. But, linear transformation adaptation methods like VTLN & SAT introduces correlation in the features. Hence a further step is necessary to remove the correlations. In this thesis, we have studied and experimented Speaker Normalization with different VTLN, Adaptation, SAT methods, and a feature decorrelation methods in ASR. In VTLN, we have used the Band-limited Interpolation method as the linear transformation approach for VTLN warping, and in speaker adaptation, we have used CMLLR and MLLR for our experiments. CMLLR was also used to build compact acoustic models during training, which is called SAT. We used MLLT, a special case of Heteroscedastic Discriminant Analysis (HLDA) as the decorrelating transformation. We have also tried to cascade different methods (like VTLN with MLLT, and SAT with MLLT) appropriately to see their effects on word recognition accuracies

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*Title* : *A Novel Architecture And Handoff Protocol For In-Building Wireless LAN Operating At 60 GHz Frequency*  
*Author(s)* : *Agrawal Abhishek Kumar*  
*Roll No* : *Y7104003*  
*Supervisor(s)* : *SinghYatindra Nath*

***Abstract:***

This research work deals with implementation issues for wireless local area network operating at 60 GHz frequency. The main factors for using this band for communication are lack of spectrum resources in traditional frequency bands, ever growing demand for high data rate wireless networks, availability of huge unlicensed spectrum at 60 GHz frequency band and some recent advancement in CMOS fabrication technology for devices operating in this band. There are some serious issues in designing a communication system operating at 60 GHz frequency. Here we have worked on two issues; frequency spectrum allocation and handoff management. Thus there are two major contributions of this thesis. Firstly a highly efficient spectrum allocation is proposed and its feasibility is validated through simulation. This allocation method exploits some non-favorable characteristics of 60 GHz radiation like higher free space absorption, inability to reach out of the room due to lack of diffraction and requirement of high gain directional antennas, to achieve a high capacity system for an in-building wireless LAN. Simulation results show that this allocation is feasible with practically achievable system parameters. Secondly a novel cognitive pre-detection approach for handoff is proposed to overcome handoff problems, like “Corner Effect”, previously published in literature. Mathematical analysis for performance of the suggested scheme is done. An analogy is identified between suggested hand-off prediction method and Standard Binary Hypothesis decision problem. This analogy is used to define performance parameters like detection probability, probability of false alarm and probability of miss for suggested protocol. Mathematical analysis and simulation is performed to find these parameters and results are analyzed. Effect of randomness in simulated mobility model on the performance of the protocol is analyzed

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*Title* : *Localized Re- Flooding For Time Synchronization In Wireless Sensor Networks*  
*Author(s)* : *Singh Ishdeep*  
*Roll No* : *Y4177170*  
*Supervisor(s)* : *SinghYatindra Nath*

***Abstract:***

RBS, TPSN and Hybrid Synchronization achieve clock synchronization within a few microseconds of uncertainty. Though the former techniques were not well designed for large networks in terms of energy, hybrid Synchronization went a step further to reduce the energy consumption of the entire network. The issue unanswered in all these techniques is loss of network connectivity caused due to depleted sensors. Simulating each of these methods shows that synchronizing a large sensor network requires an unnecessarily large number of transmissions, which will quickly deplete sensors and reduce the network coverage area rapidly. The work done in this thesis addresses the connectivity problem in wireless sensor networks. To accomplish the required connectivity of the network an efficient algorithm, localized re-flooding has been proposed which connects is connected parts of the network by flooding only a certain area of the network as compared to complete flooding proposed in previous studies

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*Title* : *Cluster Adaptive Training For Automatic Speech Recognition*  
*Author(s)* : *Jodha Hemant*  
*Roll No* : *Y4177160*  
*Supervisor(s)* : *Umesh Srinivasan*

***Abstract:***

Among all difficulties that an Automatic Speech Recognition (ASR) has encountered, a major challenge has been to handle the variations in the speech signal caused due to multitude of factors that affect the production of speech signal. This variability of speech has become a significant source of performance degradation for an Speaker Independent (SI) ASR systems. Speech variability is generated by diverse factors, whose nature can be purely physical, cultural or sociological. Variation in speech not only appears between speakers but also within a single speaker and are referred to as Inter-Speaker variability and Intra-Speaker variability, respectively. To reduce this speaker related variabilities in the speech signal, Speaker Adaptation is widely used in SI ASR systems. In speaker adaptation, the acoustic model parameters are transformed to better fit the statistics of observed speech. When performing speaker adaptation, there are two conflicting requirements. First, the speaker transform must be powerful enough to represent the speaker. Second, the transform must be reliably and easily estimated for a particular speaker. This limits how rapidly the models may be adapted to a new speaker or acoustic environment. The most popular speaker adaptation methods (e.g., MLLR/CMLLR) linearly transform the parameters of the SI model to obtain the individual speaker model parameters. Since matrices have to be estimated, these linear transform based speaker adaptation methods require large amount of adaptation data for reliable estimate of the speaker transforms. ii In this thesis, we have discussed a cluster based adaptation technique called Cluster Adaptive Training (C.A.T). In CAT, speaker adaptation is achieved by linearly interpolating the means of a set of speaker-clustered models, which requires estimating of only a few weighting parameters for each test speaker. Therefore, the amount of adaptation data required for reliable estimation of speaker transforms (weight vector) is much less than linear transform based speaker adaptation methods. Hence CAT is more suitable than MLLR/CMLLR in the case when available adaptation data is less. In this thesis, we have performed studies on using different methods for speaker clustering and have compared performance of CAT for each of the them. By conducting experiments on the DARPA Resource Management database, we have compared the word recognition accuracy performance of CAT with linear transform based methods of speaker adaptation and shown that performance of CAT is superior to MLLR/CMLLR when amount of adaptation data is less.

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*Title* : *Enhanced Mobile Station Localization Using Map- Matching*  
*Author(s)* : *Mahajan Sameera*  
*Roll No* : *Y7104044*  
*Supervisor(s)* : *SinghYatindra Nath*

***Abstract:***

The Mobile Station Location (MSL) problem is the problem of physically locating a user of a cellular phone. Various methods for location estimation are currently used but none of the triangulation methods are accurate due to non-line-of-sight (NLOS) errors. This thesis aims at reducing the NLOS errors to obtain higher accuracy. The network based location estimation schemes have been widely adopted. Most widely used methods include the Time based positioning methods. The two-step Least Square (LS) method is widely used Time of Arrival (TOA) location estimation method. The LS algorithm results in inaccurate location estimation due to the existence of NLOS errors. The NLOS errors are reduced in the LS method by using Maximum Likelihood (ML) estimation which is the NLOS LS algorithm. In this thesis few modifications in the NLOS LS method are proposed to obtain the location estimates with greater accuracy. In case of low NLOS noise environment with only three hearable Base Stations (BSs) the Virtual Base Station (VBS) can be used to improve accuracy. The VBS method introduces additional simulated BSs or virtual BSs in order to compute the location estimate of the MS, thus improving the estimation accuracy. We observe the performance of the VBS method for different combinations of Gaussian noise variance and maximum NLOS error. In this thesis we use the residual test method to identify the LOS BSs which are used to compute the height of mobile station from the ground. Using this information along with the location estimates obtained, we propose an alternative map-matching algorithm to obtain highly accurate location of the Mobile Station

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*Title* : *A Study Of Speaker Diarization*  
*Author(s)* : *Kumar Himanshu*  
*Roll No* : *Y4177165*  
*Supervisor(s)* : *Umesh Srinivasan*

***Abstract:***

Speaker diarization is the process of partitioning the input audio data into homogeneous segments according to the speakers identity. The aim of speaker diarization is to improve the readability of an automatic transcription by structuring the audio stream into speaker turns, and in cases when used together with speaker-identification systems, by providing the speakers true identity. Such information is of interest to several speech and audio processing applications. This task is sometimes referred to as the "Who Spoke When" task. Speaker diarization consists of three stages: speech and nonspeech detection, speaker turn detection and speaker clustering. The thesis mainly focuses on speaker turn detections using SVMs and GMMs for speaker clustering. There are several methods available in literature for speaker turn detection, such as BIC and KL2. These methods are computationally expensive and hence there is a need for fast approaches. In this thesis, we propose the use of SVMs and show that they are efficient for detecting speaker turns. Employing SVMs also provides better results than existing techniques.

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*Title* : *A Dynamic Programming Based Study Of Speaker Variability Using Spectral Envelopes Of Vowel Sounds*  
*Author(s)* : *Haris AN*  
*Roll No* : *Y7104001*  
*Supervisor(s)* : *UmeshSrinivasan*

***Abstract:***

Vowel normalization has been a widely researched topic for many years and several approaches have been adopted to characterize inter-speaker relationships in vowel sounds. All techniques proposed so far for vowel normalization are based on formant data of vowels and some of them are suggestive of the fact that linear scaling of the frequency axis produces the best performance. In this thesis, an approach based on spectral envelopes is followed to investigate the nature of relationships that exist among speakers uttering the same vowel, and an attempt is made to ascertain whether these relationships have something more than a simple linear behavior. A Dynamic Programming (DP) based technique is used to derive relations between spectra of speakers enunciating the same vowel sound. Analysis on data from TIMIT, Hillenbrand et al. and North Texas vowel databases leads to two major observations: (i) The relations between speakers show a deviation from the origin before increasing monotonically with frequency. This behavior is consistent in all vowels in all three databases. In other words, the relations are not simple linear functions of frequency. (ii) The relations exhibit at least one change in slope, indicating a frequency dependent scaling relation between speakers. The changes in slope are also observed to be vowel dependent. To examine the validity of the above observations, experiments are designed to test the normalization performance of the derived relations and compare it with the linear or uniform scaling method. Normalization is performed both on formants and Mel Frequency Cepstral Coefficients (MFCCs) obtained from spectral envelopes. A statistical vowel recognition experiment is also designed using single gaussian mixture models. Results based on measures such as residual variance of formants, class separability of MFCCs and vowel recognition accuracy indicate that incorporating the observed non-uniform behavior provides a significant improvement over the linear scaling approach..

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*Title* : *On Turbo Code Performance In An AWGN Channel*  
*Author(s)* : *Kothamasu Soujanya*  
*Roll No* : *Y6104034*  
*Supervisor(s)* : *Banerjee Adrish*

***Abstract:***

In this work, we have evaluated the performance of turbo codes in an AWGN channel. Turbo decoder works in an iterative fashion. We have presented the bit error rate performance of turbo codes under different number of iterations, different choice of constituent encoder, different interleavers and under condition of wrong SNR estimation at the decoder. We have also used mutual information based EXIT chart to analyze the performance of iterative decoding of turbo codes and searched for good constituent encoders to be used in turbo codes.

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**Title** : *Design Of Low Power 32-Bit Logarithmic Converter*  
**Author(s)** : *Kumar Sunil*  
**Roll No** : *Y7104076*  
**Supervisor(s)** : *Qureshi Shafi*

***Abstract:***

In this thesis work, a low power 32-bit binary to binary logarithmic converter is designed at 0.35 V and 1.2 V. The novelty of this work is that a voltage dependent circuit design approach is used to design the basic combinational logic gates to get optimum performance. Sizing factor equations for stack connected NMOS and PMOS are modeled at 0.35 V supply voltage for bulk CMOS and DTPMOS circuits. Further the optimum circuits are also designed at 1.2 V. The optimum value of  $W_p/W_n$  ratio is determined from simulation for given operating voltage. To increase the performance of the design at circuit level, pipelining technique is used. Transmission gate based master slave D flip-flops are used as storing elements between the combinational blocks. The variation of D flip-flop clock to Q delay ( $t_{c-q}$ ) with flip-flop data to clock offset ( $t_{d-c}$ ) is also discussed. To improve the frequency response of the design the optimum value of flip flop data to Q ( $t_{d-q}$ ) is used. Fast 4, 16, and 32-bit leading-one detector circuits are designed to obtain the leading-one position for a 4 input, 16 input and 32 bit input binary word respectively. A 32-bit  $\times$  5-bit NOR based MOS ROM is used to generate the integer part of the output. Delay is calculated for all combinational blocks used in the design. A 5-stage logarithmic shifter is used to generate fractional part of the output. The 32-bit LOD and 5-stage logarithmic shifter are dominating blocks in terms of propagation delay. Therefore, to ensure the correct performance, layouts are drawn for these blocks and back annotation is done to calculate the actual delay and power dissipation. Three error correcting algorithms are discussed and implemented with low-power and fast circuits that reduce the maximum conversion error. All designs are simulated in 90nm GPDK (Generic Process Design Kit) using Cadence Spectre and Assura simulators for schematics and layouts respectively

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***Title*** : ***Design Of First And Second Order Sigma Delta Modulators For Audio Frequency Applications***  
***Author(s)*** : ***Thumma Arun Kumar***  
***Roll No*** : ***Y7104008***  
***Supervisor(s)*** : ***Qureshi Shafi***

***Abstract:***

The use of sigma delta modulators in the integration of high resolution analog to digital converters has shown promise for overcoming the analog component limitations inherent in modern VLSI technologies. The design of a switched capacitor first and second order single loop sigma delta modulators for 20 KHz base band bandwidth is presented in this work. The contribution made in this work is the development of a set of behavioral models to include various circuit level non idealities for each of the functional building blocks used in sigma delta modulator. Three different sigma- delta modulator architectures are designed at system level in this work, namely first order, second order single loop and (1-1) MASH. Two different architectures, first order and second order single loop sigma delta modulators are designed at circuit level. Second order sigma delta modulator is designed at transistor level with low gain and low slew rate obtained from system level simulations. An 8 bit resolution is achieved from the second order sigma delta modulator with an SNDR of 50.8 dB and a dynamic range of 52 dB. Layouts for the building blocks are drawn. Key analog blocks designed are folded cascode OTA, common mode feedback loop, two phase clock generator, dynamic comparator, switches (CMOS) and integrator. All the designs are done in 1.8 V, 0.18 um CMOS technology from GSDK (Generic Process Design Kit) Cadence EDA tool suite.

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**Title** : *Fully Integrated Low Phase Noise Integer-N and Fractional-N CMOS Frequency Synthesizers For Bluetooth Applications*  
**Author(s)** : *Mittal Abhishek*  
**Roll No** : *Y4177023*  
**Supervisor(s)** : *Dutta Alope*

***Abstract:***

A 1.8 V fully integrated, low phase noise, 2.4 GHz integer-N and fractional-N frequency synthesizer with sigma-delta modulator controller for Bluetooth applications is implemented in 0.18 um CMOS technology. In this design, a novel structure of dual-modulus divide-by-15/16 prescaler using dynamic DFF and transmission gates is proposed, with a maximum operating frequency of 3.425 GHz at 1.8 V supply. The current mismatch at the output of the charge pump is reduced using a novel cascading architecture, thus limiting the output jitter, with the simulation results showing a maximum current mismatch of less than 0.02%. Hajimiri-Lee noise model is used to design a low phase noise I-MOS varactor based -Gm LC-VCO meeting Bluetooth specifications, with a linear tuning range of more than 20%. The VCO achieves a measured phase noise of -134.8 dBc/Hz at 3 MHz offset, consuming 8 mA current from 1.8 V supply. The phase noise and fractional spurs have been reduced by a third-order Multi-stage noise SHaping (MASH) modulus controller in case of the fractional-N frequency synthesizer. The proposed synthesizer settles in approximately 35 us and achieves a phase noise of -122.9 dBc/Hz at 1 MHz offset, consuming 14.5 mW from 1.8 V supply

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***Title*** : ***Surface Potential And Threshold Voltage Models For Short-Channel Single-Gate Fully Depleted (FD) SOI MOSFETs Without Invoking The Charge Sheet Assumption***  
***Author(s)*** : ***Shah Shaheen***  
***Roll No*** : ***Y4177397***  
***Supervisor(s)*** : ***Dutta Alope***

***Abstract:***

In this work, we present surface potential and threshold voltage models for short-channel single-gate fully depleted SOI MOSFETs. The developed models take into account the contribution of the inversion charge to the total charge density, for thin film SOI MOSFETs with high substrate doping and large BOX thickness. The importance of the inclusion of the inversion charge in the threshold voltage model is first highlighted for long channel devices. Both source referenced and substrate referenced models have been developed, and they are shown to converge. The source referenced model has been used in this work. For short channel devices, a fitting parameter and a series of approximations are used to include the inversion charge, which has never been attempted before. A second fitting parameter is used to take into account the non-uniformity in the lateral electric field across the silicon film thickness. The resulting surface potential model comes out to be transcendental in nature, which is made analytical using empirical approximations for a given set of device parameters. The developed model correctly predicts the rapid roll off of the threshold voltage for small channel length devices, a characteristic of the DIBL and charge sharing effects. The results obtained from the threshold voltage model, derived from the analytical potential model, show a very good match with that obtained from the transcendental potential model. The results (threshold voltage values), obtained using the transcendental potential model, match closely with the 2D MEDICI results and experimental data reported in the literature, thereby validating the approach of the model presented. While the errors produced by the results of other models range as high as 30-40% for a channel length of 100 nm and silicon thickness of 10 nm, under the same conditions, the results of our model show a maximum error of only 0.75%, which is a significant improvement

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**Title** : *Power And Performance Optimization Using Multi Voltage Multi Threshold And Clock Gating*  
**Author(s)** : *K R Sanjeev*  
**Roll No** : *Y7104032*  
**Supervisor(s)** : *Qureshi Shafi*

***Abstract:***

As technology shrinks every year, leakage power and dynamic power of ASIC designs have become an important issue. This work attempts to use a combination of different low power techniques on a design candidate and hence arrive at an optimal design with minimum power and maximum performance. The low power techniques used are clock gating, multiple threshold and multiple supply voltage. The design candidate, an 8 bit RISC machine, is first designed with a high generic quality. The architecture of the design is kept simple and general which will ensure the general nature of this work. The design is coded in verilog and later thoroughly tested for correct functionality. For each combination of the above low power techniques, the design is synthesized, its static timing is analyzed and power readings are taken. To keep a reference for all analysis, a base design is first synthesized which does not have any optimization techniques applied on it. Finally based on the results of the power and timing analysis, the optimal design is achieved and an algorithm is charted out. This algorithm is based on a factor introduced in this work as criticality rank of the modules of the design. According to this rank, the algorithm decides which module should go into which threshold or supply voltage domain to give the optimum design. Layouts are created of the base and optimal designs for back annotation to include interconnect parasitics. Using the extracted parasitic information, a final power and performance comparison showed a 33.33 % improvement in performance and 42.53 % reduction in power using multi threshold with clock gating technique. The design was implemented at 90 nm technology node using TSMC libraries. The EDA tools used includes Synopsys VCS for verilog simulation, Design Compiler for synthesis, PrimeTime for static timing analysis, PrimePower for power analysis and Cadence SoC Encounter for creating the layouts.

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***Title*** : ***Study Of Capacitance Voltage Characteristics, Compensation Voltage And Open Circuit Voltage Of Organic Bulk Heterojunction Solar Cells***  
***Author(s)*** : ***Choudhary Ruchi***  
***Roll No*** : ***Y4177367***  
***Supervisor(s)*** : ***IyerSSundar Kumar***

***Abstract:***

Organic solar cells, attractive for their potential for low cost and high volume production, continue to be a subject of intensive research. In this thesis, we have looked at some characterization techniques and device parameters of organic solar cells to gain better understanding of the working of these devices. This should help us in the design of efficient devices. The capacitance voltage characteristics of bulk heterojunction organic solar cells both in dark and under illumination have been studied in conjunction with the current voltage characteristics of the device to be able to qualitatively estimate the traps in the device. There is a shift in the peak capacitance value under illumination which suggests a modification of injection due to the presence of photogenerated carriers. All the experimental results have been verified by simulations with a device simulator. The compensation voltage, the bias voltage at which the current in the dark is equal to the current under illumination, has been studied in detail. It has been shown that compensation voltage varies with intensity which was till now reported to be constant and equal to the built in voltage. The analysis of intensity variation of compensation voltage and open circuit voltage has been used to predict the built in potential more accurately.

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**Title** : *Evaluation Of Synthesized Poly (3- HexylThiophene) For Solar Cell Application And A Study Of The Effect Of Doping It With Ferric Chloride*  
**Author(s)** : *Pawar Hitendra Singh*  
**Roll No** : *Y7104028*  
**Supervisor(s)** : *Iyer SSundar Kumar*

***Abstract:***

Poly(3-hexylthiophene) (P3HT) based polymer solar cells are being extensively studied and new device structures, blends, and methods are being explored to achieve higher efficiencies. Thus methods of synthesizing P3HT at low cost and steady volume are imperative. Though efficiencies over 6.5% have been demonstrated due to high absorption in visible spectrum, device performance varies according to device structures, material properties, and spin speed and preparation methods. This work demonstrates the evaluation of synthesized P3HT processed by Defence Materials and Stores Research and Development Establishment (DMSRDE), Kanpur for solar cell applications. Firstly, optical properties of synthesized P3HT are evaluated and compared with that of commercially available P3HT. Absorption spectra in thin films and photovoltaic parameters of single layer devices fabricated from the synthesized P3HT were analysed and compared with those of commercial P3HT. Cyclic voltammetric (CV) test was done for synthesized P3HT and its HOMO and LUMO Energy levels were found comparable with the HOMO & LUMO Energy levels of commercial P3HT. Current density-voltage (J-V) characteristics for Single layer devices fabricated from both P3HT's were measured in light and dark. Plot of dark forward bias J-V Characteristics shows that synthesized P3HT has higher mobility than commercial P3HT. Though Voc for single layer devices fabricated from both P3HT's were same i.e. 0.85V but the Fill Factor for synthesized P3HT device was lower than for commercial P3HT device. Next a P3HT:[6,6]-phenyl-C61-butyric acid methyl ester(PCBM) (1:1) blend device was fabricated from synthesized P3HT which exhibited a photovoltaic effect comparable to commercial P3HT which improved after annealing. Lastly the effect of doping on synthesized P3HT was studied as in one of the Research Papers of National Physical Laboratory, Delhi. For this purpose, absorption spectra was studied for synthesized P3HT films doped with 2%, 5%, and 10% of FeCl<sub>3</sub>, and compared with an undoped film. The absorption peak of P3HT film doped with 5% FeCl<sub>3</sub> was highest, showing that it absorbed maximum radiation. The morphology of synthesized P3HT film has changed after doping but on the other hand the decrease in conductivity of P3HT may be attributed to the strong etching nature of Fe ions.

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**Title** : *Designing And Fabricating Organic Solar Cell With New Imidazolin-5-One Molecule*  
**Author(s)** : *Kailashnath Chidvilas*  
**Roll No** : *Y4177185*  
**Supervisor(s)** : *Iyer SSundar Kumar*

***Abstract:***

This thesis describes various aspects of designing solar cell devices for a new material (4Z)-4-(4-Methoxybenzylidene)-1-phenyl-2-(4-phenyl-(1E)-(3E)-butadienyl)-1,4-dihydro-5H-imidazolin-5-one (Molecule C). Solar cells fabricated with previously reported imidazolin-5-one molecules and structure were used as a benchmark for new solar cells being designed and fabricated. The imidazolin-5-one molecules are derivatives of a bio-molecule luminophore and are particularly attractive due their biodegradable nature. The absorption spectrum and photoluminescence of the material were studied. The energy gap ( $E_g = 2.35$  eV) and diffusion length ( $LD = 10.5$  nm) of excitons in the material were calculated. Atomic force microscopy (AFM) measurements were done to study the morphology of the thin film. Cyclic-voltammetric measurements were conducted and the EHOMO (-6.19 eV) and ELUMO (-3.84 eV) were calculated. Single layer devices were fabricated to evaluate the mobility and charge conduction in thin films made with Molecule C. The electron mobility was determined to be  $1.12 \times 10^{-11}$  cm<sup>2</sup>V<sup>-1</sup>s<sup>-1</sup>. Single layer solar cells showed solar cell property under standard illumination (1 sun AM 1.5G) with  $J_{sc} = 0.332 \mu\text{A}/\text{cm}^2$ ,  $V_{oc} = 0.734$  V,  $FF = 0.16$ , efficiency =  $4 \times 10^{-5}$  % for incident power of 100 mW/cm<sup>2</sup>. Bilayer devices were designed with ITO|PEDOT:PSS as anode, Molecule C as hole transport layer (HTL), C60 as electron transport layer (ETL) and Ca-Al as cathode and fabricated. In another experiment the exciton dissociation efficiency of bilayer was improved by the use of bathocuprione (BCP) as an exciton blocking layer. To reduce the rate of degradation of material due to moisture and oxygen, experiments were carried out and devices with an addition protective layer of lithium fluoride (LiF) deposited over the cathode were fabricated. The degradation studies indicated significant improvement in the device performance. In this work the device performance was significantly improved by designing and successfully fabricating better device structure. The best performance of device achieved in this work is  $J_{sc} = 0.973 \mu\text{A}/\text{cm}^2$ ,  $V_{oc} = 0.66$  V,  $FF = 0.15$ , efficiency =  $9.5 \times 10^{-5}$  %.

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**Title** : *P3HT:PCBM Bulk Heterojunction Solar Cells On Flexible PET Substrates*  
**Author(s)** : *Dembla Ashish*  
**Roll No** : *Y4177101*  
**Supervisor(s)** : *Iyer SSundar Kumar*

***Abstract:***

The goal of this thesis is to develop and study the organic solar cells fabricated using P3HT (Poly-3-hexylthiophene-2,5-diyl):PCBM ([6, 6]-phenyl-C61-butyric acid methyl ester) blends on flexible PET (Polyethylene Terephthalate) substrates. Bulk heterojunction solar cells fabricated at IIT Kanpur show an efficiency of upto 1.4% on glass substrates at the time of starting this thesis. Developing similar solar cells on flexible substrates poses challenges in terms of processing as well as characterization. One of the major hurdles in sustained development is the degradation of solar cells. This work focuses on developing a flexible encapsulation technique which can increase the lifetime of the fabricated devices. Un-pixelized device structure was fabricated by spin coating P3HT:PCBM blend on flexible ITO (Indium Tin Oxide) coated PET substrates with Ca/Al electrode. Photovoltaic effect was observed on flexible substrates ( $J_{sc} = 1.32 \mu\text{A cm}^{-2}$ ,  $V_{oc} = 0.29 \text{ V}$ ,  $FF = 0.2$  and  $\eta = 7.8 \times 10^{-5} \%$  under 1 sun illumination). For further improvement in lifetime pixel based device structure was fabricated, which led to improved device performance and better fabrication yield. These devices were initially encapsulated using vacuum tape and lasted 3-7 days. They also had better performance post fabrication ( $J_{sc} = 125 \mu\text{A cm}^{-2}$ ,  $V_{oc} = 0.225 \text{ V}$ ,  $FF = 0.2$  and  $\eta = 6 \times 10^{-3} \%$  under 1 sun illumination). The last part of the thesis is concerned with developing a novel LiF (Lithium Fluoride) based encapsulation and comparing it with an organic-inorganic multilayer encapsulation. The multilayered encapsulation (alternating LiF and BCP layers) has shown promising results and need further optimization to meet lifetime requirements for organic solar cells. The devices show lifetimes greater than 15 days with improved performance over earlier fabricated flexible solar cells ( $J_{sc} = 1.26 \text{ mA cm}^{-2}$ ,  $V_{oc} = 0.375 \text{ V}$ ,  $FF = 0.15$  and  $\eta = 7 \times 10^{-2} \%$  under 1 sun illumination). Multilayered sidewall encapsulation shows greater protection to open circuit voltages.

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**Title** : *Reliability Studies Of P3HT: PCBM Organic Solar Cells Fabricated With Calcium-Aluminium And Lithium Fluoride-Aluminium Cathodes*

**Author(s)** : *T S Krishnan*

**Roll No** : *Y7104038*

**Supervisor(s)** : *Iyer S Sundar Kumar*

**Abstract:**

Organic solar cells have made rapid strides over the years in terms of efficiency. In order to ensure commercial utilization of these devices, stability of these devices must be improved. Lifetime is one of the most critical parameters to determine the stability of organic devices and this needs to be comparable to that of the conventional photovoltaic devices. This work addresses the shelf life characteristics of Poly-3 hexylthiophene-2, 5-diyl and [6, 6]- phenyl-C61butyric acid methyl ester (P3HT: PCBM) blend devices fabricated with Ca-Al and LiF-Al cathodes. Some of these devices are encapsulated in nitrogen ambient and some in room ambient. The device electrical characteristics under both dark and light are studied. In the analysis for dark ambient conditions, the degradation in peak dark current is monitored over time (in days) and from the decay curves obtained, an empirical model is postulated for this degradation based on statistical curve fitting techniques. In the analysis under light, degradation of various parameters such as fill factor (FF), short circuit current density (Jsc) and open circuit voltage (Voc) is monitored over time in all these devices ( for different cathodes and different ambients ) and the results are analyzed and compared. Accelerated stress tests are conducted wherein the devices are subjected to continuous illumination for a period of 1.5 hours under two different intensities (1 sun and 0.76 sun) and the results are analyzed and compared as well. A model is fitted to the observed degradation in the normalized short circuit current density and the values of the degradation constant (kdeg) are found out. It is seen that the devices fabricated with LiF-Al cathode and encapsulated in nitrogen ambient provide the best performance over time.

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**Title** : *Design Of SOC For Network Based RFID Applications*  
**Author(s)** : *Malladi Krishna Teja*  
**Roll No** : *Y4177196*  
**Supervisor(s)** : *Qureshi Shafi*

***Abstract:***

The last decade has seen an increased usage of RFID systems and peer-to-peer sensor nodes. These need a hardwired PC/FPGA/Network Processor to communicate with remote servers for enterprise applications, which consume atleast three orders of magnitude higher power than the system. Ongoing research addresses low power RFID, sensor nodes design, but the additional cost and power for the communication modules are hidden. Our current work addresses the issue of providing a scalable, power- area- cost efficient network connectivity to the above class of applications by the design a custom SoC. The design principle rests on the observation that a Network processor has hardware intensive features like IP Address look-up, parsing, hash functions,etc which could be simplified for the given application. A Systolic-Array architecture of hardware units each operating on one level of network OSI hierarchy is proposed here for the network transceiver. It is further parallelized into packet engines each operating at a line speed of 125 MHz on the 100 base-TX ethernet network. Also, interface units to the RFID reader, a GSM unit for SMS connectivity, DES Security module for secure transmission, a Co-processor for system acceleration are designed. With the SoC acting as a UDP client, a remote server has been programmed to poll for RFID data and send it as an email to a mail-server. After the functionality and throughput requirements are met, we use a novel multi-layer hierarchy framework which enables power and area optimizations across the boundary of algorithm, architecture and circuits by employing techniques like parallelism, pipelining, clock-gating, scheduling, queuing algorithms etc . A general purpose RISC processor and an SRAM cache controller have been designed to have flexibility for additional functionalities. Further, at the circuit level, we propose a novel optimization framework to use Multi-Vdd and Multi-Vth techniques simultaneously in the presence of process variations which showed power savings of 57% in the transceiver. The design is then floor-planned for area, timing and the layout of the proposed SoC is completed. By a series of tests, the SoC has been veri fied for IEEE 802.3 Ethernet requirements in Xilinx where it has synthesized and mapped to onto a Xilinx Vitrex-5 FPGA also. After the entire design flow hierarchy, the SoC has an area 0.1015 mm<sup>2</sup>, power of 2.143 mW at a clock speed of 125 MHz and a supply voltage of 1 V for about 0.1 million transistors in 90 nm CMOS process.

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*Title* : *Preliminary Studies In Row Buffer Locality Enhancement Via Dynamic Address Remapping*  
*Author(s)* : *Gupta Saurabh*  
*Roll No* : *Y4177392*  
*Supervisor(s)* : *Iyer S Sundar Kumar &Chaudhuri Mainak (CSE)*

***Abstract:***

In a chip-multiprocessor (CMP) system, the DRAM system is a shared resource. In a shared DRAM system, requests from a core can delay requests from other cores by causing row buffer conflicts. As a result of this problem, many execution cycles are wasted waiting for critical data requests. This thesis approaches the problem of degraded row buffer locality and attempts to improve this locality by deploying a dynamic page address remapping technique. The page remapping attempts to cluster a subset of active pages(within a bank) to a common row to avoid further row conflicts. The FRFCFS scheduling is used as the memory request scheduling policy and enhanced throughput is obtained by implementing the remapping algorithm. The implementation and performance issues of page remapping algorithm are dealt with and discussed in detail. The gains of deploying such a remapping technique are also quantified and findings suggest that the scope of reducing overall execution time by reducing latency of off-chip DRAM system is not excessively beneficial. The proposed model to estimate the gains of improving row buffer hit rates estimates that the reduction in execution time varies linearly with respect to improvements in row buffer hit rates. This model is verified by comparing the estimates with the simulation results. The improvement in row buffer hit rate is suppressed by the overheads of remapping in most of the cases and therefore, the benefits of improving the latency of off-chip DRAM system by page remapping are found to be limited..

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*Title* : *Vertical Organic Thin Film Transistor To Achieve Sub Ten Micron Channel Length Devices*  
*Author(s)* : *KhanAbdul Rauf*  
*Roll No* : *Y6104002*  
*Supervisor(s)* : *Iyer SSundar Kumar*

***Abstract:***

The channel length of the top contact organic thin film transistors are usually defined during their fabrication by optical lithography or by shadow masking during the metal deposition process. Realising short channel (sub-ten micron channel length) transistors by lithography will require costly lithography equipment. On the other hand, it is extremely challenging to achieve short channel transistors using the low cost shadow mask process. One low cost method of achieving short channel devices is to build vertical transistors with the transistor, where the channel gets defined in the vertical part of the device. In this thesis, vertical channel top contact organic thin film transistor has been successfully realized on Si Substrate with SiO<sub>2</sub> as gate insulator and pentacene as the organic semiconductor. The active channel was defined on the vertical edge of a wide trench etched in the substrate. This helped in creating the device with channel lengths less than ten microns, much smaller than what could be typically achieved with the use of shadow masks. The sub-ten micron vertical organic thin film transistors were electrically characterised. The characteristics and transistor performance parameters estimated from these were compared with the transistor characteristics of the more standardized horizontal top contact organic thin film transistor of channel length (140µm).

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*Title* : *Study Of Printed Ultra-Wideband Antennas*  
*Author(s)* : *Sinha Chetan Kumar*  
*Roll No* : *Y7104014*  
*Supervisor(s)* : *Sachidananda M & Harish AR*

***Abstract:***

In the present thesis printed ultra-wideband antenna designs have been studied. In order to achieve such an antenna design that can be operated over the entire ultra-wideband i.e. over the frequency range 3.1-10.6 GHz, several changes in the antenna structures have been considered starting with a planar version of biconical antenna named as antenna-A. Simulations of all the antenna structures have been performed using IE3D, a commercial software from Zeland Inc. In order to improve the impedance bandwidth of the microstrip fed planar antenna-A, the width of microstrip line were varied, different numbers of slots were cut at different places of the antenna, and effect of each change on the return loss curve was observed. An antenna structure with combination of slots and parasitic patches was found to have satisfactory impedance bandwidth but improvement in the radiation pattern was not observed. So, the structure without any slots was considered for simulation and effect of its structural variations on the return loss curve was studied. Some of the simulated structures, named as antennas-I, are found to have good return loss characteristics over entire UWB, and satisfactory patterns over wide bandwidths. With increase in frequency, the simulated patterns of these structures tend to loose uniformity. In order to achieve improved radiation characteristics and also to reduce the physical size, the structures with smooth ground edges were simulated. Finally a structure with the top edge of its ground being a circular arc was found to have satisfactory impedance as well as radiation characteristics over the entire ultra-wideband. Effects of variation in various structural parameters on return loss of this antenna, named as antenna-II have been given. The finally optimized structure, antenna-II was fabricated. Measurement of return loss and pattern characteristics of antenna-A and antenna-II were carried out. The measurement procedures have been briefly described and comparisons between simulated and measured results have been presented. The antenna-II is more compact and has been found to have relatively better impedance and radiation characteristics, both in simulation and measurements, as compared to other antennas studied in the thesis

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*Title* : *Mobile Ad-Hoc Network Of RFID Readers*  
*Author(s)* : *GuptaSwastik*  
*Roll No* : *Y7104077*  
*Supervisor(s)* : *Harish AR & Kalra Prem Kumar*

***Abstract:***

With increase in demand of ‘context aware services’ and ‘customized services’, the RFID technology is being looked upon by various service providers as a powerful technology, playing a vital role to fulfill the customer requirements. A Basic RFID System consists of a Reader (Interrogator) and Tags (Identification Data Carrying Devices). Most of RFID readers available in market today are dependent on a wire network infrastructure like Ethernet. But with increase in demand of customized services, a strong need has been felt to create Wireless RFID Readers which are capable of forming a Mobile Ad-hoc Network (MANET) thus resulting in a distributed and ubiquitous computing environment and providing seamless service. IEEE 802.15.4 networking standard has been chosen for solving the purpose as it is capable of forming cost effective and reliable MANETs. In this thesis we present a complete framework for making the existing RFID readers wireless. These readers are capable of working in mobile environment in ad-hoc fashion with existing software solutions. Implementation of a gateway for data exchange between existing LAN (or WLAN) and IEEE 802.15.4 network is done

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*Title* : *Reader Collision In RFID Networks*  
*Author(s)* : *Anand Gautam*  
*Roll No* : *Y7104023*  
*Supervisor(s)* : *Harish AR & Kalra Prem Kumar*

***Abstract:***

Radio Frequency Identification (RFID) is a means to identify and track objects using radio frequency transmission. An RFID system consists of readers and tags. Readers use radio signals to communicate with the tags. RFID is increasingly being used in many applications such as inventory management, object tracking, retail checkout etc. The reader collision problem occurs when the signal from one reader interferes with the signal from other readers. Such interference can result in lack of communication between the readers and some of the tags in the vicinity leading to incorrect and inefficient operation of an RFID system. This problem is further aggravated when mobile/hand-held readers are used in the system. Hence efforts are required to minimize this interference. We proposed a distributed MAC layer protocol to reduce these reader collisions in the RFID systems. The operation of the proposed protocol is based on periodic broadcasting of packets on a separate control channel by the reader, while it is reading the tags. We implemented the protocol using ATMEGA128 microcontroller as a master chip and Xbee module for communication with other readers on a separate control channel. In case of "Listen Before Talk" protocol based on ETST EN 302 208 standard, average percentage drop in tag read rate is around 53% whereas for our protocol it is only 17%.

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*Title* : *Design Of Novel Left-Handed Transmission Line  
Metamaterials And Their Application In The Realization Of  
Miniaturized Bandpass Filter*

*Author(s)* : *Naga Satish Godavarthi*

*Roll No* : *Y7104052*

*Supervisor(s)* : *Biswas Animesh &Srivastava Vibava kumar*

***Abstract:***

Metamaterials (MTMs) are the artificial composite structures having simultaneously negative values of  $\epsilon$  and  $\mu$ . The E, H and k vectors of the electromagnetic (EM) wave interacting with MTM forms a left handed triad, so these are also called Left-Handed Materials (LHMs). The left handedness of EM waves in a MTM provides various new properties which can be used in microwave components such as waveguides, couplers, power dividers, resonators and filters for size reduction, dual band, enhanced bandwidth, backward wave coupling, phase compensation and propagation of evanescent waves etc. The physical realization of LHM can be obtained either by combining resonant structures, such as Split Ring Resonators (SRRs) and wires, providing negative  $\mu$  and  $\epsilon$  respectively, or by transmission line (TL) approach with series capacitance and shunt inductance. In any type of implementation the periodic repetition of fundamental element, called unit cell, under the homogeneous limit constitutes the composite structure of the MTM. So, the design and characterization of the fundamental unit cell is sufficient to study the LH properties of the composite structure. In this thesis the fundamental properties of LHMs are initially investigated and their traditional realization in non resonant type is implemented. A novel via free microstrip LH TL unit cell using radial stub is proposed and characterized by approximating the input impedance of radial with a series combination of inductance and capacitance. An open circuited zeroth order resonators with different number of unit cells are designed to verify the length independent zeroth order resonance (ZOR) property of the proposed unit cell. The unit cell of the traditional microstrip LH TL with vias and the proposed via free LH TL are slightly modified to obtain symmetrical configuration and the open circuited ZOR is designed. A 3 pole narrow bandpass filter with 3% fractional bandwidth is designed at 4.3 GHz with ZORs and it is shown that a size reduction of 61.3% is obtained when compared bandpass filter with half wavelength resonators.

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*Title* : *Application Of Particle Swarm Optimization For Antenna Arrays*  
*Author(s)* : *Talluri Salman Raju*  
*Roll No* : *Y7104070*  
*Supervisor(s)* : *Sachidananda M & Harish AR*

***Abstract:***

The particle swarm algorithm has widespread applications in engineering. This is a new stochastic evolutionary computation technique based on the movement and intelligence from a swarm of particles. It has been shown in certain instances to outperform other stochastic methods of optimization like genetic algorithms. The particle swarm algorithm is entirely treated in the decimal system and becomes very straightforward, efficient, and easy in formulation and programming. Restrictions can be easily imposed on the fitness function in the optimization process. Therefore, it is very useful in the design of antenna arrays. In this thesis, Particle Swarm Optimization (PSO) is applied to different problems in antenna arrays. In the first problem, the PSO is applied to synthesize the radiation patterns of linear arrays in a direct way and in an indirect way (using the adaptive array technique). In the second problem, PSO is applied to synthesize the frequency invariant (FI) beamforming and the results obtained using PSO are compared with the Fourier Transform method along with suitable substitutions which is used for FI beamforming. In the third problem, PSO is applied to reduce the number of antennas in a linear array for symmetrical beam patterns and results obtained using PSO are compared with matrix pencil method (MPM) for reducing the number of elements in a linear array. Then PSO is applied to synthesize the COSECANT Pattern with reduced number of elements (The minimum number of elements is taken from the concept of Singular Value Decomposition). Finally, PSO is applied to reduce the side lobe levels in the radiation pattern of a nonlinear half wavelength folded dipole antenna array including the mutual coupling relying on the active element patterns.

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