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Title : *Timing Synchronization of Bandwidth Efficient Coded OFDM System*

Author(s) : *Samal Umesh Chandra*
Roll No : *Y9104099*
Supervisor(s) : *Vasudevan K*

Abstract

In this work, we propose data aided (DA) timing synchronization schemes for orthogonal frequency division multiplexed (OFDM) signals, transmitted through independent Rayleigh fading multipath channels, in the presence of additive white Gaussian noise (AWGN) and frequency offset. The channel is assumed to have an exponential power delay profile. The timing metric is independent of the preamble structure. The OFDM subcarriers are modulated by QPSK signals. The proposed timing synchronization algorithm estimates the starting point of OFDM frames by using a filter that is matched to a known preamble. The performance of the proposed scheme is simulated and compared in terms of probability of erasure (PE) probability of not detecting a frame when it is present) and mean squared error (MSE), with the previously existing timing synchronization methods for OFDM systems. The simulation results indicate that the proposed method improves the performance of the system significantly. Moreover, the computational complexity for the proposed timing synchronization method is less as compared to previously existing methods, which is helpful in real-time applications. In order to improve the throughput, the same preamble can be used for frequency offset and channel estimation. Next, bandwidth efficient turbo codes, commonly known as turbo trellis coded modulation (TTCM) is proposed for OFDM systems. It improves the bit-error-rate (BER) performance and spectral efficiency simultaneously, which are the major requirements for modern communication systems. The throughput can be improved by puncturing. In addition to TTCM, data interleaver (DI) is incorporated to enhance the BER performance of the system further. The BCJR algorithm is used at the receiver to decode iteratively the received turbo trellis coded interleaved OFDM signals. Simulation results study the performance of TTCM schemes with and without DI for different values of preamble and data lengths, assuming non-ideal synchronization, channel and frequency offset estimation.

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Title	***:***	***Analysis of Pitched Polyphonic Music for Source Transcription***
Author(s)	***:***	***Arora Vipul***
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Supervisor(s)	***:***	***Behera Laxmidhar***

Abstract

Music is ubiquitous in everyday life. Mostly music is polyphonic in nature, i.e., consisting of several musical sources (voices and instruments) playing simultaneously. The ability of human auditory system to comprehend polyphonic music is highly difficult to be mimicked computationally. It is an example of the famous cocktail party problem to listen to a sound (mostly speech) of interest immersed in many concurrent sounds. This thesis aims at analyzing different melodic aspects of single-channel polyphonic music, with source transcription as the final goal. First, a novel on-line method is proposed for predominant melody extraction from audio files with one predominant source in midst of many accompaniments. It complies with the spectral harmonics as well as the temporal constraints simultaneously, and is robust to low frequency distortions due to accompaniments. Further, given an audio file and the corresponding multiple pitch (F0) values, novel methods are proposed to classify or cluster these F0s into their originating sources. This problem is approached in supervised, unsupervised as well as semi-supervised ways, using the framework of source-filter model based Probabilistic Latent Component Analysis (PLCA). In the supervised approach, novel ways are proposed to enhance the ability of PLCA features to distinguish between different sources, firstly with the help of discriminative training, and secondly, by non-Euclidean modeling of the acoustic space. The semi-supervised and unsupervised approaches are grounded in a theoretical framework, which is inspired from the principles of cognitive grouping of sounds, and are implemented using the tools of PLCA and constrained graph clustering. Finally, a complete unsupervised source transcription system for pitched polyphonic music is developed. It consists of two parts, viz., (i) estimation of multiple F0 values and (ii) clustering of these F0s into different sources. It is based on the PLCA framework embedded into Hidden Markov Random Fields. The two sub-tasks are amalgamated using a novel strategy so that the errors of one do not cripple the other. Experimental evaluations have been carried out for all the above proposed systems and their performances have been compared with that of the state-of-the-art methods to substantiate the improvements. The proposed techniques have great applications in music information retrieval based tasks like music search, music processing, automatic music transcription, source separation, music recommendation as well as music education.

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Title : *Spatial correlation-based efficient communication protocols for wireless sensor networks*

Author(s) : *Shakya Rajeev kumar*
Roll No : *Y8104073*
Supervisor(s) : *Singh Yatindra Nath&Verma Nishchal Kumar*

Abstract

In this thesis, a basic spatial correlation function has been proposed to model the correlation characteristics of the event information observed by multiple sensors with Omni-directional coverage and communication capabilities. Two frameworks – mathematical and analytical -- using this new alternative correlation model has been presented at both medium access control (MAC) and network layers. At the network layer, it is demonstrated that how, through proper tuning of both the sensing range and the correlation threshold, WSNs can be partitioned into the disjoint correlated clusters without any degradation in the information reliability, thus enabling significant energy-saving during data collection. At the MAC layer, extending the work of Vuran and Akyildiz, a theoretical framework has been developed to estimate the event source and reconstruct the distortion at the sink. The impact of correlation between nodes on achieved distortion at the sink is investigated using various parameters such as sensing range, selected node numbers and spatial node density. The performance of the proposed model in terms of observed event distortion have been compared with what one gets with the correlation models found in the existing literature. Motivated by the benefits of the framework and methods, energy-efficient communication protocols (a MAC protocol called Event-MAC and a routing protocol called PS-NLEACH) are also developed for event-driven sensing systems. They exploit the spatial correlation to improve the system's life-span. The spatial correlation-based, localized event-oriented MAC (Event-MAC) is developed first. It aims to reduce energy consumption by scheduling event reports based on correlation and priorities, without compromising the achieved distortion constraint and event latency. Next, a correlation-based hierarchical routing protocol (PS-NLEACH) is developed that optimizes the network structure according to correlation between nodes without degrading the data resolution or fidelity. The proposed protocols are simulated and compared with the existing protocols to examine their performance

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Title : *Microphone Array Processing for Acoustic Source Localization in Spatial and Spherical Harmonics Domain*

Author(s) : *Kumar Lalan*
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Supervisor(s) : *Hegde Rajesh Mahanand*

Abstract

With increased computational power and evolution of compact device technology, microphone arrays are being used in hand held devices like mobile phones to large scale defense equipments. Source Localization is a central problem in microphone array signal processing, and it becomes even more challenging in the presence of noise, reverberation and sensor array ambiguities. In this thesis, novel methods for acoustic source localization are proposed in spatial and spherical harmonics domain. In the context of spatial domain signal processing, a high resolution method that utilizes the phase of MUltiple SIgnal Classification (MUSIC), is proposed for far-field source local- ization over planar array. This method computes the group delay of MUSIC, and is called MUSIC-Group delay (MGD) method. The MUSIC-Group delay method is able to resolve closely spaced sources with a minimal number of sensors in contrast to the standard MUSIC method, even in a reverberant environment. Signal processing in spherical harmonics domain provides ease of beampattern steering and a unified formulation for a wide range of array configurations. Both far-field and near- field source localization problems are addressed in the spherical harmonics (SH) domain. The MUSIC-Group delay method is formulated in spherical harmonics domain (called SH-MGD), to resolve the spatial ambiguity in planar array. A search-free algorithm, SH-root-MUSIC is also proposed for azimuth only estimation of far-field sources. A new data model is developed for near-field source localization in spherical harmonics domain. In particular, three methods namely SH-MUSIC, SH-MGD and SH-MVDR, that jointly estimate the range and bearing of multiple sources are proposed. The near-field MVDR beampattern analysis is also performed to illustrate the significance of the proposed method. Stochastic Cramér-Rao bound for far-field and near-field data model is formulated in spherical harmonics domain to evaluate the location estimator. Several experiments on 3-D source localization are conducted in reverberant and noisy environments. Additionally, experiments are also performed on real signal acquired over spherical microphone array in anechoic chamber. The comparative performance of the proposed methods is presented in terms of root mean square error, probability of resolution and average error distribution.

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Title	:	*Development of Synchrophasor Measurement Based Wide-Area Damping Controllers For Improving Power System Stability*
Author(s)	:	*Padhy Bibhu Prasad*
Roll No	:	*Y9104091*
Supervisor(s)	:	*Srivastava S C&Verma Nishchal Kumar*

Abstract

Small signal oscillations are frequently observed in the power system networks, which, under stressed conditions, may lead to major system blackout. Conventional Power System Stabilizers (CPSS) are provided in the generator excitation system to damp out the small signal oscillations. These are designed using linearized model, obtained at a given operating point, and its performance may not be guaranteed at other operating conditions. These also, in general, lack global observation and may not effectively damp out the inter-area oscillations. Wide Area Monitoring, and Control (WAMC) system, employing synchrophasor technology, is being increasingly used in power system networks, which utilizes Phasor Measurement Units (PMUs), to provide synchronized and time stamped voltage and current phasors in real time. These measurements can be effectively utilized to design a centralized Wide Area Damping Controllers (WADC). The networked based implementation of the WADC need to address certain issues such as selection of appropriate input/output signals, compensation of network delays, packet disorder and packet drop out, apart from the use of robust controller.

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Title	:	*Spectral Methods for Single and Multi Channel Speech Enhancement in Multi Source Environment*
Author(s)	:	*Nathwani Karan*
Roll No	:	*11104170*
Supervisor(s)	:	*Hegde Rajesh Mahanand*

Abstract

Hands-free mobile telephony has become ubiquitous in modern day living with its wide variety of applications in our day to day life. Generally speech signal received at the microphone is degraded by background noise, and room reverberation. However in multi source environments additional speech sources are present making the problem even more challenging. These challenges have motivated research on single and multi channel speech enhancement methods. In this thesis several new methods for single and multi channel speech enhancement are proposed. In particular spectral methods for source separation, de-reverberation, and noise cancellation are described. Additionally methods that jointly perform the aforementioned tasks are also developed. The group delay spectrum (GDS) has hitherto not been used for single channel speech enhancement, although it has been widely used in feature extraction. The high resolution and robustness property of the GDS is e ectively used in this thesis to propose novel methods for source separation and dereverberation. The rst method addresses the problem of source separation using the group delay cross correlation spectrum and an iterative graph cut method. The second method jointly addresses the problem of single channel source separation and dereverberation in a nonnegative matrix factorization (NMF) framework. The enhancement problem is formulated herein by assuming di erent room impulse response (RIR) for each source location. The group delay spectral magnitude used in the NMF framework is shown to exhibit accurate decomposition property. Both methods give signi cant improvements in perceptual quality of separated signals and speech recognition performance when compared to conventional methods. Multi channel systems utilize spatial diversity which is not present in single channel systems. Novel beamforming based spatial spectrum estimation methods for multi channel speech enhancement have been proposed in this thesis. Under the xed beam forming framework, a new reverberant speech enhancement method that utilises the LP residual cepstrum is developed. On the other hand, a linearly constrained minimum variance (LCMV) based spectral method is developed for joint noise cancellation and dereverberation in a beamforming framework. This is realized as a multi channel LCMV lter that constrains both the early and late parts of the speech frame. The lter outputs are then beam formed to remove late reverberations. These methods indicate signi cant improvement in perceptual quality of separated signals and distant speech recognition performance when compared to conventional methods. Information retrieval systems on a cell phone and in a teleconferencing environment are developed to demonstrate the e ectiveness of the methods proposed in this thesis. Blind source separation (BSS) in a multi channel framework can be investigated in future as part of related work. In this context, a Bayesian approach for separation of convolutive mixtures in the spectral domain can also be explored.

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Title	***:***	***Development of control schemes for power management and operation of DC microgrids***
Author(s)	***:***	***Kumar Mahesh***
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Supervisor(s)	***:***	***Srivastava S C&Singh Sri Niwas***

Abstract

The concept of a DC Microgrid (DCMG) is promising option to integrate various non-conventional Distributed Energy Resources (DERs), in islanded and grid connected modes. A ring type architecture of the smart DCMG with autonomous controls, based on dc power pool, has been proposed in this work, which consists of Wind Turbine (WT), solar photo-voltaic, solid oxide fuel cell, micro-turbine Distributed Generators (DGs), Energy Storage Systems (ESSs), and various dc and three-phase as well as single-phase ac loads. The Pulse Width Modulation (PWM) based Voltage Source Converters (VSCs) have been used to integrate various DGs, ESSs, and loads to the DCMG, which allow effective voltage and power flow control, system balancing, and maximum power point tracking of the DG sources. A Hybrid Energy Storage System (HESS), consisting of the battery and the hydrogen storage system, integrated to the proposed DCMG, and its control strategy has also been proposed to achieve power balance in the remote areas, where utility grid may not be available. Further, for sharing the power between two or more remote areas, a scheme for interconnection of the clusters of the neighboring islanded DC Microgrids (DCMGs), operating at different voltages, has also been developed using Bidirectional DC-DC Converter (BDC). Several control strategies of PWM VSCs, used for interfacing purpose, have been proposed for maintaining the power balance and the DCMG voltage almost constant at desired rated value, under different operating scenario, including fault conditions. Various control strategies proposed are as following. • Control strategy of the bidirectional three-phase VSC for integrating WT DG, using a combination of a feed-back and two feed-forward control loops, with dual controllers, into two rotating d-q SRFs viz. positive SRF and negative SRF. • Control strategy of three-phase VSI for integration of three-phase loads and utility grid to the DCMG, using a combination of a feed-forward and two feed-back control loops, with dual controllers into two d-q SRFs for controlling of the negative sequence and the positive sequence components, independently, in its own SRF. • Control strategy of the single-phase full-bridge Voltage Controlled VSI (VCVSI), using feed-forward and feed-back control loops into single rotating d-q SRF for integration of single-phase ac loads to the DCMG. • A control strategy for the single-phase full-bridge VCVSI, based on Two-Revolving Field Theory, using a combination of a feed-forward and two feed-back control loops, with dual controllers, into two rotating d-q SRFs for integrating all single-phase loads to the DCMG. The simulations have carried out under different operating scenarios to verify the robustness and the effectiveness of the proposed DCMG control strategies in islanded and grid connected modes, in MATLAB/Simulink as well as on Real Time Digital Simulator (RTDS).

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Title	***:***	***Studies on Ultra-thin Microwave Metamaterial Absorber for Multiband and Wideband Applications***
Author(s)	***:***	***Bhattacharyya Somak***
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Supervisor(s)	***:***	***Srivastava Kumar Vaibhav***

Abstract

Due to the compact and thin nature of metamaterial structures, they find applications in designing absorber ranging from microwave to far infrared frequency domain. First, an electric field driven LC resonator driven metamateral absorber structure has been proposed which shows two distinct absorption peaks close to each other to achieve bandwidth-enhancement in C-band for airborne radar applications using two different sub-cells. Thereafter, a single ELC structure exhibiting polarization-sensitive dual band absorption has been discussed. Later, it is modified to achieve triple band absorption in C-band having polarization-insensitivity over wide incidence angle. Also, a triple band polarization-insensitive absorber with bandwidth-enhancement at X-band has been developed using square-shaped closed ring resonators over wide angle of incidence. Thereafter, the equivalent circuit model of the triple band absorber has been developed sequentially considering the single band and double band absorber models. The circuit simulation of the final model agrees well with the full-wave simulation, thus validating the modeling technique. The structure is also fabricated and experimental absorption peaks are found close to the simulated values. Further, ultra-thin (compared to the operating wavelengths of the center of the two frequency bands) polarization-independent metamaterial absorbers with enhanced bandwidths at two separate frequency bands (C and X-bands) are developed over wide angle of incidence using two layers of dielectric substrates. The proposed structure is fabricated and experimental results are in good agreement with the simulated responses. Finally, a broadband metamaterial absorber is presented with octave bandwidth for practical applications covering the entire X-band over broad incident angles. The proposed structure is very thin compared to the commercially available microwave absorbers.

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Title : ***Improved Estimation of Dynamic Phasors, and their Applications in Distance Protection & Stability Assessment***

Author(s) : ***Banerjee Paramarshi***

Roll No : ***Y9104095***

Supervisor(s) : ***Srivastava S C***

Abstract

Synchrophasor based Wide Area Monitoring System (WAMS), employing Phasor Measurement Units (PMUs), are being increasingly deployed in the power system networks. Fast and accurate estimation of voltage and current phasors, during dynamics conditions, is required for various monitoring, protection and control applications. This work attempts to accurately estimate the dynamic voltage phasor, current phasor, the first and the second derivatives of their amplitude and phase angle, using sampled values of the signals. The amplitude of the voltage is estimated by Total Least Square Estimation of Signal Parameters via Rotational Invariance Technique (TLS-ESPRIT), and suitable compensation has been proposed to improve its accuracy. The phase of the voltage signal is estimated by Propagator Method with certain modifications to increase its estimation accuracy. The accuracy of the voltage phasor estimation is evaluated based on Total Vector Error (TVE) obtained with the proposed method, and compared with an adaptive Discrete Fourier Transform (DFT) method for different dynamic scenarios including the noisy signal. The combined uncertainty of the TVE by the proposed method is also calculated to comply with the Guide to the expression of Uncertainty in Measurement (GUM) standard. A robust model order estimation is suggested for the current signals having multiple decaying DC offset, oscillations and non-integral harmonics. Accurate estimation of the model order is proposed using the logarithm of the singular values of the Hankel Matrix, comprising of the data samples. The TLS-ESPRIT, applied to the current signal, is extended to second order Taylor's series to properly model the signal dynamics. The TVE and Frequency Error (FE) obtained by the proposed method are compared with a three cycle data window based second order Taylor series method. The proposed method is also tested for different cases of the dynamic signal model with noise and for the cases mentioned in the IEEE Standard C37.118.1 on Synchrophasor Measurements for Power Systems. The expression for the first and the second derivative of the amplitude and the phase are also derived using the single data window, and their accuracies are validated through the predicted TVE, obtained from the phasor calculated at an advance time. The Rate of Change of Frequency (ROCOF) is particularly tested for different test cases mentioned in the recently amended IEEE Standard C37.118.1a.2014, and their compliance with the standard is established in the presence of noise. The accuracy of the phasors, the first and second derivatives of the amplitude and phase for both the voltage and the current signals are also tested on New England (NE) 39 bus system for various scenarios of oscillations and fault. The phasors and their derivatives, estimated in this work, have been further applied to develop a scheme for preventing unintended operation of the distance relays during power swing and

voltage instability. The proposed scheme has been tested for different fault locations and impedances on WSCC 9 bus and NE 39 bus systems. Further, a method to assess the transient stability of the power system, under post disturbance scenario, is proposed using Maximum Lyapunov Exponent (MLE). The MLE has been estimated using the phasors from the PMUs and the stability of the system is established based on the sign of the MLE. The proposed method is tested for different scenarios of disturbances in WSCC 9 bus and NE 39 bus systems and the results obtained through offline simulations have been validated on Real Time Digital Simulator (RTDS).

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Title : *Path tracking control of a Moon rover: modeling, design, and implementation*

Author(s) : *Gunasekaran Manavaalan*
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Supervisor(s) : *Potluri Ramprasad*

Abstract

This dissertation is related to autonomous articulated all-terrain rovers (ATRs). ATRs require the capability of automatic traction control, which involves sensing, estimation, and control. The methodologies for modeling and controlling stationary manipulators and wheeled mobile robots on 2D hard and smooth surfaces are mature. On the other hand, the methodologies for modeling and controlling ATRs are not yet mature. This dissertation presents a path-tracking control of a rocker-bogie mechanism-based moon rover, including modeling, controller design, and implementation. The contributions are as follows. (i) The work of P.F. Muir and C.P. Neuman presents the kinematics model of wheeled mobile robots in 2D motion, without considering displacement slips, using the concept of instantaneously coincident coordinate systems. The work of M. Tarokh and G.J. McDermott attempts to give a general procedure to develop the kinematics model of ATRs in 3D motion with slips. However, that work has fundamental errors and needs corrections before it can be applied. This dissertation uses the concept of instantaneous coincident coordinate systems from the work of P.F. Muir and C.P Neuman and borrows a few correct elements from the work of M. Tarokh and G.J. McDermott to develop a general procedure for modeling the kinematics of ATRs undergoing 3D motion with wheel slips. This procedure is applied to derive the kinematics model of the moon rover. (ii) Planetary rovers operate on unknown terrain. Their speeds are limited by insufficient knowledge of the terrain, and possibly by the existing technologies. Thus, kinematics model-based control is sufficient to control the motion of these rovers. There already exist kinematics-based path-tracking control algorithms. However, they do not comprehensively include wheel slips. This dissertation presents a path tracking control, which includes wheel slips using a kinematics-based motion estimator that includes the turn slip and translational slip. (iii) A dynamics model of the rocker-bogie mechanism-based rover is not available in the published literature. A dynamics model of the moon rover is presented. This dynamics model is used to estimate the wheel-rotational slip. The path tracking control mentioned in Item (ii) above is implemented on a laboratory 2-wheel steered 6-wheel drive moon rover. Due to the limitations of this setup's motor speed sensors and current sensors, only a kinematics-based position estimator that includes the estimates of the wheel translational and turn slips is implemented, and the rotational slip is assumed zero. In multiple trials on 2D sandy terrain, the rover tracks an 8 m long figure 8 with a maximum error any point of 12 cm. For comparison, this estimator-based control helped track a curved path of length 2.3 m with a maximum error at any point of 3 cm, while a control that did not use the estimates of translational slips helped track this curve with an error of 20 cm. In trials on a 3D terrain, the rover tracks an approximately 2 m long curved path with a maximum error of 3 cm. Finally, it is indicated that if the driving motor angular position and current sensing can be adequately accurate, then Item (iii) too can be implemented, helping improve the path-tracking significantly.

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Title : *Studies of Multiple Band-Limited Filters and their Realization using Metamaterial and Dielectric Resonators*

Author(s) : *Awasthi Seema*
Roll No : *Y9104098*
Supervisor(s) : *Biswas Animesh&Akhtar M Jaleel*

Abstract

This thesis presents the coupling matrix approach to the synthesis of prototype filter networks, enabling the realization of the hardware embodying the enhanced performance needed by today's high capacity systems. In today's very fragmented public frequency band spectrum, a multiple band and multiple frequency tunable filter is becoming increasingly in demand. Beside the multiband operation, high performance and compactness are desired features for multiband filters. This thesis concentrates basically on the synthesis of generalized multiple bandstop filters. The frequency transformation has been used for the transformation from low-pass prototype to multiple bandstop filters. A simpler and efficient procedure for synthesizing both symmetric and asymmetric multiple bandstop frequency responses including any number of stopbands is presented. Multiple band filters have been realized using metamaterial resonators because metamaterial mushroom structures offer a compact dimensions .The most valuable feature of the zeroth-order resonators is their miniaturization with the moderate Q factors. These metamaterial mushroom resonators are much smaller in size compared to the conventional Right-Handed resonators. Thus, these resonators have significant advantages in building filters with smaller size. Various single, dual and triple band filters has been designed and fabricated. High-performance radio frequency (RF) tunable filters are needed in reconfigurable systems to facilitate efficient utilization of the available frequency spectrum. Dielectric resonators have been widely employed in wireless and satellite communication systems due to their inherently large Q allowing them to fashion low loss and narrow bandwidth tunable filters. The technology at present consists of an assortment of bandpass filters using dielectric resonators but there is little published material on bandstop filters employing such resonators. Bandstop filters are desirable to suppress frequencies at the front end of wireless communication systems. To meet future demands, it is imperative to reduce the costs of these filters in both volume and weight using dielectric resonators. Two types of dielectric loaded resonator filters are commonly used. One type is the dual-mode filter, operating in HE11 mode, providing low loss, smaller volume, Here only half the number of physical cavities are needed. The other type is the single-mode filter with all resonators operating in TE01δ mode, providing low loss, flexible layout structure, and better spurious free performance. This thesis presents compact TE01δ mode dualband and quadband bandstop filter and a novel dual-mode (HE11 mode) dualband bandpass resonator filter using multilayer multi-permittivity dielectric resonator is developed.

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Title : *Wideband circularly polarized antennas*

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Supervisor(s) : *Harish A R*

Abstract

Special features of circularly polarized (CP) radiation over linear polarization, make CP antennas an attractive solution for space-based communication systems. With the surge in today's wireless communication, circularly polarized planar antennas operating over a large frequency band are in demand. This thesis proposes and explores the ways to achieve circular polarization over a wide frequency band and demonstrates the design of various antennas. Firstly, the use of electric and magnetic current elements (J and M respectively) for circular polarization is proposed. An antenna structure is realized with the combination of half wavelength printed dipole and slot on a single PCB substrate. The bandwidth of the antenna is limited by the bandwidth of dipole and slot elements. The axial ratio (AR) bandwidth (3 dB AR bandwidth 17.5%) is found to be more than the S11 (-10 dB S11 bandwidth 10.3 %). Dipole and slot elements are modified to increase the S11 bandwidth and microstrip feed is designed to feed them. This improves the performance of the antenna and we achieve S11 bandwidth of 56% and AR bandwidth to 41%. Another combination of J and M for circular polarization is presented with printed monopole and slot antenna. This antenna gives -10dB S11 bandwidth of 51% and 3dB AR bandwidth of 30%. It is also shown that, a printed monopole alone can also radiate circularly polarized radiation in broadside direction with the help of off-centered feed and defected ground. A dipole excited slot antenna (DESA) is resented for wideband circular polarization where rotated flared arm dipole with external microstrip balun is used to excite the slot. This structure has 30% AR bandwidth. A low profile variant of DESA is further evolved with two layer dipole with connected wings. This antenna gives a remarkable performance viz, -10dB S11 bandwidth of 75% and 3dB axial ratio bandwidth of 56% with CP gain in the range of 5 to 6 dBic. A smaller size novel rectangular patch with the rotated slot is proposed as a radiating electric current element. Based on this concept, wideband CP antenna is presented with different feeding mechanisms. Due to its wide beam and high gain features along with the complete coverage of the universal UHF RFID frequency band, this antenna is most suitable for RFID reader applications.

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Title	:	*Semiclassical Monte Carlo Simulation and Atomistic Simulation Study of Spin Transport in Graphene Nanostructures*
Author(s)	:	*Salimath Akshaykumar*
Roll No	:	*11104161*
Supervisor(s)	:	*Ghosh Bahniman*

Abstract

As the device dimensions shrink to nanometer regime the leakage power becomes significant portion of total power dissipation while there is no significant improvement in switching speed. The demonstrated potential of spintronic devices, namely, non-volatility, ultra-low power dissipation and higher switching speeds, has been the motivation behind experimenting with spin based logic devices. In recent years there has been intense research focused towards understanding the spintronic properties of graphene nanostructures and theoretical modeling of carrier transport in these nanostructures. This theoretical modeling has led to what is known as computational nanoelectronics. Semiclassical Monte Carlo methods and Non equilibrium Greens function (NEGF) approach are the commonly employed theoretical formalisms for quantum transport studies in nanostructures and devices. Graphene is the ideal material for spintronics application due to low spin orbit interaction and ultra high carrier mobility. In this work we employ semiclassical Monte Carlo method to model spin transport in few layer graphene and graphene nanoribbons. We further perform NEGF study of spin transport in rippled and twisted zigzag graphene nanoribbons with defects using ab-initio software package ATK from Quantumwise. Towards the end we slightly extend our work to understand spin transport in monolayer Tungtenite (WS2) which is another 2D material of significant interest in recent years.

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Title : Junctionless Tunnel FET

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Abstract

In this thesis work, we have proposed and examined a new TFET structure, called double gate junctionless tunnel field effect transistor (n-type DG-JLTFET (DG-nJLTFET), p-type DG-JLTFET (DG-pJLTFET)), which gives the combined advantages of both double gate junctionless field effect transistor (DG-JLFET) and double gate tunnel field effect transistor (DG-TFET). The DG-JLTFET (DG-nJLTFET, DG-pJLTFET) is heavily n-type or p-type doped Si-channel JLFET, where two isolated gates of different metal work-functions are used; the electrical behavior of DG-JLTFET resembles a conventional DG-TFET structure. The primary principle applied here is to transform the equally doped n-type drain, channel and source regions of DG-JLFET into a (N+-I-P+) structure for the DG-nJLTFET, and the equally doped p-type drain, channel and source of DG-JLFET into a (P+-I-N+) structure for the DG-pJLTFET without any physical doping. Since this device is based on the principle of junctionless channel, intrinsically it would be less prone to variability and short channel effects (SCEs), and also requires less thermal budget as compared to the conventional TFET, even with the requirement of an extra gate, and an isolation layer, and also an extra gate contact space, which increases few fabrication steps. The simulation results of DG-JLTFET (DG-nJLTFET, DG-pJLTFET) shows excellent characteristics with high ON-current (ION), low OFF-current (IOFF), high ION/IOFF ratio and a low SS at room temperature for the channel length of 20 nm. The astonishing results indicate that junctionless tunnel field effect transistor (JLTFET) is a promising candidate for low power and switching application in Sub-22 nm regime. In this work we also investigate the performance comparison of DG-nJLTFET and DG-nTFET, and then further optimization of different performance parameters for the DG-nJLTFET is achieved by varying the different device parameters. Finally, by taking the optimized device parameters, we achieved excellent results of different performance parameters for the DG-nJLTFET. Analog performance comparison for the DG-nJLTFET and DG-nTFET is discussed in the following chapters. The results are compared with the conventional DG-nTFET of the same device structure parameters, and also for the same threshold voltage. The results show that DG-nJLTFET gives better analog performance in terms of its transconductance generation factor (gm/ID), intrinsic gain (gm/gd), and also for its unity gain frequency (fT). Finally, silicon-nanowire (Si-NW) gate-all-around (GAA) device performance of both n-type JLTFET (nJLTFET), and p-type JLTFET (pJLTFET is discussed, and the results are compared with its counterpart n-type and p-type conventional Si-NW GAA TFET (Si-NW GAA nTFET, Si-NW GAA pTFET)). The use of multi-gate device structure, especially gate-all-around device structure gives better controllability over the channel. From the simulation results it is observed that the ON-current of both n-type and p-type junctionless Si-NW GAA TFET (Si-NW GAA nJLTFET, Si-NW GAA pJLTFET) are less than that of both n-type and p-type conventional Si-NW GAA TFET for the same OFF-state leakage current. Furthermore, improvement in ON-current for both n-type and p-type junctionless Si-NW GAA TFET are achieved by scaling down the radius of cylindrical semiconducting nanowire. The two-dimensional simulation is carried out using 2D device simulator (Atlas (Silvaco)), and the three-dimensional simulation is performed using 3D device simulator (Sentaurus Device (Synopsys TCAD)).

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Title	***:***	***Gate Current Modeling of AlGaN/GaN HEMTs***
Author(s)	***:***	***Manchuri Silpa***
Roll No	***:***	***13104074***
Supervisor(s)	***:***	***Dutta Aloke&Chauhan Yogesh Singh***

Abstract

The AlGaN/GaN High Electron Mobility Transistor (HEMT) is considered to be an excellent candidate for future power and RF applications due to its high breakdown voltage, high electron mobility, and low on-resistance (Ron). However, current collapse, device degradation, and gate leakage current are regarded as the most important issues to be resolved for actual powerswitching applications. In this work, we discuss about the conduction mechanisms of the gate leakage current, and develop a model for it based on the surface potential. The total gate current model in our work is decomposed into three distinct components, namely the Poole-Frenkel emission, the thermionic emission, and the trap assisted tunneling. We include the polarization effect within the AlGaN layer for the calculation of the surface electric field underneath the metal-semiconductor Schottky contact. This adequately describes the field-dependent characteristics of the reverse gate leakage current of AlGaN/GaN HEMTs. This component of current is well described by the Poole-Frenkel emission model. Based on the emission barrier height and the operating temperature, it is observed that the reverse leakage current is due to the presence of highly conductive dislocations in the AlGaN layer. It is suggested that the electron emission is from a trap state near the metal-semiconductor interface into the continuum states associated with the conductive dislocations. The forward gate leakage current, on the other hand, is well described by the thermionic emission model. The trap assisted tunneling model is observed at low reverse bias, however we have neglected this component by using extra fitting parameters in the model developed. The results of our model matched very well with the experimental data published in the literature.

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Title : *Address Auto-Configuration Protocols and their message complexity in Mobile Adhoc Networks*

Author(s) : *Munjal Amit*
Roll No : *11104162*
Supervisor(s) : *Singh Yatindra Nath*

Abstract

A mobile ad hoc network (MANET) is a multihop infrastructureless network that con- sists of a collection of nodes which communicate among themselves via single or multi-hop wireless links. In order to provide correct communication between the nodes, each individ- ual node must be uniquely identified in the network. In infrastructure networks, the unique identity to each node is provided by a centralized server e.g. dynamic host configuration protocol (DHCP) server. The unique identity provided by DHCP servers is in the form of IP address given to each new node at the time of joining the network. But in MANETs, no such centralized server exists to provide an IP address to the nodes. Thus, in adhoc networks, an auto-configuration protocol is needed that can automatically assign an unique IP address to each of the unconfigured nodes. The job of an address auto-configuration protocol is to automatically assign an unique network address to an un-configured node in the network. The address auto-configuration protocol needs to be fast enough and also it should consume less overhead for configuring a new node i.e. each node needs to be configured with minimum delay and least number of signalling packet transmissions. Moreover in the MANETs, due to random mobility of the mobile nodes, there is a high probability that nodes can split into multiple partitions or different networks may merge. So, it is also important for AAP to efficiently detect the network mergers and partitions. Apart from detecting the network partition and merger, the address auto-configuration protocol must also be robust enough to handle the network partitioning as well as the network mergers that occur frequently in mobile adhoc networks (MANETs) to retain the uniqueness of node addresses. The amount of overhead involved in handling network mergers and partitions should be as low as possible. The other objective for AAP is to detect merger and partition as early as possible, resolve duplicate addresses in least possible time. Our reseach work focusses on performing auto-configuration of mobile nodes in mobile adhoc networks, i.e. how nodes will configure automatically when they wish to join the network. Most of the existing auto-configuration protocols in the literature use different methods to detect the network partition. These protocols involve periodic broadcast of Hello packet from each of the nodes in order to make their presence known to other nodes in the network. Nodes in the network periodically transmit their partition number to the neighboring nodes. This generates a lot of control overhead in the network. In our research work, we have designed stateful as well as stateless address auto- configuration protocols for MANETs. We have also modified one of the existing state- ful auto-configuration protocol. In this thesis, we have also computed and compared the message complexity for the existing auto-configuration protocols. 1

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Title	***:***	***Economic and stability analyses of optimally placed Distributed generations in distribution systems***
Author(s)	***:***	***Ponnaganti Pavani***
Roll No	***:***	***10104116***
Supervisor(s)	***:***	***Singh Sri Niwas***

Abstract

With the growing electric energy consumption, there is a significant increase in the deployment of the Distributed Generations (DGs) in the distribution systems to fulfill the increases demand. Network reconfiguration is a powerful tool in the distribution automation systems for enhancing the reliability and power quality of supply. The objective of the work is to investigate the influence of distributed generation and network reconfiguration on the stable and economic operation of the distribution systems. However, the integration of the DG into existing networks has associated several technical, economical and regulatory concerns. The DG causes the system to lose its radial power flow, besides the increased fault level of the system. This may result in the elongation of fault clearing time and hence disconnection of equipments in the distribution system or unnecessary operation of protective devices. Therefore, new stability assessment schemes for utility distribution networks have to be developed and need to address these issues properly. The DGs in the distribution network plays a significant role in the Distribution Company (DisCo) operation, structure, design and up-gradation issues. Both the DisCos and/or the customers can invest in and operate the DG units. With the varying load conditions and the effect of the DGs along with the network reconfiguration on Disco profit is not studied in the literature. In this thesis, the effect of the short circuit level along with power loss reduction, reliability improvement and voltage limit, are considered in the optimal placement and sizing of the DGs. Fuzzy logic based min-max problem is used. Different cases have been studied. All the objectives are calculated in DIgSILENT power factory software and imported into the Matlab. A data exchange technique between the Matlab and power factory software has been developed. A Sequential Quadratic Programming (SQP) based network reconfiguration algorithm has been developed for finding the optimal configuration of switches in the distribution systems with distributed generation for power loss reduction and reliability improvement. Probabilistic reliability models are used for the reliability assessment. Simultaneous optimal network reconfiguration and the DGs placement algorithm have been developed for different system loading levels and various DGs penetration levels. Analytical hierarchy process tool is used for finding the optimal results. The cost/benefit analysis of the optimally placed DGs with the optimal network configuration in-order to maximize the DisCo profit has been carried out considering the hourly varying distribution system load and electricity price. Finally, a Support Vector Machine (SVM) based transient stability assessment algorithm with the DGs in the distribution systems has been proposed. The input feature vector to the SVM is the post disturbance signals of real power, reactive power, speed, and voltage magnitude from the DG locations. The training and testing data are generated for stable cases (faults cleared within critical clearing time) and unstable cases (faults cleared > critical clearing time) considering the synchronous generator driven distributed generations. The effectiveness of the proposed algorithms are demonstrated on IEEE 33-node, IEEE 69-node and IEEE 123-node standard test distribution systems.

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Title	***:***	***Performance Analysis and Power Forecasting of Single-Stage Large Scale Grid Connected PV System***
Author(s)	***:***	***Lal Vivek Nandan***
Roll No	***:***	***11104184***
Supervisor(s)	***:***	***Singh Sri Niwas***

Abstract

In recent years, there is a large penetration of Photo-Voltaic (PV) power generation into the electric grid leading to considerable attention and investment in PV systems all across the globe. Therefore, it is essential to investigate the performance of grid connected large PV systems. Hence, the detail modelling of arrays, control devices, and other related systems is required for the simulation studies. There are already diode models available for PV array, but simulation of large PV array is not easy. In this thesis, an improved mathematical model of PV system is proposed, which gives simple, accurate and smooth PV characteristics with having flexibility to be implemented easily in changing environmental conditions. A PV system is generally used to inject the real power into the electric grid. As per IEEE 1547 standard, it is not allowed to actively participate in reactive power support to the connected grid. However, by following the rules by local Authorities Having Jurisdiction (AHJ), for VAR support, it can also be used for delivering reactive power by utilizing the capability of power converter to improve the power quality. In that case, a P-Q capability curve will be useful tool to control the amount of reactive power injected into the grid according to the demand as well as the limit of the PV system. A P-Q capability curve has been developed, in this thesis, for grid connected PV system, which also represents the reactive power limits in case of maximum power point operation with different atmospheric conditions. Various control schemes have been proposed in literature for the grid connected PV system. With the existing control schemes, dynamic behaviours of the system are not very good, as their responses are of different nature at different operating points due to non-linear PV characteristics. A control scheme with linearization technique can be able to overcome this problem and also the schemes should be simple. This thesis also proposes voltage controller with Feedback Linearization (FBL) technique, which is simple and gives better dynamic response. The small-signal analysis with eigenvalues has been carried out for PV system connected to IEEE 33-bus distribution network. The stability is also investigated in transient conditions through fault analysis. Another transient case, voltage dip in the grid, has also been considered, for which, a compensator has been developed to improve the performance of system. The Maximum Power Point Tracking (MPPT) algorithm, which works properly in normal conditions, may not work in changing environmental conditions and may fail in partially shaded condition, thus, reducing the output power. Therefore, a Particle Swarm Optimization (PSO) based MPPT scheme has been developed which is very effective, accurate and simple to implement, and able to track the MPP in the complicated partial shaded conditions, where the conventional hill climbing and incremental conductance methods fail. The operation and stability

of electric power system is primarily governed by demand and supply balance. The subsidies or concessions provided to the PV power producers may not be continued with the aggressively growing PV solar penetration scenario in the feed-in-tariff system introduced all across the world. In such situation, to participate in electricity market for PV power suppliers, accurate solar power forecasting tools are, therefore, very much essential. This thesis develops a single-stage direct solar power forecasting model based on Adaptive Wavelet Neural Network (AWNN) for hourly prediction, as well as day-ahead power forecast. Furthermore, by having knowledge of forecasted real power, and power rating of other supporting devices (transformer and power inverter), reactive power scheduling on demand can also be done to enable secure and efficient grid VAR planning and operations.

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Title : *Waveform Shaping Methods for OFDM Systems*

Author(s) : *Sharique Mohd*
Roll No : *Y8104070*
Supervisor(s) : *Chaturvedi Ajit Kumar*

Abstract

Orthogonal Frequency Division Multiplexing (OFDM) has been adopted as the modulation technique for modern wireless standards, in both cellular as as well as LAN settings. It is also a strong candidate for cognitive radio systems. Despite its several advantages, OFDM has certain unique limita- tions like Inter Carrier Interference (ICI) caused by Carrier Frequency Offsets (CFO) and out-of-band (OOB) interference. For example, in cognitive radio, due to the high OOB power of the OFDM signal it is often not sufficient to de-activate sub-carriers which lie in the primary user's band. Thus, wave- form shaping methods are required in addition to sub-carrier deactivation. In this thesis we address the above two issues using waveform shaping techniques. The work done in the thesis can be broadly divided into three parts. In the first part, we propose the OOB and ICI reduction in conventional OFDM systems using new time-limited Nyquist pulses at the transmitter. We consider a linear combination of two time-limited Nyquist pulses. A lin- ear combination (LC) of POLY4 and POLY5 pulses has been considered to obtain LC pulses which provide a trade-off between OOB and ICI power re- duction. LC pulses also provide a tuning parameter which can be used to tailor the pulse for any feasible combination of OOB and ICI power. We have proposed a method to obtain new time-limited Nyquist pulses for OFDM systems by multiplying any two existing time-limited Nyquist pulses in frequency domain. The new pulses will not only have higher ADRs than their constituent pulses but also lower levels of sidelobes. The necessary and sufficient condition for the roll-off factor to be less or equal to unity has been established. The proposed family also provides flexibility in designing time-limited pulses even when the roll-off factor has been fixed and can be optimized with respect to any performance criteria. As an illustration, three new pulses have been obtained by considering BTRC and RC pulses. The obtained pulses are found to have good OOB as well as SIR performance. In the second part of the thesis we note that OOB power is a bigger problem 1 in OFDM based cognitive radio (CR) systems. We propose the design of an orthogonal precoder in conjunction with optimal windowing for waveform shaping in CR systems. First we derive the power spectral density expression to calculate the interference power in the primary users frequency bands. We then construct an interference minimization problem which is called a generalized Hermitian eigenvalue problem with orthogonality constraint. The resulting precoding in conjunction with optimal windowing reduces the in- terference power when compared to only precoding and only windowing but at the cost of spectral efficiency. In the last part of the thesis we address OOB power reduction in MIMO- OFDMbased CR systems. We propose a cross antenna rotation and inversion (CARI) technique for reducing interference power in MIMO-

OFDM systems having two transmit antennas. It is found that the OOB power is reduced compared to the phase alignment technique with no change in ICI perfor- mance. However, the CARI technique requires signaling overhead and results in a slight loss in the system throughput. We also study the CARI technique in conjunction with phase alignment technique for two transmit antennas in MIMO-OFDM based CR systems. First, an optimal sequence for minimum total OOB power is obtained. Next, the optimal phase corresponding to this sequence is calculated. The combined approach gives lesser OOB power as compared to CARI technique with no change in ICI performance and overhead.

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Title	:	*SINR and Power Allocation Based Relay Selection, Positioning and Reliability for Cluster-Based Wireless Sensor Networks*
Author(s)	:	*Singh Mukesh Kumar*
Roll No	:	*11104173*
Supervisor(s)	:	*Sharma Govind&Naik Naren*

Abstract

Wireless relaying has attracted a lot of attention in the last few years due to its advantage in multi-hop communication systems. Cooperation among nodes in a network enhances the overall system performance. Power allocation schemes have been discussed with respect to optimization of signal to noise ratio (SNR) without considering the interference. The contribution of our present approach is to allocate power to relay nodes in presence of interference, for cluster-based wireless sensor networks (CBWSNs). In the present work, we consider optimization of the signal-to-interference plus noise ratio (SINR) and allocating the power to relay nodes by using the difference of two convex functions (dc) algorithm. The best relay is selected based on the comparisons of power allocated to relay nodes. Accurate positioning of randomly deployed nodes is one of the important tasks which have great effect on the performance of CBWSNs. We analyze node position evaluation schemes for randomly deployed nodes of CBWSNs in presence of multi-path fading. Finally, in order to prolong the network lifetime and to improve robustness of CBWSNs a reliability model is proposed in detail for path loss, Rayleigh fading, Rician fading and Nakagami-m fading in, which is based on fractional coverage area with respect to the entire area of interest in order to support different quality of service (QoS) requirements. Such schemes would be typically applicable to a network where allocation of orthogonal channels to sensor nodes will not be feasible and fading present in medium cannot be avoided.

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Title : *Hybrid state estimation and enhanced monitoring of power systems using synchrophasors*

Author(s) : *Mallik Sanjeev Kumar*
Roll No : *Y9204070*
Supervisor(s) : *Singh Sri Niwas&Chakrabarti Saikat*

Abstract

State estimation plays a critical role for the wide area monitoring system (WAMS) at the control center. The measurements are collected from the field and telemetered to the control center, where they are typically processed using weighted least squares (WLS) static state estimator (SE) to estimate the states of the system. The synchrophasor technology has brought a revolution in the SEs due to its capability to measure time stamped and synchronized phasor data at a high refreshing rate (as high as one phasor per cycle). The time stamped synchronized measurement of voltage and current phasors with high accuracy and high reporting rate make the PMUs preferable over the conventional SCADA measurements. In presence of limited number of PMUs, hybrid SE combines the conventional SCADA measurements with the PMUs and estimates the states of the system. Convergence problems and loss of accuracy due to numerical ill-conditioning is a frequently encountered problem in power system state estimation. This work describes a simple technique to analyze the possible causes of ill-conditioning for different measurement configurations in terms of the condition number of the state estimation gain matrix in presence of PMU. With the direct inclusion of the PMU current in rectangular form, the gain matrix may become ill-conditioned due to high weight associated with the PMU current measurements. The convergence issues associated with the PMU currents can be resolved by converting the PMU current into branch flow pseudo-measurements. Further, to deal with the convergence problems associated with ill-conditioned gain matrix, an L-curve based regularization method is proposed to solve the ill-conditioned state estimation problems that may not be solved by the conventional WLS algorithms. An open source SE package is developed in this thesis. It considers both PMU and conventional measurements, incorporates a number of error distributions for the measurements, and includes observability analysis. This package can be used for engineers and researchers working in the area of power system state estimation. The SE output is obtained typically at few minutes interval. Hence, the existing control center software cannot provide a real-time picture of the power system. A new method is proposed in the thesis to enhance the monitoring of the power system in parallel to the existing software. The proposed method The SCADA and the PMU measurements are available at each 2s, which is processed through extended Kalman filter based dynamic SE. Between two dynamic SE outputs, there is a number of instants where PMUs provide synchronized phasor measurements at sub-second rate. These measurements are processed using linear estimator and ANN to estimate the states at these instants.

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Title : *Higher-Order Statistics Based Techniques for Processing Stationary and Non-Stationary Signals*

Author(s) : *Gaikwad Chandrakant Jagannath*
Roll No : *10204064*
Supervisor(s) : *Sircar Pradip*

Abstract

In this thesis, we address the issues like higher dimensionality of the higher-order statistics and find some solutions. We develop following higher-order statistics based techniques for various applications. Concepts of accumulated bispectrum and accumulated modified bispectrum are developed and their applications in the stationary and non-stationary signal analysis is demonstrated. A new approach for parameter estimation of stationary and non-stationary signals in multiplicative and additive noise is formulated based on higher-order statistics. It is demonstrated that the parameters of complex sinusoidal signal, complex frequency modulated (FM) sinusoidal signal and complex linear chirp signal in presence of additive and multiplicative noise can be estimated using a new definition of the fourth-order cumulant (FOC) and the accumulated fourth order cumulant (AFOC). The variance of parameters estimated using a new definition of FOC/AFOC is compared with the computed CR bound. In case of complex sinusoidal signal, the results of parameter estimation show that the proposed method based on the new defifinition of FOC performs better than the existing method based on fourth order statistics.

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Title	***:***	***Acoustic Variability Compensation Methods for I-vector based Speaker Verification***
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Supervisor(s)	***:***	***Hegde Rajesh Mahanand***

Abstract

Speaker verification is a method of verifying a claimed identity using the speaker's voice. It has wide ranging applications including access control, forensics, and security. It is also a preferred method of biometric authentication due to its non invasive nature. However, the performance of a speaker verification system degrades under mismatched train-test conditions. At the acoustic signal level this mismatch is called acoustic variability. Acoustic variability is a result of several factors including types of microphones used, variability in acoustic environment, transmission medium, and the inherent variability in speaker utterances. In this thesis, new methods for acoustic variability compensation are developed both at model and score level in an i-vector framework. I-vectors are in general based on the total variability subspace which contains both speaker variability and acoustic variability. In the i-vector framework, acoustic variability is compensated at the model level by minimizing the intra-class variance and maximizing the inter-class variance of the i-vectors. In addition to this, score normalization methods are generally employed to reduce the acoustic variability at the score level. A large margin nearest neighbor metric learning method (LMNN) is first developed to compensate for acoustic variability at the model level. In this method, a transformation matrix is learnt from the training data which transforms the input i-vectors into a discriminative subspace. The transformation matrix is learnt in a such way that the distance between the i-vectors of the same speaker are minimized and impostors are pushed away by a large margin. This leads to better speaker verification system performance. Additionally, a new method based on cosine similarity large margin metric learning is also developed at the model level. This method uses cosine similarity as a distance measure. Finally, an efficient discriminative method based on a collapsing classes transform is proposed for compensating acoustic variability. In this method, i-vectors of the same speaker are collapsed to a single point thereby reducing the distance between same class i-vectors to zero. This approach leads to a new transformed space where i-vectors of the same speakers are close and impostors are separated by a large margin. This results in a maximized discriminative sub space for accurate speaker verification. Experiments conducted on the NIST-2008 and YOHO databases indicate improved performance when compared to i-vector based speaker verification methods with conventional acoustic variability compensation methods. New methods for cohort set selection and normalization are also developed in the thesis to compensate for acoustic variability at the score level. The proposed method of cohort set selection uses speaker specific and phoneme specific properties to select the cohort set. This is further applied in score

normalization to improve the i-vector based speaker verification system performance. Two approaches to cohort selection are proposed. The first method utilizes speaker specific properties and is called speaker specific cohort selection. In this approach speaker specific information is used in cohort selection. The second method is phoneme specific and uses verbal information at the phoneme level. A third method that combines the speaker and phoneme specific properties is also developed. A late fusion method that utilizes majority voting on normalized scores is finally used to improve the speaker verification performance. Speaker verification experiments were conducted using NIST 2002, NIST 2004, and TIMIT databases. Experiments were also conducted on an Indian language (Hindi) database to verify the multilingual efficacy of the proposed acoustic variability compensation methods at score level. Reasonable performance improvements are obtained as indicated by the detection error trade-off (DET) curves and the equal error rate (EER) values compared to conventional i-vector based speaker verification.

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Title : *Node Localization and Tracking using Multi-Sensor Data in Wireless Sensor Networks*

Author(s) : *Kumar Sudhir*
Roll No : *11104181*
Supervisor(s) : *Hegde Rajesh Mahanand*

Abstract

Recent advancements in wireless communication, MEMS technology, and sensing theory have accelerated the fabrication of small size and low powered wireless sensor nodes. Hence development of novel methods for localization and tracking that are accurate, energy efficient, cognitive, and work in real time are of considerable interest in the area of ad-hoc wireless sensor networks. Applications of localization and tracking methods include animal tracking, habitat monitoring, military surveillance, disaster management, and assistive living. Traditionally these methods have relied on location aware anchor nodes. However utilization of location aware devices like GPS increases the deployment cost and reduces the overall energy efficiency, and localization accuracy in large WSN. Multiple low-cost sensors like radio, acoustic, and visible light can be used in this context. Measurements obtained from multiple sensors contain complementary information which can be utilized in a multi sensor data fusion framework for developing high resolution localization methods over large areas. In this thesis, both range-free and range-based methods for node localization and tracking using multi-sensor data are developed. A range-free localization method, that uses multi sensor data and principles of data depth is first developed. In this context, a hybrid maximum depth k-Nearest Neighbour (hybrid MD-kNN) method for sensor node localization is proposed. The method combines two individual location hypothesis functions obtained from generalized maximum depth and generalized kNN depth based methods. The individual location hypothesis functions are themselves obtained from multi-sensor data. The hybrid MD-kNN method combines the lower computational complexity of maximum depth with the outlier association ability of kNN to realize a robust node location estimator. No assumption of an underlying distribution under non-line-of-sight (NLOS) conditions is made here. Additionally this method utilizes multivariate data obtained from multiple sensors which has hitherto not been used. The affine invariance property of the proposed method is proved and its robustness is illustrated in the context of node localization. Experimental results on the Intel Berkeley research data set indicate reasonable improvements over conventional methods available in literature. A range-based method for sensor node tracking using semi-supervised Hidden Markov Models (HMM) is developed. A new methodology to develop a combined attenuation model from data gathered from multiple sensors is also described. Observations emitted from sparsely deployed beacons are measured over the network area. HMMs are trained using these sparse observations measured at each grid point. The inter anchor-node range is estimated using likelihood maximization. The local

location co-ordinates of the node positions are then computed by solving a constrained volume optimization problem. Location coordinates are finally refined using the geometric dilution of precision (GDOP). Experimental results on a real WSN realized by deploying Crossbow and National Instruments (NI) motes indicate an improvement in localization accuracy, when compared to the conventional methods. Combining the advantages of range-based and range-free methods using a decentralized cognitive WSN architecture has hitherto not been explored in earlier work. This is specifically relevant under skewed LOS and NLOS data conditions. In this context, an efficient compartmental model for real-time node tracking over cognitive wireless sensor networks is proposed. The compartmental model is developed in a multi-sensor fusion framework with cognitive bandwidth utilization. The multi-sensor data attenuation model is first derived using a sum of exponentials model. The parameters of the compartmental model are computed using the modified Prony estimator. Additional advantages of the proposed method include lower computational complexity and asymptotic distribution of the estimator. Cramer-Rao bound and elliptical error probability analysis are also discussed to highlight the advantages of the compartmental model. Experimental results on real time node tracking over a WSN realized using Crossbow and National Instruments (NI) motes indicate a significant improvement in tracking performance when compared to state-of-the-art methods in literature. The cognitive abilities of the proposed methods can be utilized in applications like underwater and terrestrial sensor tracking. The hybrid MD-kNN method can be further investigated for functional data using band depth. The performance of the SS-HMM method can be explored using principles of maximum entropy and conditional random fields. Additionally, a method which accurately predicts the location of node with malicious anchors can also be investigated as part of future work.

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Title : *Integrated Converters: Synthesis, Characterization, and Application to DC Nano Grid*

Author(s) : *Ray Olive*
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Supervisor(s) : *Mishra Santanu Kumar&Joshi Avinash*

Abstract

Multi-port power converter topologies are widely used in a large number of applications e.g. hybrid electric vehicles, renewable integrated battery chargers, residential distribution systems, dc bias supplies, computer switch mode power supplies, etc. The use of multi-port topologies reduce the number of single-input-single-output converter stages. The work proposes multi-port power converter topologies which provide an additional output apart from the step-up dc output provided by a conventional boost topology. These circuit configurations, denoted as integrated power converters, are synthesized by replacing the control switch of the boost converter by series-connected switch networks in order to achieve the additional output port. The major features of these converters are the reduction in the number of switches compared to the constituent converters and inherent shoot-through protection feature. In the conventional power system, electric power is generated in a centralized manner, transmitted through transmission infrastructure to the distribution systems to the consumers. Due to the mismatch between conventional generation and load demand, renewable energy sources are increasingly being used to meet the energy deficit. Residential systems comprising of local power resources, grid supply, local loads, storage, etc, in a residential application comprise a nanogrid. The power converters used in a nanogrid should be able to perform different functions: interfacing renewable sources, grid, storage systems and loads. Multi-port power converter topologies can be effectively used for such applications. Due to the presence of dc and ac source and load types, the power converters used must be able to interface with dc as well as ac bus. The work explores the suitability of the integrated converter topologies in such applications.

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Title : *Enhancement of Light Absorption in Organic Solar Cell Active Layer in the Presence of Metal Nano-Particles*

Author(s) : *Kataria Devika*
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Abstract

An important direction of research to increase OSC efficiency is by increasing the light trapped from the solar spectrum into the OSC active layer. Localized surface plasmon (LSP) is one of the promising approaches. Here, metal nano-particles (MNP) are built into one of the layers in OSC to achieve increased light trapping in the cell's active layer.

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Title : *Boost-based Power Amplifier: Implementation and its Application in Power-Hardware-in-the-Loop Simulations*

Author(s) : *Jha Kapil*
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Supervisor(s) : *Mishra Santanu Kumar&Joshi Avinash*

Abstract

Computer based simulations are vital part of today s research and development community. These simulations provide useful insight and understanding of a system prior to its actual realization. The operating conditions in simulations can often be extreme which are usually very difficult to replicate in practice. A power-hardware-in-the-loop simulation facilitates integration of a computer simulated network with real power network (in hardware). These two networks operate in conjunction; therefore, exchange of virtual power happens between the two networks. A power amplifier is required to facilitate this exchange of virtual power. Traditionally, Voltage-Source Inverter (VSI) based topologies are used to realize the power amplifier because of their linear control-to-output characteristics in large signal sense. The fundamental drawback of a VSI is that its output voltage is always smaller than the dc-supply voltage. The output of a Differential-Boost Inverter (DBI) can be less or more than the dc-supply voltage. However, the control-to-output characteristic of a DBI is nonlinear in large signal sense at pseudo-dc (low operating frequency). These characteristics become highly nonlinear as the operating frequency increases. Therefore, a DBI cannot be used as a power amplifier for PHIL applications, as such. In this thesis, a Dynamic Linearizing Modulator (DLM) has been proposed which linearizes the control-to-output characteristics of a DBI, in large signal and for higher frequency of operation. The DLM-linearized DBI can source as well as sink both real and reactive power. Therefore, a DLM-controlled DBI can be used as a power amplifier for PHIL applications. In a PHIL system, the computer network is simulated inside a Real-Time (RT) simulator. Commercially many such RT simulators with very high computation capabilities are available; however, the cost associated with them is fairly high. In this thesis, a low cost PHIL test-bed has been build using MATLAB/Simulink based RT simulator. The linearized DLM-controlled DBI has been used as power amplifier in PHIL simulations. Various experiments have been conducted to validate the viability of the designed PHIL test-bed.

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Title	:	*Design of superimposed training for estimating the spatially correlated MIMO channel*
Author(s)	:	*Mishra Himanshu Bhusan*
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Supervisor(s)	:	*Kasturi Vasudevan*

Abstract

In this thesis, the problem of estimating the spatially correlated channel of a multi-input multi-output (MIMO) system is considered. Channel estimation using training signals is better than the blind schemes, since it reduces the receiver complexity and improves the estimation accuracy. However, such conventional training methods are throughput inefficient due to the use of pilot symbols in extra time slots. To overcome this disadvantage, a new spectrally efficient scheme known as superimposed training (ST) is used for channel estimation. In the existing literature, an iterative solution based on ST signal is proposed, to estimate the spatially correlated channel, in the presence of additive white Gaussian noise (AWGN) for MIMO systems. However, the AWGN assumption may not be valid in the presence of co-channel interference (CCI) and/or jamming signals. Moreover, the iterative solution of the optimization problem given in the literature has a higher computational complexity compared to the approach given in the thesis. In this work, a sub-optimal closed form solution based on ST signal is proposed to estimate the spatially correlated MIMO channel for such an interference-limited environment. Considering the power allocation issue between the data and training symbols, a sub-optimal average training power is also proposed such that the lower bound on signal-to-interference ratio (SIR) is maximized.

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Title : ***Evolutionary Techniques Based Solution to the Unit Commitment Problem Including Renewable Energy Sources***

Author(s) : ***Shukla Anup***
Roll No : ***11104164***
Supervisor(s) : ***Singh Sri Niwas***

Abstract

Due to rapid industrialization and increased standard in the life style, the electric power requirement is increasing day-by-day. Various concerns related to progressive depletion of traditional fossil energy sources, increasing cost of fossil fuels, environmental protection, etc. have increased the interest in integrating renewable energy sources into the existing power systems. In the presence of renewable energy sources along with the volatile nature of demand and supply in electricity market environment, it has become a challenging task for the power utilities to perform proper scheduling of the generating units to serve the load demand at minimum operating cost. This research work has mainly dealt with evolutionary techniques and hybrid approach to solve large scale Unit Commitment (UC) and Profit Based UC (PBUC) problems. Advanced Three-Stage (ATHS) algorithm is developed and Weight-Improved Crazy Particle Swarm Optimization (WICPSO) along with pseudo-inspired algorithm is proposed for solving the large-scale UC problem. To solve multi-objective UC and PBUC problems, weighted sum method and normal boundary intersection technique with proposed Search Space Based Crazy Particle Swarm Optimization (SSB-CPSO) is utilized. Unit commitment with uncertainty of wind velocity is carried out on the forecasted data and the prediction error. The scenario generation, reduction and analysis techniques are applied to simulate the impacts of wind uncertainty on system operation. New approach is developed for creating clusters of unit status, associated with a probability of occurrence from an initial set of large wind power scenarios. SSB-CPSO is utilized for Security-Constrained Unit Commitment (SCUC) problem with different constraints such as multi-fuel options, prohibited operating zones and nonlinearities due to valve point loading effects. Economic dispatch and optimal power flow is performed using CPSO and Newton Raphson method for satisfying power flow constraints, generator's real power output and network losses for each time period. Occurrence of various contingencies, such as generator outage and transmission line outage are also considered in problem formulation. The effectiveness of the proposed approaches is demonstrated on several systems and results are compared with other techniques reported in the literature.

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Title : *Improved load modelling and its impact on stability of power systems having large penetration of wind generation*

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Supervisor(s) : *Srivastava S C&Chakrabarti Saikat*

Abstract

Extensive steady state and dynamic studies are required to be carried out for power system planning, operation and control. It is established in the literature that accurate load models have a direct impact on power system stability studies, and requires further research efforts in improving the existing models. Most of the utilities rely on large, balanced disturbances to model the loads. However, balanced disturbances are rare in power systems and between two large disturbances, a system may undergo several small disturbances. Hence, it is necessary to develop a methodology for identifying the load model for small as well as unbalanced disturbances. Most of the works on load modelling have used either the component based or the measurements based method, and have not exploited the advantages of the two together. Recently, power production from renewable energy sources, particularly from the wind, is continuously increasing, which is causing a significant impact on power system stability and control. This, along with dynamic loads, may cause short-term voltage instability, delayed voltage recovery, and oscillatory voltage instability. To address these problems, proper planning of Flexible AC Transmission System (FACTS) controllers, such as Static Var Compensator (SVC), is required. With the advent of the synchrophasor technology, employing Phasor Measurement Units (PMUs) in the field, it is possible to design wide area damping controller to effectively damp inter-area oscillations. This work has suggested several new approaches for accurate modeling of loads. It has first examined the measurement based approach for load modelling using PMU measurements. The parameters of each load model structure considered are derived by minimizing the mean square error between the model output and the measurements using an optimization algorithm. Methodologies to determine the load models using measurements recorded under both balanced and unbalanced disturbances are suggested. Sensitivity analysis is performed to identify the most significant parameters of the load model. For large disturbances, the accuracy and the speed of execution of the load modelling are enhanced by using a variable projection based optimization algorithm. Further, a comprehensive method of load modelling, combining the component based and measurement based approaches, has been proposed. Fuzzy C means clustering is used to cluster the loads into various classes. The parameters of the load model are, then, estimated using the disturbance measurements obtained at the load cluster centers. The effect of the measurement data rate on load modelling is analyzed using the Real

Time Digital Simulator (RTDS) facility available at the host Institute. A method to determine the optimal location and size of the SVCs in power systems with high wind penetration and dynamic loads is proposed. A set of critical contingencies is screened using a dynamic ranking index. A sensitivity index has been proposed to find the locations of the SVCs, which can damp the voltage oscillations effectively. A hybrid optimization technique has been used to determine the sizes of the SVCs at the selected locations considering the peak and off peak load conditions. The supplementary damping controllers of the SVCs are designed to improve the damping of the electromechanical modes. A robust decentralized TS fuzzy wide area damping controller for DFIG wind farms and various FACTS devices, such as SVC and TCSC, is designed. A detailed load model, which captures the effects of industrial, commercial and residential load classes in the power system, and the uncertainties in the load model parameters, has been considered. The proposed decentralized TS fuzzy control has been designed by solving a set of linear matrix inequalities. The controller has also been tested on the RTDS and on a large practical Indian power system network.

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Title : *Optimal Transceiver Design and Channel Estimation in Multi-User Multiple-Input Multiple-Output (MIMO) Wireless Networks*

Author(s) : *Venkategowda Naveen K D*
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Abstract

This thesis addresses two major problems encountered in wireless communications: interference and channel estimation. The first part of the thesis focuses on interference management towards maximizing the signal-to-interference-plus-noise ratio (SINR) of the users in multi-cell multiple-input multiple-output (MIMO) wireless networks and reducing the computational complexity of decentralized estimation in MIMO wireless sensor network. The second part of the thesis focuses on developing channel estimation techniques, which have superior mean square error (MSE) performance and bandwidth efficiency, for multi-carrier MIMO wireless systems. First, considering unicast and multicast data transmission with interference among users/user groups in a downlink multi-cell cooperative network, we propose successive minimum variance beamforming (SMVB) schemes to determine transmit and receive beamformers which maximize the SINR of the users/ user group. The proposed beamforming schemes are demonstrated to achieve a superior sum-rate performance and schedule more users compared to conventional block diagonalization based schemes. Subsequently, for the broadcast scenario, we propose a broadcast beamforming scheme with power constraint on total network and individual base station. Further, we also consider the multi-cell cooperative uplink scenario and derive a successive multi-user uplink beamforming (SMUB) scheme which maximizes the SINR of each user. Further, the thesis considers the problem of decentralized estimation in a coherent multiple access channel based MIMO wireless sensor network. We propose a minimum variance distortionless precoding (MVDP) framework for decentralized estimation of a vector parameter where the precoders force the transmitted signals to interfere constructively without distortion at the fusion center and thereby increasing the estimation accuracy. Moreover, the proposed precoding techniques enable the fusion center to obtain minimum variance distortionless parameter estimate without requiring any processing at the receiver. The analytical expression derived for the mean square estimation error demonstrates that the proposed schemes asymptotically achieve the centralized minimum mean square error bound. Next, we consider frequency selective MIMO channel estimation in multi-carrier code division multiple access (MC-CDMA) systems. We propose a new receiver framework, termed multi-path multi-carrier decorrelator (MMD), which reduces the frequency selective MIMO MC-CDMA system to an equivalent flat-fading MIMO model of appropriate dimension. The channel can be now

estimated using the flat-fading MIMO model which leads to a significant reduction in the computational complexity. In this context, we then propose semi-blind and robust channel estimation paradigms which employ the statistics of the data in addition to pilot symbols to decrease the channel estimation error. The final part of the thesis considers superimposed training based channel estimation techniques in MIMO orthogonal frequency division multiplexing systems. We propose optimal superimposed pilot sequence (SIP) and pilot placement to minimize the MSE of the channel estimate. The proposed technique exploits the spatial correlation knowledge of the MIMO channels and the orthogonality of subcarriers to find the optimal pilot sequence, optimal number of pilot subcarriers, and pilot locations to minimize the MSE of the channel estimate. To achieve an identical MSE performance with respect to the existing superimposed training based techniques, the proposed scheme requires pilots on less number of subcarriers and thus exhibits superior bandwidth efficiency.

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Title : *Resource Allocation And Stable Throughput Tradeoffs in Cognitive Radio Networks*

Author(s) : *Kulkarni Kedar*
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Abstract

In cognitive radio networks, secondary users opportunistically access spectrum allocated to primary users in such a way that quality-of-service requirements of primary users are satisfied. Our thesis forays into two aspects of cognitive radio networks– physical layer and network layer. In the former, we first consider dynamic activity of primary users that can arrive or depart at any time in the transmission period of secondary user. We propose a power allocation method to maximize transmission rate of secondary user under average interference constraint. Dynamic activity can be captured by modeling the primary user as queue based system. While accessing spectrum allocated to primary user, secondary user must ensure that primary user's queue remains stable. Under this constraint, we propose a power allocation method to maximize outage capacity of secondary user. Next we investigate energy constrained secondary users in a multi-channel environment where sensing can only be done one channel at a time. Objective of secondary users is to maximize average bit-throughput in a frame duration while satisfying rate constraint of primary users. We model the problem of finding optimal sensing times and transmission powers as a resource allocation problem and provide solution for single as well as multiple secondary users case. Study of queue based systems gives insights in network layer aspects like packet throughput and packet delays. Primary user's quality-of-service requirement in this case is queue stability. Packet throughput achieved while keeping all queues stable, is called stable throughput. We first analyze and compare stable throughput of secondary user in two access modes– interweave mode and joint interweave-underlay mode. Then we propose optimal spectrum access method as well as low complexity suboptimal methods that maximize secondary packet throughput, utilizing knowledge of primary user's queue state. Next we consider a scenario where secondary user acts as a relay for primary transmission. Considering all queues to be of finite size, an optimal access method is proposed under packet loss constraint of primary user. A more general scenario is cooperative relaying case where secondary user only relays failed packets of primary user. In this case, we study effect of energy availability on stable throughput assuming all nodes to be battery powered. Finally, we propose three cooperation protocols where multiple secondary users assist primary user in retransmission of its unsuccessful packets. We analyze users' packet throughput by modelling the protocols as signal flow graphs. We also analyze energy efficiency of the proposed methods. Effect of imperfect sensing on stable throughput is examined for individual sensing case as well as for cooperative sensing case.

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Title	***:***	***Studies On Performance Enhancement Of Substrate Integrated Waveguide Based Antennas And Antenna Arrays***
Author(s)	***:***	***Mukherjee Soumava***
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Abstract

With rapid development of microwave and millimeter wave technologies, compact wireless components and systems are of prime interest now a days. At these frequencies, the circuit building blocks are closely related to each other via electromagnetic couplings and interconnect. Successful development of these wireless systems requires the definition of a platform with a high performance, low-cost technology to which the conventional planar techniques are limited in performance. Several studies on integration of non-planar waveguide technology with low cost printed circuit technology has been studied over the years. Recently a new technology has emerged known as "Substrate Integrated Waveguide (SIW)" which incorporates waveguide circuits in planar form and thus inherits the advantages of both planar and non-planar circuits e.g. low loss, high Q, good electromagnetic shielding, easy interconnections etc. Realization of different components e.g. antennas, filters, directional couplers, diplexers with SIW technology have attracted much attention among the researchers in recent years. For easier excitation of SIW based circuits, efficient broadband transitions is required. Hence, design of broadband transition from SIW environment to other planar technologies e.g. microstrip, coaxial line etc. is studied along with its working principle. These interconnections are then used extensively in many designs for measurement and interconnection purpose to build SIW antenna system. Next, a detailed study on performance enhancement of SIW cavity backed slot antenna is studied. Several topologies to implement multiband and broadband performance of the slot antenna using SIW cavity modes are discussed. The working principle of the antenna is explained with the help of equivalent circuit model. The use of SIW cavity backing helps to realize multiband and broadband slot antenna in planar substrate with high gain and unidirectional radiation pattern which makes them attractive for practical applications. However, another attractive solution for high performance antenna system is to implement high gain single element slot antenna. Several design topologies to realize high gain SIW slot antenna is discussed. The working principle of the antenna is explained and prediction of far field radiation pattern is also demonstrated. Moreover,further research work is carried out to implement high gain SIW antenna systems by implementing SIW based slot array antennas. Several design topologies to implement dual frequency, dual polarized dual band and broadband SIW slot array antenna is also implemented. A detailed study of feeding network consisting of SIW based power divider network to implement equal and unequal power division ratios for using in antenna array feeding network is demonstrated. The research work presents a detailed study of several design methodologies to enhance performance of high frequency microwave antenna systems in terms of compactness, bandwidth and gain. The use of SIW technology makes the designs advantageous for using in high frequency microwave applications. All the proposed designs are validated by experimental results and detailed analysis of the proposed designs are also developed. The proposed antenna systems are suitable for X and Ku band Antenna applications.

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Title	:	*Spin and Charge Transport in Nano-Scale Atomistic Device through Semi-Classical Monte-Carlo Method and Non-Equilibrium Green's Function formalism*
Author(s)	:	*Bishnoi Bhupesh*
Roll No	:	*11104166*
Supervisor(s)	:	*Ghosh Bahniman*

Abstract

In this thesis work, we address Spin transport study through Semi-Classical Monte-Carlo method in the various semiconductor materials and device structures like Silicene, Germanene, armchair Silicene nanoribbon, bilayer Silicene, Lithiated Silicene (Silicel) and Molybdenum Disulfide (MoS2). We have also investigated Spin transport in Silicon nanowire, Silicon-Germanium nanowire, core-shell nanowire structure of Silicon and Germanium. Core-shell structures have been investigated as they offer many advantages in terms of electrostatics and transport in comparison to bare nanowire structure. For all the semiconductor materials and structures considered in this thesis, we have investigated the effect of variation of temperature and electric field. We have also studied the effect of variation of width in the monolayer, nanoribbon structures and variation of diameter in the nanowire and core-shell nanowire. In the Monte-Carlo simulation method, we have incorporated various scattering mechanisms for the above-mentioned materials and structures under consideration. Due to the diffusive nature of transport, electron's undergo through various scattering processes which results in electron's Spin randomization. Further due to the applied transverse electric field, the electron's Spin precess due to the Spin-Orbital coupling. we have studied Spin polarized electronic transport along the length of the structure and the Spin dephasing length is estimated to be in the range of 0.5 µm for Silicene, 1 5 µm for Germanene, 3 µm for armchair Silicene n anorib bon, 2 µm for bu ckled bilayer Silicene, 2 µm for Lithiated Silicene, 0.4 µm for monolayer MoS2. In the second part of the thesis, we have investigated charge transport in quantum transport regime for the nano-scale atomistic devices through the non-equilibrium Green's function (NEGF) formalism. Vertical L-shaped (p+-Al0.3Ga0.7Sb) pocket-implanted GaSb/InAs hetero-junction Tunnel Field-effect Transistor and vertical L-shaped InSb/InAs hetero-junction Tunnel Field-effect Transistor, Si junction-less nanowire Tunnel Field-effect Transistor, and Si junction-less ultra-thin body Tunnel Field-effect Transistor are investigated by 3-D full-band atomistic sp3d5s* Spin-Orbital Coupled Tight-Binding method. We have investigated the current-voltage characteristics, ON-current, OFF-current and sub-threshold swing as a function of Equivalent Oxide Thickness (Tox), Gate length (LG), Drain length (LD), Gate Undercut (LUC), Dielectric Constant and Channel Thickness (TInAs) in L-shaped TFET for low voltage operation.

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