CHAPTER 57

TECHNOLOGY
ELECTRONICS & COMMUNICATION ENGINEERING

Doctoral Theses

01. AMBRISH
Physical Layer Security in Wireless Communication Systems.
Supervisor : Prof. Parul Garg
Th25463

Abstract
(Verified)

Security is one of the key issues in the design of wireless communication systems due to their broadcasting nature. We have proposed information-theoretic security solutions to wireless systems. Our complete work can be described into the following four problems.In the first problem, we propose a decode-and-forward (DF)-relayed dual-hop free-space-optics/radio-frequency (FSO/RF) system where FSO technology is following the Gamma-Gamma distribution while RF technology is following generalize eta-mu distribution. It has been illustrated through numerical result analysis that the proposed system can provide a longer distance transmission coverage with a high-speed data transmission rate, and due to the use of RF technology, the system is suitable for both indoor and outdoor network environments.In second problem, we consider an indoor-network environment wherein visible-light-communication (VLC) technology is used as the primary user and RF technology is used as a backup technology. Moreover, the secrecy-rate is formulated based on known/unknown channel state information (CSI) knowledge of legitimate and eavesdropping links. It has been illustrated through numerical result analysis that the use of RF technology in addition to VLC technology is an effective solution to provide uninterrupted secure communication to indoor users.In third problem, we have investigated the security performance of an indoor VLC network. The secrecy-rate was formulated for imperfect known/unknown CSI scenarios with the use of the minimum-mean-square estimation (MMSE) estimation technique. The proposed secure-LED selection scheme has an efficient ability to provide guaranteed secure broadcasting against an active/passive eavesdropping attack.In fourth problem, the secure and reliable broadcasting analysis of an underlay cognitive radio network (CRN) system was investigated by proposing a novel two-step relay selection scheme. It has been verified through the result analysis that the proposed system can overcome the spectrum scarcity of the RF networks and provide secure and reliable broadcasting against active/passive eavesdropping attacks.

Contents

02. DUA (Shilpa)
Passive Approaches for Detection of Digital Image Tampering.
Supervisor : Prof Harish Parthasarthy and Prof. Jyotsna Singh
Th 25457

Abstract
(Verified)

Nowadays, it is a challenge to visually identify forgery in an image due to the expeditious growth of image editing software. The two most types of forgeries are copy-move forgery and image splicing. Segregation of authentic and forged images and subsequently localization of malicious modifications in a forged image is the prime objective of our thesis.In the first stage of our thesis, a block-based scheme has been developed for the localization of CMF in an image using the localized intensity features. In continuation with this work, we have utilized the circular shift of Radon transform and elementary properties of Fourier series to estimate the angle of rotation of forged image patch using the least square technique.Next, a unified detector is proposed to deal with either type of forgeries, splicing or copy-move in the same instance. When a JPEG compressed image is tampered, there is a change in the statistical properties of AC components of block discrete cosine transform (DCT) coefficients. The proposed scheme captures this change by using standard deviation and count of non-zero DCT coefficients corresponding to each of the AC frequency components independently as feature vectors.Finally, a comprehensive approach is presented for investigating JPEG compressed test images, suspected of being tampered either by splicing or CMF. Initially, doubly stochastic model of block-wise quantized discrete cosine transform coefficients is exploited to segregate authentic and forged JPEG images from a standard dataset (CASIA). Once the presence of tampering is detected, the next step is to localize the forged region according to the type of forgery. In the case of spliced JPEG images, the tampered region is localized using block-wise correlation maps of dequantized DCT coefficients and its recompressed version at different quality factors. Alternatively, duplicated regions are identified using highly localized phase congruency features of each block.

Contents

03. GARG (Naman)
Some Theoretical and Numerical Studies in Quantum Filtering and feedback Control.
Supervisor : Prof. Harish Parthasarathy and Prof. Dharmendra K. Upadhyay
Th 25461

Abstract
(Verified)

The subject of the thesis is simulating quantum systems described by Hamiltonians plus quantum noise and then designing algorithms for filtering the state on a real time basis based on non-demolition measurements, ie, measurements which do not interfere with the state evolution and finally to design control algorithms for tracking a given state or reducing noise in the filtered state. The final part of the thesis deals with computing the entropy of the the system state in the presence of noise, then the entropy of the filtered state and finally the entropy of the controlled state and demonstrating via simulations how filtering and control reduce the state entropy in agreement with

the basic fact that making a measurement gives us some information about the state thereby reducing its Von-Neumann entropy.

Contents

1. Introduction 2. Simulation of H-P noisy Schrodinger equation 3.Simulating the belavkin filtering equation for quadrature noise measurements 4.Simulating the belavkin filter for mixture of quadrature and photon counting noise 5. Quantum control of the belavkin filtered state 6. Von-Neumann entropy rate for H-P, belavkin and controlled belavki filtered states 7. Conclusions and future scope. References.

04. GAUTAM (Usha)
Design and Analysis of Microwave Differentiators and Integrators.
Supervisor : Dr. Tarun Kumar Rawat
Th 25464

Abstract
(Verified)

Fractional calculus has maintained tremendeous vitality in various areas of automatic control systems, signal processing, image processing, circuit theory and biomedical engineering. It involves a unique feature of generalization of integral and derivative to a non-integer order. This synopsis presents the designing of integer order and fractional order microwave differentiators and integrators. These proposed designs are obtained by using different combinations of transmission line sections and shunt stubs in cascading. Evolutionary algorithms like cuckoo search algorithm (CSA), particle search optimization (PSO), gravitational search algorithm (GSA), hybrid PSO-GSA (HPSO-GSA) and real-coded genetic algorithm (RCGA) are used to design optimal fractional order and integer order microwave differentiators and integrators. Meta-heuristic algorithms are applied to obtain the optimal values of the characteristic impedances of these line elements to approximate the ideal magnitude response. The proposed designs using CSA, PSO, GSA, HPSO-GSA and RCGA have been proved to be very robust, simple and generic. The effectiveness of the proposed methods is evaluated and compared with the existing methods. This work also focuses on the phase response of proposed integer order and fractional order microwave differentiators and integrators. Further, the structure of the designed differentiators and integrators are implemented in the form of microstrip line on RT/Duroid substrate with dielectric constant 2.2 and thickness 0.762 mm.

Contents

1. Introduction 2. Design and analysis of microwave integrators 3. Design and analysis of microwave differentiator 4. Conclusions and suggestions for future work.

05. GOSWAMI (OM Prakash)
Computationally efficient Design and Realization of Discrete-Time Systems.
Supervisors : Prof. D. K. Upadhyay and Dr. Tarun Kumar Rawat
Th 25527

Abstract
(Not Verified)

This thesis deals with optimum designs of the digital differentiator, digital integrator, and s-to-z operator. Though ample varieties of their designs are available in the literature, this work portrays the design's improvements after modifying various techniques using mathematical frameworks and optimization algorithms. Based on the literature survey, four problems have been formulated. Additionally, the realization of the optimum digital differentiator has also been presented.The first problem considered in this thesis is the designing of digital differentiators using different techniques. The first technique includes fractional interpolation followed by suitable optimization. The second technique is based on the fractional delay's hybrid approximation. In the third technique, the L1-

norm-based error objective function is optimized to get the low order design. The optimum design is also realized by different structures. The simulation results of these designs indicate the noteworthy improvements in the magnitude matching of the ideal one.The second problem is concerned with designing the digital differentiators consisting of fractional delay-based transfer functions. The designs utilize the optimum fractional bilinear transform and fractional interpolation-based transfer function to match the low-frequency magnitude response. The multirate technique is then applied to extends this matching magnitude for the complete Nyquist interval. The next problem is concerned with the designs of digital integrators. The fractional interpolation and fractional bilinear transform have been optimized along with the implementation of the multirate technique. The comparative analysis of these designs depicts the significant improvements in the magnitude matching. The last contribution of the thesis is concerned with the extension of the digital differentiator and integrator for designing the *s*-to-*z* operator. This extended bilinear transform-based operator provides the perfect phase response and magnitude response with high accuracy. The proposed operator is also applied in filter transformation to validate its acceptability as an alternative operator for existing ones.

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06. GUPTA (Mridul)
Design and Implementation of Optimal Digital Filters.
Supervisor : Prof. Dharmendra Kumar Upadhyay
Th 25460

Abstract
(Not Verified)

Filters are the most widely used circuit elements used to obtain desired frequency response and eliminate the undesired frequency components. Digital filters can be classified in two types as infinite impulse response (IIR) and finite impulse response (FIR). While implementing a discrete time system, IIR design techniques are preferred over FIR. This thesis focuses on obtaining IIR filtering circuits by utilizing the most efficient optimization process. It is identified that the terms lowpass filtering and integrators are interchangeably used many times due to similarity in their frequency responses. A highpass filter also shows similar characteristics to that of a differentiator wherein the output voltage taken across the load resistance is the derivative of the input voltage. In this thesis, optimal designs of lowpass filters, second-order integrators, fractional-order integrator and fractional-order differentiators are proposed. Z-domain chain-scattering parameters for serial transmission line sections, shunt-connected open stub, shunt-connected short stubs and coupled-line are used as the elementary design elements. Superiority of the proposed designs are identified through analysing various error performance parameters. Butterworth lowpass filter designs are proposed using colliding bodies optimization algorithm for approximating the magnitude response of desired transfer function with the ideal ones. Afterwards, a new design methodology is developed for the implementation of a second-order microwave integrator on microstrip circuit. Mostly it is seen that work had been done on the fractional-order integrators and differentiators which can operate hardly upto frequency of few hundred MHz. However, the benefits of fractional calculus can be exploited upto GHz range. In view of this, novel optimal designs to obtain fractional-order integral and differential of the microwave signals using cuckoo search algorithm and bat algorithm are proposed in this thesis. Band specific fractional-order differentiator circuits to cover the full ultra-wide band range are also proposed.

Contents

1. Introduction 2. Design of optimal butterworthlowpass filters 3. Design and implementation of second-order integrators 4.Design and implementation of optimal fractional-order integrator 5.Design and implementation of optimal fractional-order differentiators 6.Conclusion and future scope.Bibliography.

07. PANDEY (Vishal Kumar)
Higher Order Statistics for Image Analysis.
Supervisor : Prof. Jyotsna Singh and Prof. Harish Parthasarathy
Th25459

Abstract
(Not Verified)

The higher order moments and their invariants can be used efficiently for the analysis of image in many useful applications such as face recognition, object tracking, pattern recognition etc. Keeping this in mind, we have concentrated on certain important issues related to the higher order moments in our thesis work. Invariance of higher order moments is one of the important property that can be exploited for successful implementation of said applications. Computational complexity and reconstruction capability are the other two important parameters of any technique.In this work, we have mainly focused on discrete orthogonal higher order moments. In first stage of our thesis, we have implemented an indirect method to derive the translation and scale invariants of Hahn moments for 2D and 3D images. In this method, the orthogonal moment invariants are derived from the non orthogonal geometric moments. However, in this method the computational complexity increases with the order of the moment. In order to overcome this drawback, we have derived the translation and scale invariants of Hahn moments using direct method.In next chapter, the technique used for deriving the moment invariants of higher order discrete Hahn family is further extended to generalized (fractional) order. The research work is further extended by deriving the moment invariants of higher order discrete Hahn family for generalized order. As an example, the generalized Tchebichef moment and its invariants are derived from Tchebichef polynomials of fractional order. In the final phase of our research, we have presented a technique for estimating the optical flow from the sequence of images. The analysis is mainly based on real sequences where little information is available about the motion that is occurring over image frames. Experiments are performed to show the efficiency of the proposed estimation technique under noisy and varying illumination conditions.

Contents

1. Introduction 2. Motivation, objectives and contribution 3.Algebraic computation of 2D and 3D HMI 4. Fractional order tchebichef moment invariants 5. Robust optical flow estimation using tchebichef moments 6. Conclusion on future work. Appendix A. Publication base on the thesis. Data of the author. Bibliography.

08. PRATEEK KUMAR
Two-Dimensional Material Based Field Effect Transistors and their Application.
Supervisor : Prof. Manesha Gupta and Dr. Kunwar Singh
Th25458

Abstract
(Not Verified)

Moore's law held well till metal oxide semiconductor field-effect transistor entered the nanoscale regime. With continuous scaling of metal oxide semiconductor field-effect transistor, short channel effects like drain-induced barrier lowering, impact ionization, surface scattering has hampered the

performance of the device. Short channel effects have impacted the performance, modeling and reliability of the device. In the past few decades, tunnel field-effect transistors, carbon nanotubes and junctionless transistors have emerged as possible candidates to replace metal oxide semiconductor field-effect transistor in the future.Another bottleneck for researchers is the failure of Silicon as a few-layer structure. Major setbacks of Silicon as a few-layer semiconductor are degraded mobility, failure in optoelectronics and higher power dissipation. The Discovery of graphene revolutionized a new field of semiconductor material called two- dimensional materials in which charge carriers are free to transverse in any two directions but are confined in the third direction. Major two-dimensional materials along with graphene are transition metal dichalcogenides and black phosphorous.In this work, different two-dimensional materials are studied and are analyzed as a channel material for semiconductor devices. Different devices simulated are metal oxide semiconductor field-effect transistor, tunnel field-effect transistors and nanotube. Transition metal dichalcogenides materials analyzed are Molybdenum disulfide, Molybdenum diselenide, Molybdenum ditelluride, Tungsten disulfide and Tungsten diselenide. Along with the aforementioned transition metal dichalcogenides materials, multilayer black phosphorous is also studied as a channel material. Effect of different techniques like variation in permittivity, charge plasma, interface trap charge, variation in physical dimensions and back gate on the behavior of two-dimensional materials also analyzed. To enhance the practical application of the two-dimensional materials, a single transistor AND gate using Molybdenum ditelluride as channel material is thoroughly investigated.

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09. SHARMA (Karishma)
Design and Analysis of Microstrip Patch Antennas for Wireless Communications Systems.
Supervisor : Prof. Dharmendra kumarUpadhyay and Prof. Harish Parthasarathy
Th 25456

Abstract
(Not Verified)

In last few years, the wireless communication systems are dramatically getting compact in size, so the need of light weight, low profile, versatile, small antennas have increased. Microstrip patch antennas have these properties and thereby used in satellite communication, radar engineering, military systems, mobile and radio communication etc. In order to play with the antenna characteristics for various wireless communication system applications; numerical techniques, UWB technology, gain improvement methods and reconfigurability are used. This instigated the research work focused on, design and analysis of microstrip patch antennas using numerical methods, antenna characteristics improvement techniques and reconfigurability with liquid material.The shape of the patch in MPA affects the impedance and radiation characteristics. A modified regular circular shaped patch antenna with arcs removed at different positions is proposed, in order to improve the antenna bandwidth and gain. This evidently resulted in the need to generalize antenna radiation parameters for any arbitrary patch shape, using perturbation technique in curvilinear coordinate system.Further, improvement techniques for two of the antenna parameters – bandwidth and gain, are discussed. Using which, a wideband monopole antenna is proposed with Saturn-shaped arc cut in partial ground plane and symmetric rectangular slots removed from the circular patch. Also, high-gain is achieved in a rectangular patch antenna, converting it into a resonant cavity antenna structure with a partially

reflective surface as superstrate.Liquid material in the form of conducting patch is used above the grounded substrate, replacing the high conductance metal to introduce reconfigurability in antenna. These liquid antennas can be easily tuned for desired characteristics by varying the liquid, its height and are compact, low cost, and easy to use. Theoretical E-field analysis for such an antenna is done.The entire investigations provides new directions for further research in the field of antenna designs.

Contents

10. SHASHIKANT
Visible Light Communication: Design and Analysis of Performance Enhancement Techniques.
Supervisor : Prof. Parul Garg
Th 25462

Abstract
(Not Verified)

Visible light communication (VLC) is an emerging research area focusing on last few meter communication. A VLC system consists of light emitting diodes (LEDs) as transmitter, an optical wireless channel and photo-diode (PD) as receiver. Throughout the research, we have explored various performance enhancement techniques that can be implemented on transmitter as well as receiver end. In the first problem, a novel location tracking algorithm using intelligent photo-diode receiver (IPR) is proposed for the VLC system. The algorithm for location tracking and rotation with accuracy has been analysed mathematically. Further, the switching criteria is also presented when the receiver crosses the coverage region of one LED and enters to the coverage region of another LED.There is always a trade-off between coverage and interference at the user end. We have proposed a method to reduce the interference in indoor VLC system without compromising with the coverage at the user end. Specifically, the effect of proposed method is investigated on various performance metrics such as signal to noise ratio, coverage probability, and bit error rate. In the next problem, we have proposed a novel technique for power allocation using smart LED for an indoor VLC system. An algorithm for the power allocation strategy is also presented. We have further analysed the performance of the system in terms of SNR and power transmission. In the next problem, we present the statistical analysis of the VLC system proposed in the previous problem considering random waypoint (RWP) model for user's mobility. The closed form expressions for various measures are derived. In the last problem, we have focused on the placement of LEDs on the roof and resource allocation. In this work, we have analysed coverage aspects of various hexagonal LED placement schemes.

Contents

11. SINGH (Preeti)
Design and Analysis of Analog Circuits with Enhanced Performance.
Supervisor : Prof. Maneesha Gupta
Th25455

Abstract
(Not Verified)

The proposed TIA-I provides the transimpedance gain of 56.8 dBΩ and the bandwidth of 2.7 GHz with 0.42 mW power dissipation. In proposed TIA-II, floating gate metal oxide semiconductor based Wilson current mirror is used to design transimpedance amplifier which increases the output resistance and thereby, increases the gain. The transimpedance gain of the proposed TIA-II is 56.8 dBΩ and 5 GHz bandwidth with 0.58 mW from 1 V power supply. In proposed TIA-III, negative capacitance and capacitive feedback techniques are used to extend the bandwidth without affecting the gain. The proposed TIA-III provides the bandwidth of 10.1 GHz along with transimpedance gain of 45.75 dBΩ and input noise current of 7.5 pA/√Hz. In proposed TIA-IV, floating gate metal oxide semiconductor and flipped voltage follower are used to design low voltage transimpedance amplifier. Further, inductive peaking technique is used to extend the bandwidth. The bandwidth and the transimpedance gain of the proposed TIA-IV are 13.2 GHz and 50.4 dBΩ respectively. It dissipates 3 mW from 1.2 V power supply. In proposed TIA-V, gain enhancing path is introduced in active voltage-current feedback TIA topology which enhances gain and bandwidth both. The proposed TIA-V has simulated transimpedance gain of 57.1 dBΩ and bandwidth of 6.5 GHz with 3.2 mW power dissipation from 1.8 V. In proposed TIA-VI, active common drain active feedback topology is used to design TIA in which negative capacitance and capacitive peaking techniques are employed to extend the bandwidth. The proposed TIA-VI provides the bandwidth of 7.5 GHz and transimpedance gain of 51.9 dBΩ with 4 mW power dissipation.All the proposed works are simulated in TSMC 0.18 µm CMOS technology using Mentor Graphics Eldo simulation tool. The layout of the proposed TIA-I, TIA-II, TIA-III, TIA-V, and TIA-VI has been designed.

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12. SINGH (Rohit Kumar)
Classical and Quantum Algorithm for Parameter Estimation and Restoration of Images.
Supervisor : Prof. Jyotsna Singh and Prof. Harish Parthasarathy
Th 25592

Abstract
(Verified)

The aim of thesis is to deal with three different situations of image restoration. They are categorized as restoration of classical images by classical algorithm, quantum images by classical algorithm and finally classical images by hybrid quantum-classical algorithm.The restoration of magnetic resonance (MR) image is carried out by modeling a dynamically varying image field driven by white Gaussian noise (WGN) using a linear partial differential equation (pde). Our algorithm based on EKF produces good restoration results for specific rate of change of image with time. In next stage of our work, we have proposed a likelihood function based scheme for the restoration of original image quality from

its noisy version corrupted with a mixture of Poisson and Gaussian components. The scheme makes specific use of the Euler-Maclaurin summation formula (EMSF). Finally using MATLAB simulations, we make a detailed study of the noise to signal ratio (NSR) as a function of the Poisson and Gaussian noise variance.The research work is further extended towards the estimation of fan rotation angle of a fan stroboscope in the presence of measurement noise on a real-time basis. Fan stroboscope algorithm involves modeling of the output quantum image field by multiplying the rotating fan window with the input quantum field and applying the EKF to estimate this time varying fan window angle. The measured quantity is a transition probability of an atom.In the final phase of our research, we have proposed a quantum–classical hybrid filtering (QCHF) scheme for restoring original visual quality of an image from its noisy version. Our quantum algorithm has been supplemented with classical median filtering to get excellent restoration results. The results demonstrate the marked superiority of our proposed algorithm over the existing classical restoration scheme.

Contents

13. SONI (Ashu)
Design, Analysis and Applications of Fractional Order Circuits.
Supervisor : Prof. Maneesha Gupta
Th 25454

Abstract
(Not Verified)

In this work, various optimization techniques have been used to analyze the behavior of fractional order Butterworth, Chebyshev, Elliptic, and Bessel filters. Performance evaluation of (α+β) order low pass Chebyshev filters has been done using Simulated annealing (SA), Non-linear least square (NLS), and Interior search algorithm (ISA) techniques. The best optimization technique for designing (α+β) order Chebyshev filter has been chosen and further implemented using Thomas Biquad. In addition to it, (1+α) order low pass Elliptic filter has been designed using the NLS technique and optimized results have been verified using the MIB circuit. Further, designing of fractional order low pass Butterworth filter using Genetic algorithm has been done. The simulated results obtained using NLS are verified at the circuit level by Tow Thomas Biquad. Additionally, fractional order Butterworth filter has also been designed using the Cuckoo search algorithm (CSA), ISA, and the series combination of CSA and ISA. The series combination of CSA and ISA is the best technique for designing low pass fractional order Butterworth filter. The series optimized Butterworth filter has been realized using a DVCC based circuit. Finally, (1+α), (α+β) and (2+α) order Bessel filters have been designed using optimization techniques. The (1+ α) order Bessel filter has been designed using SA, NLS, ISA, and FF. The best technique has been chosen for designing (1+ α) order Bessel filter and further realized using Tow Thomas Biquad. The (α+β) order Bessel filter has been designed using ISA and verified using Tow Thomas Biquad. Lastly, (2+α) order Bessel filters have been designed using SA, NLS, and ISA. The best technique is chosen for designing (2+α) order Bessel filter and further verified using the DVCC based circuit.

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