M.TECH. THESIS ABSTRACTS 2017

Microelectronics, VLSI & Display Technology

RF Microwaves and Photonics

Signal Processing, Communication & Networks

Power & Control

Title : ***Effect of Annealing Temperature on Imidazolin-5-one molecule/P3HT:PCBM Ternary Planar-Bulk Hetero-Junction Organic Solar Cells Performance***

Author(s) : ***Jain Sarthak***

Roll No : ***11907655***

Supervisor : ***Iyer S Sundar Kumar***

Abstract

This thesis studies the annealing effects on Inverted Ternary Planar-Bulk Hetero-Junction Organic Solar Cells for an in-house synthesised molecule M1 belonging to the Imidazolin-5-one molecule family, which comes from the chromophore responsible for fluorescence of Green Fluorescent Protein (GFP) discovered in jellyfish Aequorea Victoria. Previously OSC had been created using this molecule and had shown significant improvements by using Inverted Ternary bulk hetero-junction devices and also showed promising results while annealing. This led us to study the effects of different annealing temperature on the device performance. Ternary Bulk hetero-junction Organic Solar Cells with Inverted structure were fabricated at different annealing temperatures ranging from 100C to 200C. Peak efficiency of 3.93% was obtained at 165C. This is a 318% improvement in power conversion efficiency compared to well established binary bulk hetero-junction P3HT:PCBM active layer devices annealed at the same temperature. Further, all other parameters including Jsc, Voc, FF, Rs and Rsh showed best results for annealing the devices for 140C - 165C range.

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Title : Simulation studies of S-shaped J-V curves in single layer and bulk heterojunction organic solar cells

Author(s) : Shaik Jany Bhasha
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Supervisor : Iyer S Sundar Kumar

Abstract

Organic solar cells have the potential to be portable power sources that are lightweight, inexpensive, available for large area fabrication, and flexible. However, the highest power conversion efficiency for organic solar cells till date is ~12%. But as compared to crystal silicon solar cells the efficiencies of organic solar cells are still lower. The efficiency is the most commonly used parameter to compare the performance of one solar cell to another. We often encounter S-shaped J-V curves in organic solar cells. Because of S-shape in J-V characteristics, fill factor decreases significantly, resulting in huge losses in efficiency. This work is to investigate the reasons for S-shaped curves with the help of simulations. In this work single layer and bulk heterojunction devices were simulated in SILVACO to find out the origin of S-shaped J-V curves. Our finding provides insight into the origin of S-shape effect in single layer and bulk heterojunction organic solar cells. We found that in single layer organic solar cells, light intensity has a huge impact on S-shaped curves and electric field variations inside the device also one of the reason for S-shape. We also found that in bulk heterojunction organic solar cells, variations of electrode barrier, mobility variations and recombination at the junction are main reasons for S-shaped curves.

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Title : A Dilectric Ink Based Security Tag on Paper Substrate
Author(s) : Naidu Ponnada Appala
Roll No : 15104039
Supervisor(s) : Mazhari Baquer

Abstract

Counterfeiting is a global problem that challenges companies, governments and customers. In this thesis, different types of security tags based on a dielectric ink have been fabricated on paper substrate for anti-counterfeiting. The tags have a unique impedance vs frequency electrical signature due to several features including frequency dependent dielectric response and distributed RC network. In order to maintain process simplicity, thin layer of vacuum deposited aluminum on paper was used to obtain resistive characteristics. The electrical signature of the tag could be read through a Wien bridge oscillator where the tag served either as a series RC or a parallel RC element. Preliminary results indicate that the electrical characteristics of the tags are stable thereby indicating that they can be readily incorporated in many applications. To enhance the security features of the tag, addition of an organic diode to the tag is proposed. To explore this concept, a single layer organic semiconductor diode based on P3HT polymer was fabricated on the paper substrate. The diode showed good rectification ratio of 1.5×104, a built in voltage of 1.3V and hole mobility of 8×10-4 cm2/V-s. The diodes degraded rapidly and need better encapsulation to enhance stability.

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Title	***:***	***Analysis of switching and frequency response of organic schottky diode rectifiers***
Author(s)	***:***	***Shahi Yash***
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Supervisor(s)	***:***	***Mazhari Baquer***

Abstract

Organic RFID tags are gaining popularity due to their low costs, and are being developed to operate in different frequency bands. A constant endeavor of researchers has been to develop tags that operate in the UHF band, because they provide the advantages of long range readability and shorter read times. While tags have been developed that operate in this band, the reasons behind the performance degradation at such high frequencies have not been well analyzed. The critical element limiting the operation in the high frequency region is the rectifier, and in this work, we explore the different models and explanations put forward to explain the decrease in DC output voltage of the rectifier with increase in input frequency. We find that the two prevalent explanations suffer from inconsistencies and fall short of bringing out the deterioration in performance as observed experimentally. Through the study of switching and sinusoidal responses of the organic Schottky diode, we show that the transit time of the carrier is the parameter determining the frequency response of the rectifier. Equipped with this understanding, we develop an analog behavioral macro-model of the organic diode that demonstrates the experimentally observed frequency response of the organic diode rectifier through circuit simulations. Such a model cuts down on the high simulation time observed in device simulators like Atlas, simplifying the design of rectifier and other organic diode circuits where transient response is likely to play an important role.

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Title : ***Lateral Current Voltage Characteristics along Organic Heterojunction and its Applications***

Author(s) : ***Raj Aditya***
Roll No : ***12807049***
Supervisor(s) : ***Mazhari Baquer***

Abstract

Organic heterojunctions are being actively used in Organic Light Emitting Diode (OLED), Organic Photovoltaics (OPV) and Organic Photodiodes (OPD) to improve device performance. Most of these devices employ vertical heterojunction in which carriers predominantly move in a direction perpendicular to heterojunction. Although a lot of research has been done in understanding and exploiting vertical organic heterojunction, lateral current flow along heterojunction has not been studied in detail. This work attempts to study lateral flow of carriers along a particular type of anisotype organic heterojunction in which a large energy barrier at the interface prevents carriers from recombining. It is observed that normally depleted heterojunction in equilibrium shows high conductivity when both type of carriers are injected at interface, because of accumulation on the either side of heterojunction. Electron and hole currents are found to be strongly coupled and carriers in one semiconductor affect the transient current in other semiconductor. A qualitative explanation of simulation results is given based on origin of potential difference across heterojunction which is attributed to inherent asymmetry of the heterojunction device. Lateral counterparts of conventional vertically operated OLED and OPD are proposed which employ high conductive lateral channel at heterostructure interface. The performance of these structures based on simulation is found to be comparable to their vertical counterparts. Simple device structure of Lateral OLED also allows us to incorporate a third terminal which can be used independently to control current similar to Light Emitting Transistors. A partially gated OFET is also proposed which acts as a memory element.

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Title : ***Low voltage OTFT Using Thick Dielectric***

Author(s) : ***Kumar Suman***

Roll No : ***12807736***

Supervisor(s) : ***Mazhari Baquer***

Abstract

Fabrication of organic electronics based devices using screen printing technique is one of the most crucial step in realizing the low-cost promise of organic electronics. OTFTs are more commonly fabricated using screen printing technique but has large thickness of the printed dielectric layer, which results in very high operating voltages for significant performance of the device. In the present thesis two different approaches are used to achieve low voltage application for screen printed OTFTs. The first concept is based on the formation of electric dipole at the interface which is used as an alternate device structure called Current Induced Channel Transistor (CICT) capable of operating at low voltages even for 1µm thick layers and can give similar performance as that of low thickness OTFT. In the proposed device structure, carrier channel is created through formation of an electric dipole at the semiconductor-insulator interface. The negative charges of the dipole are injected through the gate current of the device which in turn attracts the positive charge at the interface to create channel in the active layer. Simulation results shows that the enhancement current factor of 30 can be achieved for µnE=10-4cm2/V-s and τr=100µs in comparison to traditional OTFT of similar dimension and dielectric thickness. The other approach is to insert an insulator in between the HTL and the ETL in order to prevent recombination at the interface. This new modified structure is called Metal Semiconductor Insulator Semiconductor FET (MSISFET). For depositing thin insulator in the proposed device it has to be grown by methods such as irradiation with UV light as printing techniques doesn't allow thin-film thermal depositions. Simulation results shows similar I-V characteristics as that of traditional OTFT.

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Title	***:***	***Development of Analytical Models for the 2DEG Density, AlGaN Layer Carrier Density, and Drain Current for AlGaN/GaN HEMTs***
Author(s)	***:***	***Swamy N Somashekar***
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Supervisor(s)	***:***	***Dutta Aloke***

Abstract

In this work, we have first developed an analytical model for the 2DEG density (nS) in AlGaN/GaN HEMTs, which neither uses any interpolation function nor any fitting parameter, and is much simpler than other models reported in the literature, while offering comparable or better accuracy. We have also accounted for the carrier (nB) build-up in the AlGaN layer for high gate bias, and developed a model for it, which does not have any explicit dependence on nS and is a function only of the gate voltage. To the best of our knowledge, it is the first such report in the literature. Using these models for nB and nS, and another reported model for nS in the subthreshold region, we have developed a unified model for nS, which is valid from subthreshold to high gate bias. The results of our models for nS and nB showed an excellent match with those reported in the literature, including the results obtained from FDM (Finite Difference Method) simulations, and the experimental data published in the literature. Next, we applied this model for nS in a charge-based drain current formulation reported elsewhere, with suitable modifications, along with the incorporation of several second-order effects, such as, carrier velocity saturation, drain-induced barrier lowering, carrier mobility degradation due to vertical and lateral fields, source/drain access region resistances, channel length modulation, and self-heating, for our model to be valid for small-geometry devices as well. The results of our drain current model have shown excellent match with the experimental data reported in the literature for channel length ranging from 1 µm to all the way down to 125 nm, over the entire range of gate and drain bias, including a good first-order continuity of our current-voltage model with respect to these bias voltages.

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Title : ***4-Terminal OTFT with Floating Body Contact for Thermal Sensing Applications***

Author(s) : ***Singh Jatin Vikram***

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Supervisor(s) : ***Mazhari Baquer***

Abstract

One of the major applications of OTFTs has been in temperature sensing applications like Active Matrix Temperature Sensor panels. The individual cell design usually consists of an OTFT with a temperature dependent diode or resistor for temperature sensing. Fabrication of two different components presents fabrication complexities and reduced cell density. The aim of this device is to propose a single structure, as a replacement for the conventional two-component cell structure, for temperature sensing applications. The proposed structure consists of an OTFT with floating body contact. The aim is to introduce a high injection barrier that shows a high-temperature dependent drop under the source. The floating body contact measures the drop under the source and this voltage gives us the variation of resistance with temperature. Simulation results for the proposed structure with high injection barrier showed S-shape characteristics in the output characteristics, which corresponds to a high contact resistance. The device shows a high-temperature-coefficient and measurable voltage drop values from the floating source contact. Experimental data for fabricated pentacene 4-Terminal Bottom Gate Top Contact OTFTs with silver metal contacts has been used to capture the voltage under the source and hence extract resistance. The obtained values of floating voltage (in the range of 20 mV) are measurable and the extracted temperature coefficient is 2.67E-2 per degree centigrade, which shows the proposed structure suitable is for temperature sensing as predicted by simulation

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Title : Vertical Integration of Organic Transistors and Photodiodes

Author(s) : Kumar Vikrant
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Supervisor(s) : Mazhari Baquer

Abstract

Organic Photodiodes today are being actively explored for image sensing applications. Most of the sensor arrays combine a photo-sensitive element with a transistor in active matrix array. One of the problems in fabricating such an active matrix array is increased processing complexity that arises due to separate fabrication of photodetector and transistor and their subsequent interconnection. This conventional method also limits the integration level and the fill factor of the array sensor. Another key issue in a photodiode is difficulty in achieving high photoresponsivity at low intensity levels. In the present work, two different approaches to address the problem of integration is described. In first case, the transistor and photodiode are merged into a single device called Merged Organic Transistor and Photodiode (MOTPD) in which the channel of the transistor itself acts as one electrode. The operation of the device was validated using simulations which also showed that the proposed device has a performance similar to the conventional side-by-side integrated TFT-photodiode pair. The photocurrent showed linear variation with intensity and carrier collection efficiency close to 100% for a small reverse bias voltage of -0.4V. In the second proposed device, organic photodiode operating in photovoltaic mode is integrated at the gate of the thin film transistor. The open circuit voltage of the photodiode varies with light intensity resulting in a change in the effective gate voltage and thereby the drain current of the transistor. The device shows high responsivity at low light intensity levels and more importantly can also provide current gain as compared to simple organic photodiode.

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Title	***:***	***Critical Analysis and Design of Bias Generator and Pipelined ADC for Space Imaging Applications***
Author(s)	***:***	***Yadav Ashutosh***
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Supervisor(s)	***:***	***Mazhari Baquer***

Abstract

Space missions require precise space grade sensors for different applications. For imaging applications CMOS/CCD based detectors are used. These sensors/detectors need a precise and efficient and tunable biasing scheme having a step size of less than 10mV. The feature required for detector used in ocean mapping is low noise and being programmable in the range of 0.5V to 2.1V with a tolerance of ±10mV. Also, to digitize raw analog images high-speed, high-resolution, analog-to-digital converters (ADCs) are required. Pipeline architecture is suitable for high resolution and high-speed applications. High speed, low resolution cascaded stages form the pipeline converter architecture to obtain a final conversion. Thus, the objective of this work is to design a low power programmable biasing circuit and high-resolution (12 bits) high-speed pipeline ADC in 0.18µm CMOS technology. To find optimum circuit requirements, non-idealities of the circuit realization are critically analyzed for a low power circuit design. A bias generator has been designed. After fabrication and testing, devices are working in the range of 0.5V to 2.1V with a tolerance of 6.25mV. Also, a mismatch tolerant low power 12-bit pipelined ADC was designed. Power dissipation is 100mW at 27oC and differential non-linearity is within ±0.5LSB.

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Title	:	*Simulation of Quantum well Intermixed Tapered Waveguide*
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Supervisor(s)	:	*Das Utpal*

Abstract

For optical waveguide devices, coupling loss is a major concern, where coupling of light has to be done between an optical fiber and a thin optical waveguide. The main reason behind the coupling loss is mode mismatching between them, as the mode size of the waveguide is smaller than the mode size of an untapered optical fiber. Hence to obtain better mode matching between fiber and waveguide a tapered waveguide is used. In this thesis, both horizontal and vertical taper has been modeled for a rib waveguide. Where the rib width changes, the effective refractive index along the length of tapered waveguide also changes so that the horizontal mode size of the guiding structure somewhat matches at the coupling interface. A symmetrical rib waveguide has been used in this work. Vertical taper is a lot more difficult to obtain. Here quantum well intermixing, that will change the composition of the quantum well structure leading to a change in the refractive index of guiding layers, has been used to achieve the vertical taper. The variation in rib width and refractive index profile of quantum well has been done for both linear and exponential variation in mode size. In both the case the full width at half maxima width of the mode (FWHM) has been found to observe the change from one end of the taper to the other. For the linear case the mode size increase in the vertical direction has been from 0.29 µm to 0.40 µm has been found over a 10 µm length of the taper. And horizontally it is changing from 5.9 µm to 9.0 µm over the same length. For the exponential case, the same mode size increase has been obtained for a 7.4 µm length of the taper. The exponent of the taper has been limited to 0.5 〖µm〗^(-1) to keep the condition closed to adiabatic to reduce the waveguide loss incurred. A coupling efficiency change of 21% to 28% has been achieved with this taper for a non tapered optical fiber/ waveguide interface.

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Title : ***Studies on Conformal Polarization-Insensitive Broadband Circuit Analog Absorbers***

Author(s) : ***Basu Nabarun***

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Supervisor(s) : ***Srivastava Kumar Vaibhav***

Abstract

Conventional microwave absorbers, due to their large thickness and heavy weight have limited use in practical applications. With the advent of frequency selective surface (FSS) based approaches, absorbers can be made ultra-thin with considerable reduction in weight and improved angular stability. Till date, most of the designed absorbers are based on rigid, planar surfaces. Since practical applications require absorbers to be installed on both planar and non-planar environments, a conformal absorber design is much required which can be easily wrapped on a non-planar surface and at the same time it maintains a wide angular stability in its absorptivity performance. This thesis mainly focuses on designing conformal polarization-insensitive broad- band wide angular stable, circuit analog absorbers which can be used for planar as well as curved surface applications. Three different techniques are used to achieve the above mentioned characteristics. Firstly, a broadband absorber design based on lumped resistors has been proposed. The design comprises of a printed metallic pattern on a flexible dielectric substrate where lumped resistors are mounted across the gaps in the design. The design uses a flexible foam as an air spacer in between the substrate and the ground plane. Although a wide angularly stable broadband absorption is achieved, but the use of lumped resistors make the fabrication process cumbersome. Hence a second broadband absorber design based on resistive paint, has been pro- posed. A graphite and carbon-black based resistive paint is used to print the unit cell array on a dielectric substrate. The flexible foam mentioned earlier, has been used in between the substrate and the ground copper plate. Once again a broadband wide angular stable absorption response has been achieved. Since the paint in use can be dissolved in water and its thickness cannot be properly maintained, this causes a problem with the mass scale reproducibility of the structure due to its deteriorated performance in harsh environmental conditions. Lastly two broadband absorber designs have been proposed based on resistive sheets with high values of surface resistance, as an alternative to the resistive paint used earlier. The designs are etched on resistive films pasted on an ultra-thin dielectric substrate which is separated from the ground plane by the same flexible foam used in the previous two designs. All of the proposed designs have been simulated in an ideal in finite planar surface arrangement and in a curved surface setup model. The designs have also been fabricated and experimentally verifi ed by free space measurement in planar and curved surface arrangements.

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Title : *Microwave Reflectometry Technique For Detection Of Hidden Crevasses In Glacier*

Author(s) : *R Sanjeevkumar*
Roll No : *15104047*
Supervisor(s) : *Akhtar M Jaleel*

Abstract

The microwave techniques are used today in various fields due to their numerous applications. The microwave imaging and nondestructive testing of objects are increasingly being used due to their ability to penetrate the dielectric objects, and the overall procedure does not cause any damage or destruction to the test media. The microwave techniques have also shown potential to detect cracks and other defects in various structures. Around the world, exploration missions are being carried out in glacier and polar region by many countries of late. Resources and research opportunities present in the polar regions are mainly the driving factors for the explorations. While operating in polar region, main challenge encountered by all these missions is the unforgiving weather and terrain of that environment. There are many problems due to weather and terrain which cause damage to people and equipment who are employed in such terrain for a purpose. Among all, risk of crevasse in the glaciated terrain is the most dangerous and almost unavoidable challenge faced by navigators. In recent years, the microwave imaging and testing technique has shown some potential to detect the crevasse hidden under the snow in glaciated environment. This thesis explores the usage of a time domain based microwave technique to detect hidden crevasse in glaciated terrain with lesser processing complexity. The proposed microwave technique is primarily based on the contrast in dielectric properties of various constituents of the glacier terrain viz. the snow, the ice and the air crack representing the crevasse. Due to the constraints in performing the required microwave measurement in the actual glacier region, an equivalent experimental setup is developed in the controlled lab environment mimicking the electrical properties of snow, ice and crevasse. The 2-D microwave dielectric image of the test area has been obtained, which provides the basis to detect crevasse by distinguishing it from ice in the glacier region

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Title : ***Studies on Multi-band and Ultra-wideband MIMO Antennas for Wireless Communication Systems***

Author(s) : ***Aquil Jawed***

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Supervisor(s) : ***Srivastava Kumar Vaibhav***

Abstract

In the last few decades, the ever-growing demand for high data rate in wireless communication has compelled the antenna engineering community to look for a technology that can provide high data rate within a limited frequency spectrum. Multiple input multiple output (MIMO) technology is one of the promising solutions for this, where multiple antennas are used in both transmitting and receiving ends. In such MIMO systems, multiple independent channels are created, which enhance the data rate significantly, without any additional requirement of bandwidth or transmitting power. The objective of this work is to improve the performance of MIMO antenna systems in terms of compactness, radiation efficiency and isolation between the antenna elements. First, a square slot based four-element MIMO system is proposed to achieve triple-band characteristics. The single element comprises of three slots. A square slot and an inverted Minkowski slot are placed concentrically, where a meandered line is placed beneath the square slot. The four elements are placed orthogonally to get high isolation as well as pattern diversity. Additionally, the design also exhibits polarization diversity. This design can be used for WiMAX and C band frequency range applications. Secondly, a four-element MIMO system is proposed for UWB application with band notch characteristics. The design consists of trapezoidal shaped monopole geometry with a complementary cut in the ground plane. The complementary structure has been used for good matching and high isolation. The design is further improved by cutting a slit in radiating element to avoid interference with other narrow band antennas. The orthogonal placement of elements also provides high degree of isolation. Finally, an eight-element MIMO system is presented for scenarios where both long range and short range communication with high data rate are required. The design consists of four UWB elements placed at the corners of the substrate and four narrowband (NB) elements occupy the spaces in between them. The isolation in between elements are high because of the radiating elements are placed such that maximum radiations are in different directions. This MIMO antenna system can also be used for cognitive radio application, where the UWB elements can be used to sense the environment for free spectrum and the NB elements to communicate in the same to avoid wireless traffic.

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Title : ***Design and analysis of spoof surface plasmonic based transmission lines in RF and THZ frequency band***

Author(s) : ***Kasture Nikhil Basveshwar***

Roll No : ***15104075***

Supervisor(s) : ***Akhtar M Jaleel***

Abstract

The invention of spoof surface plasmon polaritons (SSPPs) has motivated a number of researchers to develop new kinds of compact and efficient devices in the THz and GHz range of frequencies. Basically, the surface plasmon has natural appearance at the metal-dielectric interface near the infrared frequency spectrum because the metal has negative permittivity due to the plasma frequency observed in the infrared region. However, the natural surface plasmonic effect cannot be observed in the microwave and THz region at the metal-dielectric interface due to the fact that the metal does not show the negative permittivity in this frequency region. In recent years, there is a lot of interest to synthetically tailor the smooth metal surface into a rough surface by designing sub-wavelength grooves, which basically imitate the natural surface plasmons at lower frequency providing the concept of spoof surface plasmons. The presence of spoof surface plasmons reduces the plasma frequency of metal into the microwave and THz region resulting into the negative value of the effective permittivity of metal. The spoof surface plasmon polaritons thus facilitate the confinement of electromagnetic waves near the metal-dielectric surface in the THz and GHz frequency range, thereby providing a possibility to design SSPPs based devices and structures in the RF, microwave and THz range. The main aim of this thesis is to design and analyze the SSPPs based planar transmission lines and structures in the RF and THz frequency bands by optimizing the shape and size of sub-wavelength grooves called as unit cells. The dispersion diagrams of the designed unit cells are plotted using the CST, and it is observed that the dumbbell shaped unit cell provides better confinement as compared to the conventional rectangular shaped cells over the designated frequency bands. The equivalent circuit model of the proposed dumbbell shaped unit cell is determined using ADS, and values of different parameters of the equivalent circuit are extracted by comparing the dispersion diagram obtained using the ADS with that obtained using the CST in the specified frequency range. After designing the basic unit cell, a number of SSPPs based planar structures such as the high isolation transmission line and a low pass filter based on this unit cell are designed and simulated. In this framework, the mode converter for each structure is also designed so that the quasi-TEM mode of the conventional planar lines can be properly transformed into the SSPP mode with maximum efficiency. The applicability of the proposed technique is validated by fabricating a high isolation SSPPs planar transmission line with under layer ground, and a highly efficient compact mode converter for a smooth transition from the coplanar mode to the SSPPs mode. The fabricated structures are finally tested in the RF and microwave frequency range up to 20 GHz using a network analyzer, and a good matching is observed between the measured and simulated scattering data in the specified frequency range.

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Title : Two Dimensional Microwave Imaging Using CSRR Sensor
Author(s) : Agrawal Kapil Kumar
Roll No : 15104021
Supervisor(s) : Akhtar M Jaleel

Abstract

In recent years, microwave characterization and imaging techniques have been used for various applications such as detection of contamination in food materials, health monitoring of concrete structures, defect detection under paint or coating etc. Among various imaging and testing procedures, the microwave imaging has the capability to determine the shape, size, and location of various defects below the surface using scattered field measurement in non-destructive manner.In this work, the two dimensional microwave imaging procedure using the complementary split ring resonator (CSRR) based planar microwave sensor is proposed for detection of defects and flaws inside coated dielectric and metallic structures. To this end, firstly a comparison between the rectangular and the circular shaped CSRR on the basis of their sensitivity is carried out in order to find their suitability for microwave imaging. The CSRR sensors are designed and simulated using the CST electromagnetic simulator, and accordingly various sensor parameters are optimized for achieving higher sensitivity. In order to show the applicability of the designed sensor for imaging, a number of test samples having different kinds of flaw regions of various shapes and sizes are considered using both simulated and experimental data. All the test samples are coated with a thin Teflon tape in order to facilitate the sub-surface imaging configuration, and a raster scan of the sample is carried out using the designed CSRR sensor in step of 2 mm along both x and y directions. In addition to single element CSRR sensor, a 3-element linear sensor array based on circular CSRR is also designed in this work which facilitates the retrieval of microwave image of the test area by scanning along only one direction. The microwave images of the test area in all cases are obtained based on shift in resonant frequency, and using both amplitude and phase of the transmission coefficient at the unloaded resonant frequency. It is observed that for dielectric media, the images based on shift in resonant frequency are quite sharp and edges of flaw regions can be easily distinguished. For metallic media, the plot of phase at the unloaded resonant frequency provides sharp and accurate microwave 2-D images of the test region. After obtaining microwave images based on the scattering coefficients, the dielectric image of the test region indicating permittivity variation along the X-Y plane is also obtained with the help of corresponding shift in the unloaded resonant frequency at each point of the region.

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Title : Design of SIW based planar filtenna in X-Band
Author(s) : Shakya Neelam
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Supervisor(s) : Biswas Animesh&Akhtar M Jaleel

Abstract

With the advancement in technology, the demand for communication systems is increasing day by day. Furthermore, due to the lack of frequency spectrum there is a huge demand for wireless technologies at higher frequencies. So, the millimeter wave and microwave frequency bands play a vital role in modern communication systems. The advantages at higher frequencies are low interference, high data rates, small size antennas and so on. The main attention is given to multi functioning of devices at RF front ends. The multifunctioning of devices especially include the co-design of filter and antenna into a single unit. The module that contains both filtering and radiating properties are known as filtennas or filtering antennas. In this thesis, initially an X-Band Dual-mode Substrate Integrated Waveguide filter with asymmetric response and an ultra wide band Double sided printed Bow-tie antenna are designed independently. Then an incorporate design integrating both through a tapered broadside coupled line is presented in the X-Band. The radiating element has a linearly polarized broadside radiation characteristic. The Substrate integrated waveguide filter here is used as RF channel selection. The structure is simulated using software Ansoft HFSS and then fabricated using standard PCB method. The measured results show that the compact filtenna has a fractional bandwidth of 8.5% and good out-of-band rejection. The gain of the filtenna is approximately 4dBi with quasi-omnidirectional pattern. The design is simple and compact and can be used in RF front end systems.

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Title : ***Joint prediction of Arousal and Valence in music using Sub-band Synchrony***

Author(s) : ***Prabhakar Anurag***

Roll No : ***11907140***

Supervisor(s) : ***Hegde Rajesh Mahanand&Guha Tanaya***

Abstract

Music is known to have the the ability to evoke emotions in listeners, and even to alter their emotional states. Attempts to define, represent and predict the same have been an topic of research. Emotion is a natural criterion for searching, organizing and retrieval of music. Since the growth of online streaming services and digital music libraries, the problem of automated prediction of emotion in music has gained significant attention. This thesis addresses the problem of emotion prediction in music, where the emotional content is defined in terms of two continuous quantities - arousal and valence. In this thesis we investigate the effectiveness of various acoustic features for music emotion prediction, and also propose new features that can efficiently capture the emotional content. These new features rely on the coherent changes that may appear across multiple frequency sub-bands of a music signal, called the sub-band synchrony. Additionally, we also propose a prediction method that jointly predicts arousal and valence, thereby taking into account the correlation between the two quantities. Results are obtained on a publicly available benchmark database (MediaEval2014). Our experiments show competitive results as compared to the baseline methods.

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Title : ***Fast Volume calibration and Occlusion Free Depth Estimation using Enhanced Optical Orthogonal Codes***

Author(s) : ***K Lakshmi Sravya***

Roll No : ***14104055***

Supervisor(s) : ***Venkatesh K S***

Abstract

The structured light technique has been receiving increased attention for depth estimation as it is fast and robust. In this thesis, a new method for calibrating the camera-projector system required for structured light based depth estimation is proposed. The proposed calibration technique called the space calibration is simple and fast compared to the current camera projector calibration techniques, in the number of calibration images required and in the computation power involved. Among the various coding techniques available to encode the pixels of a image with unique address, hierarchical orthogonal codes are used in this thesis as they have better cross-correlation properties and are robust to ambient lighting conditions. Enhancements to this coding technique are also proposed. As the decoding procedure used in this coding technique depends on the likelihood of occurrence of a code, given the pixel intensities in a set of images, random codes get assigned in the shadow regions where an all zero code is expected. Owing to this, a self occlusion detection method is proposed to detect such shadows in advance and to suggest the readjustment of the camera-projector positions until the shadows get eliminated. As temporal codes, including hierarchical orthogonal codes, are susceptible to even slight disturbances in the position of either camera or projector, an address transition rule is proposed to correct any erroneously detected code at a pixel, based on the codes detected at its neighboring pixels. The proposed method is evaluated by computing the depth maps of objects of different known shapes.

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Title : ***Convolutional Recurrent Network for Dehazing of Video Sequences***

Author(s) : ***Malav Ramavtar***

Roll No : ***12807557***

Supervisor(s) : ***Sahoo Soumya Ranjan&Pandey Gaurav***

Abstract

In this thesis a novel end-to-end recurrent network is proposed to retrieve a key dehazing parameter, the transmission map, for video haze removal. Convolution LSTM (ConvLSTM) network is used to take advantage of both spatial relationships of image pixels and temporal redundancy of video sequence. For training the dehazing network model we use a novel dehazing specific loss function is used. This model is trained on synthetic datasets which are generated using available depth information of image sequences. Experiments are performed on real videos captured in foggy environment and synthetic videos generated from existing real world datasets available online. The performance index obtained from these experiments illustrate the superiority of the proposed method over existing state-of-the-art techniques for dehazing. To reduce the network processing time, an online algorithm is developed which enables the proposed network to process an unknown image sequence in real time.

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Title : ***Like A Speaker? A Visually Attentive Network For Predicting Speaker Likability***

Author(s) : ***Sharma Rahul***
Roll No : ***12807541***
Supervisor(s) : ***Guha Tanaya&Sharma Gaurav***

Abstract

Public speaking is an important aspect of human communication and interaction. In this thesis, we develop a computational framework for predicting speaker likability (i.e. how appealing a speaker is) in public speaking videos. For this purpose, we constructed a large database of more than 1800 TED talk videos. Collecting manual ratings of speaker likability on this large database is time-consuming, and also difficult due to the subjective nature of the task. Hence, we leverage the already available (online) viewers' ratings from YouTube. While a speaker's ability to impress the audience heavily depends on the content and delivery style of the speech, visual cues, such as gestures and physical appearance are also known to play a significant role. Thus, we consider visual cues related to facial and physical appearance, facial expressions, and pose variations to predict speaker likability. Relevant visual features are extracted from video frames using convolutional neural network (CNN) models. Thereafter, we propose a multi-channel attention-based long short-term memory (LSTM) network, which predicts a speaker's likability from the sequence of visual features. The attention network we propose is particularly useful for interpretability, i.e. how attention varies across different visual cues, indicating their relative importance. The proposed framework achieves state-of-the-art prediction accuracy outperforming relevant and challenging baselines.

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Title : ***Dynamic Probabilistic Non-Negative Matrix Factorization for Source Separation***

Author(s) : ***Kumar Anurendra***

Roll No : ***12807147***

Supervisor(s) : ***Guha Tanaya***

Abstract

We propose a dynamical probabilistic latent variable model particularly, looking at the problem of audio source separation. Our proposed model extends the popular Probabilis- tic Latent Component Analysis (PLCA) model to incorporate temporal information. The PLCA model describe discrete, non-negative data as a mixture of multinomial distribu- tions. Under certain conditions, the PLCA model converges to the Non-negative Matrix Factorization (NMF). The PLCA/NMF model in its basic form does not take into ac- count the temporal correlation in the data. However, temporal dependence is particularly important in signals, such as audio, where a strong correlation exists between consec- utive observations. To account for such temporal dependence, we impose a Markovian dependence between the consecutive time instants, and subsequently propose a dynamic Dirichlet distribution as a prior distribution. We show that the (static) PLCA is a special case of our proposed model, as our model reduces to PLCA when no temporal indepen- dence between data samples are assumed. We also show the equivalence between our model and NMF. Experimental evaluation on audio source separation shows promising results.

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Title : ***3D Semantic Segmentation & Fast Localization for Autonomous Navigation***

Author(s) : ***Pensia Ankit***
Roll No : ***12807124***
Supervisor(s) ***Pandey Gaurav &Sharma Gaurav***

Abstract

In this thesis, we first report a novel algorithm for localization of autonomous vehicles in an urban environment using orthographic ground reflectivity map created with a three-dimensional (3D) laser scanner. State-of-the-art techniques of localization of autonomous vehicles uses the entire ground surface reflectivity thereby making it computationally very expensive and often susceptible to local optimum. It should be noted that the road paint (lane markings, zebra crossing, traffic signs etc.) constitute the distinctive features in the surface reflectivity map which are generally sparse as compared to the non-interesting asphalt and the off-road portion of the map. Therefore, we propose to project the reflectivity map to a lower dimensional space, that captures the useful features of the map, and then use these projected feature maps for localization. We use discriminative metric learning technique to obtain this lower dimensional space of feature maps. Experimental evaluation of the proposed method on real data shows that it is better than the standard image matching techniques in terms of accuracy. Moreover, the proposed method is computationally fast and can be executed at real-time (10 Hz) on a standard CPU. Subsequently, we develop an algorithm to enrich the prior 3D map by assigning a semantic label to each point in the point cloud. Our proposed algorithm makes use of multi-view representation instead of volumetric representation of 3D point clouds. We virtually project the point cloud from multiple camera poses and aggregate the predictions of image segmentation model on these projections. Our method makes use of recent developments in convolutional neural networks based image segmentation models and hence, performs dense image segmentation that reduces the required number of virtual predictions.

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Title : ***Development of a Digital Trapezoidal Filter for Measuring Energy of the Output of a Radiation Detector***

Author(s) : ***Gupta Krati***
Roll No : ***15104022***
Supervisor(s) : ***Pandey Gaurav&Prasad Shikha***

Abstract

In radiation spectroscopy, the electrical charge pulse generated by a pulse radiation detector is acquired and analyzed to measure gamma-ray energies. The energy information thus obtained helps in determining the source of the charged pulse which has application in nuclear material detection and characterization. However, it is difficult to directly measure the gamma-ray energies due to pile-up, ballistic deficit and other problems. Therefore, a pulse shaping algorithm is required to obtain accurate energy measurements. This thesis proposes a digital trapezoidal filter algorithm for such energy measurements. In this work we have implemented a digital trapezoidal filter on a field programmable gate array (FPGA) using a very high speed integrated circuit (VHSIC) hardware description language (VHDL). This algorithm allows synthesis of trapezoidal shape from detector output and gives accurate energy measurement.

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Title : ***Sequential Change Detection through Universal Compression - An Asymptotic Study***

Author(s) : ***Srivastava Ritvik***

Roll No : ***12807581***

Supervisor(s) : ***Bansal Rakesh K***

Abstract

This thesis studies the asymptotic performance of a modified version of Page's sequential change detection algorithm based on universal compression. This modification injects a semi-parametric character in the test. Page's test has been used widely across numerous fields for detecting abrupt changes in stochastic systems. A number of versions of this test exist where there may be uncertainty in knowledge about the post-change distribution. A universal source code is an entropy estimator which requires no knowledge of the underlying distribution. Therefore, the asymptotic behaviour of a test based on a universal compression scheme will imitate that of the classical-log likelihood based test. Such a class of tests was first introduced by Jacob and Bansal in (2008), and the present thesis considers a version of the test proposed in the same and establishes asymptotic bounds for the detection delay for it. We consider the performance of the proposed test under various criteria incorporating three different measures of false alarm rate. We closely follow the work of Lai (1998) and Tartakovsky and Veeravalli (2005), to come up with bounds for the detection delay under the three different criteria of false alarm namely: average run length to false alarm, probability of false alarm in a given window and probability of false alarm under a prior distribution on the change point. The first two measures of false alarm do not assume a priori distribution over the change point. Finally, we point to certain extensions and directions for further research.

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Title : ***LMS and RLS Based Adaptive Time Varying RCS Estimation and MIMO Radar Imaging***

Author(s) : ***Rawat Archana***

Roll No : ***15104071***

Supervisor(s) : ***Jagannatham Aditya K***

Abstract

This work proposes an adaptive framework for radar cross section (RCS) estimation and 2D-Imaging in monostatic MIMO radar systems for an unknown number of targets present in the scanning region of the radar with unknown angles and ranges. Furthermore, the reflection coefficients/RCS of the targets are considered to be time varying. The block least mean square (BLMS) based adaptive framework is initially proposed for joint RCS estimation and 2D imaging in monostatic MIMO radar systems. Subsequently, the fast block LMS (FBLMS) adaptive framework is developed to yield improved estimation as well as imaging accuracies and faster convergence in comparison to BLMS. Further the RLS based adaptive algorithms BRLS and FBRLS are proposed to improve the convergence rate and 2D-Imaging in comparison to LMS based framework at the cost of increased computational complexity. Analytical expressions are derived for the mean square observation as well as estimation errors for the BLMS, FBLMS, BRLS and FBRLS schemes along with their global convergence analyses. Simulation results are presented to demonstrate and compare the estimation and imaging performances of the proposed schemes and validate the analysis

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Title : ***Sparse Bayesian Learning Based Channel Estimation in Millimeter Wave MIMO Systems***

Author(s) : ***Rajoriya Anupama***

Roll No : ***15104007***

Supervisor(s) : ***Jagannatham Aditya K***

Abstract

This work addresses the paradigm of channel estimation in millimeter wave (mmWave) multiple-input multiple-output (MIMO) systems. The proposed channel estimation approach exploits the inherent spatial sparsity in mmWave systems arising from the highly directional nature of propagation. The spatially sparse MIMO channel is appropriately modeled in terms of the basis array response matrices corresponding to the quantized directional cosines at the transmit and receive antenna arrays. Further, for the purpose of sparse channel recovery, the hybrid beamforming matrices are suitably chosen to ensure minimum coherence of the equivalent dictionary matrix. Initially, a novel sparse Bayesian learning (SBL)-based channel estimation technique is developed based on a single measurement vector (SMV) formulation of the system under consideration. Subsequently, an enhanced variant of the proposed SBL scheme is presented based on hard thresholding the associated hyperparameter estimates, which is observed to significantly yield precise channel estimates. In order to further enhance the estimation accuracy, we extend the SBL estimation to a multiple measurement vector (MMV) formulation of the mmWave MIMO system. Next, a temporal SBL (TSBL) scheme is discussed which accounts for the correlation between successive spatially sparse channel realizations. The Bayesian Cramér-Rao bounds (BCRBs) are also derived to benchmark the accuracy of the proposed SBL-based schemes for both SMV and MMV estimation scenarios. We also de- sign hybrid MMSE (Minimum Mean Squared Error) precoders/combiners which employ the SBL-based channel estimates for efficient data transmission. Finally, simulation results are presented to demonstrate the mean squared error (MSE) performance of the proposed SBL schemes considering both presence and absence of spatial grid mismatch. A comparison with the state-of-the-art OMP (Orthogonal Matching Pur- suit) scheme depicts the significant improvement achieved by the SBL approaches. Further, the bit error rate (BER) performance is also illustrated for the proposed hybrid MMSE precoder/combiner-based mmWave system employing the SBL channel estimates.

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Title : Online Variational Bayesian Principal Component Filtering
Author(s) : Bhatt Uttkarsha
Roll No : 15104062
Supervisor(s) : Rajawat Ketan

Abstract

Principal Component Analysis is an indispensable tool for dimensionality reduction to enable tractable analysis and processing of high-dimensional datasets, particularly real-time streaming data matrices. This work leverages the Kalman Filtering and Sparse Bayesian Learning principles to build an online algorithm for unsupervised learning paradigms of low-rank matrix completion and Robust Principal Component Analysis. A continuous first-order Hidden Markov Model is assumed as the system model, which allows to process the established Variational Bayesian Principal Component Analysis in an online fashion. Variational Bayesian optimization has been employed for model inference that allows zero prior tuning of any hyper-parameter, qualifying the algorithm to be applied 'on-the-fly'. Kalman Filter is a recursive estimator that may be used for inference of underlying latent states of the model, given the inaccurate/uncertain observations. A modified filter-smoother, akin to Kalman filter, has been incorporated for state-estimation with a better a computational efficiency than the usual Kalman filter-smoother. To further consolidate the algorithm for specific scenarios, extensions have been introduced such as state-outlier estimation and an enhancement for real-time video- surveillance. Simulations ran on synthetic data (corrupted with heavy outliers) for PCA and low-rank matrix completion demonstrate the robust low-rank recovery ability with inconsiderable average estimation-errors. This Principal Component Filtering has then been implemented on Subspace Tracking, synthetic and real videos and real-time Traffic datasets. With zero prior training, performance is substantial. The al- gorithm executes foreground-background subtraction of real videos at 10 frames/sec- ond, hence can be implemented in real-time.

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Title	***:***	***Unsupervised and Supervised Saliency Estimation Methods for Affective Speech***
Author(s)	***:***	***Kataria Saurabh***
Roll No	***:***	***12807637***
Supervisor(s)	***:***	***Guha Tanaya&Hegde Rajesh***

Abstract

Today's dialog agents and Human-Machine Interfaces (HMI) lack the ability to take into account the emotional state of a user in their decision-making process. In healthcare, there does not exist definitive tools which can analyze the prosody of patients and diagnose medical problems such as autism, depression, or bipolar disorder. One problem statement which caters to the above issues is affective saliency estimation, which refers to the task of quantifying emotional content in speech as a function of time. This problem pertains to the budding field of artificial emotional intelligence. This thesis attempts to characterize the idea of affective saliency by suggesting two methods. First, we propose a supervised method for estimating class-specific saliency based on the Minimum Classification Error (MCE) framework. We demonstrate the advantage of learning multiple saliency curves over learning a global one. We also present a multi-scale version of the supervised method which pools saliency information across different temporal scales. Second, we suggest an unsupervised saliency estimation method which uses a distance function to return a local measure of saliency by comparing window-level speech features. This method allows experimentation with different types of distance functions, speech features, and window configurations. In the absence of ground truth for saliency, an evaluation scheme is devised based on the task of Speech Emotion Recognition (SER) and utterance-level class labels. The proposed methods show promising results on IEMOCAP dataset and give valuable insights into the concept of saliency.

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Title : ***Bit Level Low Complexity Detector for Large MIMO Systems***

Author(s) : ***Mann Pushpender Singh***
Roll No : ***15104042***
Supervisor(s) : ***Chaturvedi Ajit Kumar***
Budhiraja Rohit

Abstract

Low complexity detection in Large MIMO systems is a challenging area in the field of wireless communication. With Large MIMO systems becoming an integral part of upcoming wireless technologies such as 5G and various IEEE standards, there is a need to design low complexity algorithms for large antenna systems. Local search techniques form an important class of approximation techniques that provide a near-ML solution to the MIMO detection problem in contrast to other techniques which either are sub-optimal in performance or computationally intensive. With near-ML performance, local neighborhood search still has to deal with large neighborhood size due to higher system dimensions that increases its complexity. The neighborhood size of these algorithms can be reduced significantly, if we can efficiently select the vectors that provide reduction in the ML cost. In this thesis, we propose a metric based selection rule which includes only those vectors that corresponds to K smallest component of the proposed metric to tackle the large search set. We structure the MIMO detection problem at the bit level by representing a symbol as a polynomial function of its constituent bits. The bit level model re-frames the LAS and RTS algorithms that start with an initial bit vector solution and iterate over the reduced neighborhood until it finds a locally optimal solution. We compare the proposed scheme with the symbol level approaches available for these algorithms. The BER performances and complexity curves for both the uncoded and coded systems are presented. The bit level formulation of the neighborhood search provides an easy extension to the coded systems as we directly obtain the bit wise soft values through the initial solution that are fed to the MAP detector.

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Title : ***Power System State Estimation for Delayed and Lost Measurements***

Author(s) : ***Mohammed Imran***

Roll No : ***15104028***

Supervisor(s) : ***Rajawat Ketan***

Abstract

State estimation is an essential tool in modern power systems. A reliable state estimator allows monitoring the operating conditions of the grid in real-time, enabling the utility to take control actions in a timely manner, thereby preventing blackouts. Traditional state estimation (both static and dynamic) techniques work under the assumption of perfect communication between the measurements and the estimator. In practice however, this is not often the scenario as measurements are often delayed, lost, or received out-of-order. Existing techniques generally discard delayed or lost measurements. While the measurements are always time-stamped, compensating delayed measurements is generally difficult and computationally expensive. This work investigates on state estimation problem for delayed, lost or out-of-sequence measurements, especially when the delay statistics are completely unknown to estimator. The central idea is to provide optimal estimate of the state in real time in the presence of random delays and lost measurement phenomena. The proposed approach combines information filter and conventional fixed-lag smoother (Kalman filter) to improve the estimate. The proposed method does not require any knowledge of the delay statistics.

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Title : ***Omnidirectional Hyperlapse***

Author(s) : ***Rani Prachi***
Roll No : ***15104040***
Supervisor(s) : ***Venkatesh K S***

Abstract

The prohibitive amounts of time required to review the large amounts of data captured by surveillance and other cameras has progressively brought into question the very utility of large scale video logging of everyday situations. Yet, one recognizes that such logging and subsequent analysis are indispens- able to security and safety applications. The only way out of this paradox is to devise expedited browsing, by the creation of hyperlapse summaries of the content. We address here the hyperlapse problem for the very challenging cat- egory of intensive egomotion video content. The excessive motion inherent to such content makes the hyperlapse summary highly jerky and discontinuous. Past hyperlapse algorithms for this purpose do produce excellent summaries, using SLAM like techniques for reconstruction of the actual camera trajectory and substitute it by a smooth path that is more amenable to significant hy- perlapse reduction. Some previous work proposes a more economical approach for trajectory estimation based on Visual Odometry (VO) and implement cost functions to penalize path deviation, pose change, velocity deviation from the target speed up and acceleration. In this work, we attempt to implement this on data produced by an omnidirectional camera, so that the viewer can opt to observe any direction of the omni-scene while browsing. This requires many innovations, including handling the massive radial distortions inherent to omni captures and implementing multiple layers of scene stabilization that need to be operated upon the least distorted regions of the omni view. Later we introduce inertial sensors based method for creating hyperlpase summaries which turn out to be better than the VO based summaries in terms of time computation and quality of hyperlapse.

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Title : ***6 DOF viewpoint motion, superresolution, and heterogeneous camera configurations***

Author(s) : ***Kalsi Jasleen***

Roll No : ***15104019***

Supervisor(s) : ***Venkatesh K S***

Abstract

Light Fields are the fundamental representation of light. They give a thorough description of the light rays permeating through a scene from different positions and directions. Novel views are generated by extracting suitable 2-D slices of the 4-D light fields. This work produces novel views for displaced true and tele zoom by two different approaches and proves that both yield same results. Further novel views are synthesized for virtual cameras defined by six DoF parameters. Views generated are shown to be dependent on the order of DoF parameters. Next, we present a method for the synthesis of improved superresolution images from a light field database. Finally, this thesis proposes efficient ways of image synthesis for the case of heterogeneous camera configurations. Views are synthesized and evaluated on the basis of maximizing the PSNR against the ground truth which has been generated by graphics engines such as 3DS MAX.

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Title : ***Robust Direct Data Domain Beamforming Using Cardinality Constrained Box Uncertainty***

Author(s) : ***Pratap Singh Bholendra***

Roll No : ***15104011***

Supervisor(s) : ***Sircar Pradip***

Abstract

The research in Digital beam-forming has accelerated greatly in the 1990's and early 2000's and continues even today. The driving forces behind this increased interest is the improvements due to device scaling and innovative circuit design techniques for radiofrequency integrated circuits (RFICs), data converters and digital processing circuits. The Direct data domain least squares (D3LS) approach to beamforming adapts the weight vector on a snapshot by snapshot basis and hence is an attractive beamforming methodology in highly dynamic environments. The performance of any beamforming technique degrades severely when there is a mismatch in the array steering vector. To avoid this loss in performance, beamformer needs to be robust against any mismatches in the steering vector. This work presents a comprehensive analysis of the direct data domain least squares approach to beamforming and proposes a linear programming framework for robust D3LS, in contrast to the existing methods of robust beamforming which results into a second order cone program. Simulation results are also presented which suggests that the performance of the proposed framework is better than the existing framework, especially in terms of speed of operation.

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Title : ***Extended Super Resolution of Hyperspectral Images via Non Negative Sparse Coding***

Author(s) : ***Pawar Maneesh***

Roll No : ***15104024***

Supervisor(s) : ***Venkatesh K S***

Abstract

Often high resolution (HR) RGB images generated by sparse sampling of the visible spectrum fail to produce differentiable modality for computer vision tasks, Hence computer vision tasks have to rely on gross structures in an image like corners, edges etc. instead of just the recorded reflectance of objects or materials at each pixel in a scene. In contrast to RGB, hyperspectral imaging allows pixels to record reflectance of the scene over multiple contiguous bands, which results in rich differentiable modalities. However, hyperspectral imaging, despite having a growing number of applications from agriculture, surveillance, mineralogy, food processing to eye care, is hitherto restricted to low spatial resolution imaging due to sensor hardware limitations. In this paper, we propose a hyperspectral super resolution technique to produce a high resolution (HR) hyperspectral image with a spectral support of 400nm-1020nm from a low resolution (LR) hyperspectral image of the same spectral support and a high resolution multispectral (RGB) image with reduced spectral support of 400nm-700nm. In the first step, we generate a HR prior by estimating HR hyperspectral band images in the spectral support of 400nm-700nm by detail transfer and alternating iterative minimization. In the next step, we use the generated prior to further estimate the HR hyperspectral images for 710nm-1020nm bands by learning a non-negative dictionary of reflectance spectra signatures of all the materials present in the scene from the LR hyperspectral image with spectral support in 400nm-1020nm. With the estimated prior and learned dictionary, we predict the non-negative sparse codes for HR hyperspectral band images in the band of 710nm-1020nm.

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Title : ***Fast Doa Tracking Using Lasso In Spherical Harmonic Domain***

Author(s) : ***Soni Surya Pratap***

Roll No : ***15104056***

Supervisor(s) : ***Sircar Pradip***

Abstract

DOA estimation is a centrally important problem in array signal processing. Various antenna configurations have been proposed for getting efficient solution to this problem. Recently Spherical arrays have been proposed for unambiguous estimation of DOA. Owing to the non vandemonde structure of it's steering matrix, Spherical Harmonic decomposition is necessary for spherical arrays. Continuous DOA tracking of sources require a method that can work with lesser number of snapshots. Various subspace based techniques such as MUSIC and ESPRIT are very efficient for DOA estimation using a larger data set. In this work it is shown that these subspace based techniques fail to track DOA at lesser number of snapshots, and a LASSO based approach has been proposed along with spherical harmonic decomposition on spherical arrays. The aforementioned technique is shown to work better than MUSIC at single as well as multiple snapshot scenarios.

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Title : Comparing Stationary Signals on Graphs
Author(s) : Bargotra Vishakha
Roll No : 15104068
Supervisor(s) : Rajawat Ketan

Abstract

Abstract There exist large datasets collected in very different settings, including social, information, energy, transportation, sensor and neuronal networks that can be represented using graphs because of their inherent geometric structure. These data on graph trails to new kind of signal viz. graph signal. Graph signal processing applications arise whenever we encounter one of the many signals that are supported on a graph. The purpose of graph signal processing is to exploit underlying structure of these signals to analyze and process graph signals. Existing work in this area includes common data processing tasks like lowdimensional representations, filtering, de-noising, in-painting, wavelet decomposition and compressing graph signals. However, no work related to generalized detection technique for comparing two signals on graph is yet done. In this thesis, we worked on stationary graph signals that form an important class of random signals. Using this statistical model, we formulated the detection problem as comparing two random graph signal realizations to ascertain whether they have identical power spectral densities. A binary hypothesis testing approach is formulated, analyzed and the performance of our proposed method is illustrated via simulations. Then, we applied our theory to PolSAR dataset that is helpful in remote sensing and terrain discrimination.

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Title : Router Module for Peer to Peer VoIP Telephony System
Author(s) : Sharma Vineet
Roll No : 15104067
Supervisor(s) : SinghYatindra Nath
Abstract

Thesis on design and implementation of the "Router Module for P2P based VoIP Telephony System".

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Title	***:***	***Identity Management of Peers in a Peer to Peer Network based VoIP Telephony System***
Author(s)	***:***	***Garg Vikhyat***
Roll No	***:***	***15104066***
Supervisor(s	***:***	***Singh Yatindra Nath***

Abstract

Abstract Peer to Peer (P2P) networking is a distributed application architecture that partitions tasks or workloads between peers. Peers are equally privileged, equipotent participants in the application. Peers make a portion of their resources, such as processing power directly available to other network participants, without the need for central coordination by servers. Peers are both suppliers and consumers of resources, in contrast to the traditional client- server model. Voice over IP (VoIP) is the transmission of voice and multimedia content over Internet Protocol (IP) networks, enterprise local area networks or wide area networks. VoIP encapsulates audio via a codec into data packets, transmits them across an IP network and unencapsulates them back into audio at the other end of the connection. Combining P2P and VoIP and developing a telephony system allows users a wide range of advantages. VoIP communication using peer to peer networks is one of the most upcoming applications in Peer to Peer networks. However, due to the problems of establishment of identities of participating peers in a peer to peer network, identity authentication is always hard to be implemented, which brings in some trust problems. The elements of security in a network begin with an identity. Secure identification is the foundation stone of modern computing security. The process of establishing a user identity is known as identification and authentication. The goal is to have only authorized users access a computer network or a particular service. viHence, ‘Identity Management of peers in a Peer to Peer VoIP Telephony System’ was identified as a functional block of the overall VoIP telephony system. It was pursued for identification of the algorithm for identity management in the system and its further implementation. The proposed Identity Server for ‘Peer to Peer Network based VoIP Telephony System’ would aim to achieve the successful establishment of identities for all the entities before getting an access to network resources.

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Title : ***Study and Implementation of Index Manager Module for P2P-VoIP telephony system***

Author(s) : ***Sharma Sandeep***

Roll No : ***15104046***

Supervisor(s) : ***Singh Yatindra Nath***

Abstract

Thesis work on "Study and Implementation of Index Manager Module for P2P-VoIP Telephony system.

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Title : ***Population Of Routing Table And Overlay Management For P2P Voip Telephony System***

Author(s) : ***Apte Vaibhav***

Roll No : ***15104063***

Supervisor(s) : ***Singh Yatindra Nath***

Abstract

Abstract Peer to peer (P2P) networking is a concept which has been in existence for a very long time now and is being extensively used by companies, universities and researchers alike. A P2P network conceptually follows its own independent addressing scheme superimposed on the existing IP scheme thus segmenting the latter into virtual P2P groups called "Overlays". The routing schemes being used in these "Overlays" are also different like Chord, Pastry, Tapestry, Kademlia etc. Essentially, they all incrementally improve the efficiency of routing by reducing the 'search space' of the network at every hop or routing decision at every node/client, thus decreasing the search time and the number of hops required to find resources on the network. One such novel P2P routing scheme called "Chord- Tapestry Hybrid" has been proposed which balances the trade-offs between routing efficiency, size of Routing Table and computational complexity involved at each client/node. The fundamental challenge is to develop an algorithm that populates entries (i.e. Overlay NodeIDs) into the said Routing Table at every node and also give corrections/updates to it in case of network churn. This whole process is being called "Overlay Management" which maintains consistency of the P2P network routing fabric. This thesis is aimed at achieving two objectives. First is to analyse and validate the "Chord- Tapestry Hybrid" algorithm. This involves identifying and understanding the stepwise rules for making an entry into the node's Routing Table during the process of populating the Routing Table as well as correcting/updating it. It also involves comprehending the operational structure of the overlay in terms of Node responsibilities in routing, Routing Table exchange and propagating information of any changes in the Overlay structure due to churn. The second aim is to build a pseudo-code for "Chord- Tapestry Hybrid" algorithm for building and maintaining Routing Tables. This is implemented in Java for P2P VoIP client in Brihaspati4 project. This involves building libraries and classes in Java, tailor-made for the mathematical requirements of the novel Chord- Tapestry Hybrid routing algorithm as also for accommodating the unique computational challenges while handling hex characters instead of numerical/binary values. Through this research work, the viability of "Chord- Tapestry Hybrid" algorithm has been verified and minor procedural modifications have been proposed. Contribution to the work includes assay of the proposed "Chord- Tapestry Hybrid" algorithm, development of a pseudo-code for population of Routing Table, Overlay management and generation of a working Java Code for the same.

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Title : ***Analysis of Optical Interference in Multiple Carrier Lightwave Systems***

Author(s) : ***Pandey Ashish***

Roll No : ***15104001***

Supervisor(s) : ***Sircar Pradip***

Abstract

In a practical lightwave network, optical sources have center wavelengths distributed over a broad range of wavelength. The laser line shape, line width, the difference-wavelength between sources along with the number of lasers in the network decide the interference at the distant end photodetector. For a given bandwidth and laser parameters the Signal to Interference (SIR) analysis will determine the number of laser sources that can simultaneously be used on a network . In this thesis we have discussed the above criteria which influence the optical interference in systems and formulate the dependency of SIR on the interference for single mode laser. This work formulates and verifies the case for maximum SIR in the case of multiple laser sources. Both simulation and analytical approach have been used to support the assumption. Simulation strategy is adopted for case of system having many multilongitudinal mode laser sources.

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Title : ***Performance analysis of LAMBDA-MIN based decoder for QC-LDPC codes***

Author(s) : ***Tripathi Tarun***
Roll No : ***15104059***
Supervisor(s) : ***Vasudevan Kasturi***

Abstract

Modern telecommunication and networking technologies are required to cater the users demand of high quality multimedia, real-time voice and data support. To achieve these requirements, high data rate communication links are a must. Many research opportunities are opened in this field, especially with the advent of wireless communication. To provide reliable communication, many of such current technologies like WIMAX (IEEE 802.16), WLAN (IEEE 802.11), DVB-S2, and applications like deep space communications by NASA have adopted Low Density Parity Check (LDPC) codes as a forward error correction method. While code design and parity check matrix construction for LDPC codes in many of these technologies have been standardized such as QC-LDPC codes for IEEE 802.11n, the decoder complexity and implementation still remains a field open for improvements. With increase in demand for high data rate communication systems, the requirement of decoder to have high throughput has become a necessity. Reducing decoder complexity and implementation aspects have been pursued by many researchers and still holds many challenges. In this thesis, we apply one such algorithm proposed earlier for LDPC codes in general, for layered or parallel decoding of QC-LDPC codes. The calculation of the extrinsic information in belief propagation decoder (or sum-product decoder) consumes much of the processing time. Various algorithms have been proposed which reduce computational complexity but at the cost of significant performance degradation. Error performance of the QC-LDPC codes with the layered decoder based on lambda-min algorithm is analyzed and compared with error performance of layered decoders based on sum-product algorithm and min-sum algorithm over AWGN and flat fading Rayleigh channel.

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Title	***:***	***Bits-Partitioning Based Power Domain Multiplexing Technique for Cell Edge User Performance Enhancement in 5G Systems***
Author(s)	***:***	***Arya Devesh***
Roll No	***:***	***15104017***
Supervisor(s)	***:***	***Vasudevan Kasturi***

Abstract

This work presents a novel Power Domain Multiplexing Technique for cell edge user QoS (Quality of Service) enhancement using Bit-Partitioning in a multiuser wireless environment. As we know that the cell edge user suffers from performance deterioration due to poor channel conditions and a desired quality of service is hard to achieve in the present scenario employing orthogonal multiple access schemes such as OFDMA. So there is a dire need for designing a technique compatible with the present methodologies which can further improvise the cell edge user bit error rate and hence provide a good quality of service. The Bit-Partitioning Based Power Domain Multiplexing Technique which is not a substitution but an extension to the existing schemes adds a new dimension to the present framework. This scheme in amalgamation with the prevailing standards is shown to have lower bit error rate for cell edge user. Since every user is having information for every other multiplexed user at all times, this provides an opportunity for implementing cooperative communications using users with better channel conditions as relays thereby subjecting cell edge user to have further tremendous enhancement in performance with respect to QoS (Quality of Service).

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Title : ***Action Shot Classification in Movies using Audio-Visual Features***

Author(s) : ***Boddupally Ganesh***

Roll No : ***15104013***

Supervisor(s) : ***Guha Tanaya&Hegde Rajesh Mahanand***

Abstract

This thesis addresses the problem of detecting action shots in movies using both audio and video streams. Action shots are the highlights of many movies, and automatic detec- tion of such shots can help in applications, such as movie summarisation, automated trailer generation and content analysis. We first created a database of more than 8,000 shots from various Hollywood movie, and labeled them as action or not. We propose to extract differ- ent audio and video features from the movie shots, and use them to classify movie shots as action or non-action actions. Standard classifiers such as Support Vector Machine (SVM) , Neural Networks (NN) were used to perform the classification experiments. We analyse the contribution of individual features as well as individual modalities towards the identi cation of action shots. We found that audio features perform better than video features for this task. When features from both audio and video modalities are combined the system's performance improves further. Our system can perform this binary classification with an accuracy of 83%.

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Title : ***A Sparsity based Framework for Spatial Audio Reproduction using Higher Order Ambisonics***

Author(s) : ***Kumar Vivek***

Roll No : ***15104069***

Supervisor(s) : ***Hegde Rajesh Mahanand***

Abstract

Spatial audio reproduction aims to create an immersive sound field over a predefi ned listening region so that the listener inside the region would experience a realistic but virtual replication of the original sound field. Loudspeaker array based spatial audio reproduction is widely used in modern entertainment systems like personal audio systems, auditoriums, and movie theatres. Conventional loudspeaker based spatial audio systems like Dolby, 5.1, and upto 10.1 surround sound have their limitations like the small limited sweet spot of listening, erroneous spatial reproduction among others. Higher order ambisonics is a very recent development in spatial audio which utilizes the spherical harmonic functions in the process of encoding, upscaling, and decoding mono sounds for highly accurate spatial sound reproduction. Higher-order-ambisonics reproduction allows 3D-sound fi elds to be reconstructed with improved resolution and enhanced localisation but at the expense of higher channel counts, increased broadcast bandwidth, and increased storage requirements. To overcome these drawbacks sparsity based higher-order-ambisonics methods are the focus of current research in spatial audio. In this thesis a novel sparsity based framework for higher-order-ambisonics based spatial audio reproduction is developed. Sparse source analysis is applied at both stages of encoding(recording) and decoding(reproducing) spatial audio reducing the overall complexity of the spatial sound reproduction process. Subjective and objective evaluations of the spatial sound rendered using the proposed sparsity based method are carried out using SAQI protocol. It is noted that the proposed sparsity based higher-order-ambisonics method performs better in reproducing the spatial sound when compared to other existing techniques in literature.

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Title : Stochastic optimization for SLAM
Author(s) : Kumar Akshay
Roll No : 12807072
Supervisor(s) : Rajawat Ketan

Abstract

Recently, autonomous systems have gained much attention because of their applications in developing self-driving cars, unmanned aerial vehicles, planetary rovers etc. In this thesis, we have considered the problem of Simultaneous Localization and Mapping (SLAM) problem which is very crucial in autonomous systems. Fundamentally, SLAM problem is a high dimensional non-linear non-convex least-squares optimization problem. We have proposed a Trust region method to solve SLAM problem which has fast rate of convergence. In long term scenarios, where we are mapping a spatially large environment or navigating for a long duration of time, the size of SLAM problem is huge, requiring better computational resources. Towards this end, we propose a stochastic optimization based algorithm to process long term SLAM problems with limited computational resources. The maps generated were of reasonable accuracy validating the effectiveness of proposed stochastic optimization for long term SLAM.

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Title : ***Bayesian Model Averaging of Multi-Sensor Data for Localization in Wireless Sensor Network***

Author(s) : ***Agrawal Nitesh***

Roll No : ***15104036***

Supervisor(s) : ***Hegde Rajesh Mahanand***

Abstract

Sensor node localization is a process of finding location coordinates of a wireless sensor network node. Common location estimation techniques that are widely adopted in practice assume that the location of a few nodes called anchor nodes are known. By utilizing prop- erties of RF signals the distances between mobile node and anchors can be computed. With known distances from few reference points, location of the mobile node can be estimated. Many multi-sensor data fusion approaches have also been proposed in the literature to obtain accurate location estimate. In this thesis, the problem of multi-sensor data fusion and localization of unknown node is addressed. A novel method for Multi-sensor data fusion using Bayesian model averaging for localization is proposed and evaluated for both indoor and outdoor scenarios. The proposed method comprises of three stages. The first stage involves the development of an attenuation model that gives the relationship between the received signal strength and the distance between the transmitter and receiver. An combined attenuation model that utilizes both radio and acoustic signals is developed with the help of Bayesian model averaging and least square approximation method. In second step, Lens presence test method is used to localize the unknown node in the wireless sensor network. The unknown node is able to construct a virtual neighboring anchor list with the help of lens presence test method. Lens presence test method is then effectively used to determine the region of unknown node with the help of two neighboring anchor nodes and distance corresponding to attenuation model developed in first stage. Finally in the third stage a weighted centroid localization approach is used to estimate the location of unknown node with the help of virtual anchor list. Simulation results indicate that the proposed method yields reasonably accurate location estimates when compared to location estimates obtained from individual sensor data and other conventional fusion based methods

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Title : ***Cooperative Moving Horizon State Estimation for Joint Tracking of Multiple Robots and Targets***

Author(s) : ***Shubham Singh***

Roll No : ***12807704***

Supervisor(s) : ***Hegde Rajesh Mahanand***

Abstract

Localization and tracking of moving robots in an indoor environment where GPS often fails is still an open problem especially in the area of wireless sensor networks and IoT. On the other hand, joint localization and tracking of multiple robots and targets are hitherto not addressed in earlier work in this area. In this thesis, the problem of jointly estimating the trajectories of multiple robots and targets in an indoor environment is addressed. A State Space Estimator (SSE) based Indoor Localization and tracking system is developed in this context. SSE is based on the minimization of noise in state model and measurement model using least square minimization. Several variations of the state space estimator are presented for different scenarios such as locating a single robot, locating multiple robots cooperatively and locating multiple robots along with tracking a target. A Moving Horizon Estimator (MHE) is also proposed based on the concept of moving horizon approximation. MHE is based on the concept of taking only a certain number of previous states for lo- cation estimation. Several variations of this estimator are also presented for localization and tracking. Finally, a comprehensive experimental study in an indoor environment is presented. UTIAS dataset is used in the experimental evaluation. The results obtained are motivating enough for the algorithms developed in the thesis to be used in controlled indoor environments.

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Title : Virtual camera effects and depth estimation Using light fields
Author(s) : Sravya Eleswarapu Rajeswari Veena
Roll No : 13104043
Supervisor(s) : Venkatesh K S
Abstract

Abstract Light fields have been explored extensively as a means of quickly rendering images of 3- dimensional scenes from novel camera positions. Because a light field models the light rays permeating a scene, rather than modelling the geometry of that scene, the process of render- ing images from a light field is fast, with a speed which is independent of scene complexity. The light field itself is a 4-dimensional data structure, representing the values of the light rays permeating a scene as a function of their positions and directions. Because a light field can be used to model a real-world scene, and because the resulting model contains a wealth of information about that scene, simple and robust techniques may be applied to light fields to accomplish complex tasks. In this thesis, we have developed a method to create the camera effect used in movies called dolly zoom virtually. We develop techniques of zoom interaction to generate at selected locations in the scene. Virtual dolly is created using a set of neutral point views which is balancing True zoom and Tele zoom effects. The virtual dolly is distinguished by the fact that it requires no physical motion of the equipment to create virtual dolly effects, and the effect is produced purely by computation on the light field data. This is demonstrated on a synthetic dataset, which is taken as input either created using 3dsmax or taken from online sources. All the output novel views are created using ray tracing. A brief study of the geometrical properties of the loci of neutral points us presented. Finally, this thesis proposes a method for Depth estimation by using size cues. Depth is estimated just by using true zoom of a scene. This may be considered as an interesting alternative approach to generate quantitative depth, given a robust correspondence algorithm, from any light field data.

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Title : Distributed Learning Based Model Identification in Multi-agent Systems

Author(s) : Shinde Chinmay
Roll No : 14104034
Supervisor(s) : Behera Laxmidhar

Abstract

The thesis is concerned with distributed learning in multiple non-linear systems. The research problem aims to obtain a common model for the evolving system with multiple agents, where each individual has an independent learning framework with the sparse communication network. Development of a Multi-Agent Learning (MAL) system is considered as a challenging task as it requires each learner to adapt its behavior concurrently in the context of other co-learners. Learning with co-agents makes the environment dynamic and the model state variable grows exponentially with the number of interacting agents involved. We present a distributed reinforcement learning (DRL) framework to infer the desired relation where the training data is distributed throughout a network of agents. The algorithm works in a fully distributed manner and requires no coordination from a central agent during the process with the possibility of more workspace exploration. We consider reinforcement learning with an actor-critic network to model the agent behavior. In the actor-critic framework, the critic models the utility function and the actor learns the optimal actions required to perform a task. The agents communicate the learned model with its neighbor during message exchange. An average consensus protocol is used to obtain a common model of the actor-critic network among the networking agents. The proposed distributed framework is validated for two benchmark problems - 1) cart-pole system and 2) mobile robot formation control. The cart-pole problem is considered as a non- cooperative task, where the agents aim to balance the pole in the upright position. The val- idation results show that the proposed framework models each individual system with better workspace exploration as compared to a particular individual system's workspace was during the training. The mobile robot formation control problem is a collaborative task with intera- gent communication to achieve the desired formation while maintaining inter-agent separation rule. Each robot models has force field describing the effect of the neighboring agents on the action that an individual would perform. The proposed framework is shown to be stable and its performance is demonstrated through simulation and experimental results. Robot navigation is considered as a multi-objective problem i.e. target seeking and obstacle avoidance. We investigate distributed learning using the evolutionary technique to navigate mobile robots in an unknown static environment. NSGA-II, a multi-objective genetic algorithm is used for modeling a single evolving controller for mobile robot navigation. The traditional NSGA-II algorithm is extended with 1) distributed population in master-slave model, which reduces the generation computation time based on the number of processor as the resource 2) parameterised operation is introduced altering the NSGA-II solution selection method. The existing algorithm performs next generation solution selection from the Pareto-optimal front based on crowding distance operator which considers only objective value space. We propose a parametric operator which considers diversity in solution space along with existing NSGA-II algorithm to increase the solution diversity. We further propose to investigate the evolving fuzzy controller in a coevolutionary model, reducing the problem dimensionality. In the model, each consequent part will be evolved to learn the dynamics by different agents exploring different environments with distributed value function such that all the consequent parameter co-evolve together. Thus, the task at hand can be considered as a non-cooperative distributed learning.

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Title : Simulation of Lightning Protection of Aircraft's Radome
Author(s) : Singh Ranjeet
Roll No : 14104132
Supervisor(s) : Gupta Nandini

Abstract

An Aircraft may become part of a lightning channel, in and around a thunder cloud. Very large transient currents might flow through it in such a situation. Nowadays, composite materials are widely used in civil as well as in fighter aircrafts. Aircrafts made of composite materials are more vulnerable to lightning than traditional metal aircrafts. The aircraft in such a case can provide a conduit for lightning current, jeopardizing the safety of the carrier. To prevent catastrophic failure of radome due to lightning current flow and consequent problems of controllability of aircraft, lightning diverters are placed on the external surface of the radome. The number of diverter strips to be used and their geometrical layout depends on various factor and need to be optimized. Solid diverter strips in front of a radar antenna may cause unacceptable distortion in the directivity pattern of the antenna. In such cases diverter arrangements which are nearly transparent to radar transmission is preferred. The current work undertakes a numerical study of the temperature distribution due to a lightning strike in and around the radome of a lightning protected Aircraft. The finite element based software COMSOL is used for the purpose. Additionally electromagnetic performance of radome structure has been calculated

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Title : Quality Index Based Controller and Transient Analysis for DC Microgrid

Author(s) : Ingle Anoop
Roll No : 15104006
Supervisor(s) : Sahoo Soumya Ranjan& Anand Sandeep

Abstract

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Microgrids are the most effective way of integrating renewable energy sources. Also, most of the power electronic loads like household appliances, computers are dc in nature and dc systems have no issue of frequency. For similar voltage levels, the effeciency of an DC grid is more than an AC grid. Hence, research in DC microgrids is gaining popularity. Sources in a dc microgrid are required to have proportional current sharing and low voltage regulation. Distributed secondary controllers are the most effective way to address this problem. They can be classified as methods using either full communication or reduced communication. Full communication network requires the power electronics converters to share the measurement data over a common communication bus. This data will be available to all other converters in the microgrid. The central communication bus becomes a single point of failure, and hence, reliability of such a scheme is low. Reduced communication in turn depends on sparse communication network with exchange of data done between a few selected converters. Thus, in case of single link failure, the stability of the microgrid can be maintained. Additionally, the sparse communication network allows to scale the system with ease. This thesis compares both these methods for a particular secondary distributed scheme. The settling times for both the cases are compared by finding out the dominant poles. Computer simulations are done to illustrate the findings. The subsequent part of the thesis is based on the design of a secondary controller based on quality index. In literature, secondary controllers are discussed to improve either the voltage regulation of one bus or, the average voltage regulation of the entire system. Also most of these techniques rely on the communicated values of both terminal voltage and output current of individual sources. This work puts forth a new approach to address the aforementioned issues. A figure of merit called Quality Index is introduced which constitutes of weighted average of terms representing voltage regulation and power sharing at each bus/node. An algorithm to find the optimal droop coefficient based on Quality Index is suggested. It reduces congestion in the communication network as only output current information is exchanged among sources. The method is online and does not require the knowledge of the system parameters. Equations for current sharing error and voltage regulation in a microgrid system are derived based on droop gain values of the sources. Working of the proposed algorithm is tested using computer simulation. The method is validated on a scaled down dc microgrid prototype.

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Title : ***Adaptive Protection Schemes for Distribution and Transmission Systems with Renewable Energy Resources***

Author(s) : ***ShuklaVarsha***

Roll No : ***14104283***

Supervisor(s) : ***SinghSri Niwas& Mohapatra Abheejeet***

Abstract

The integration of renewable energy resources into the existing distribution network poses several challenges to the protection of the distributed system. One such challenge is the increase in the fault current which is more than the breaking capacity of existing circuit breakers and fuses. Consequently, the relay settings, circuit breaker capacities and other related protective devices need to be changed to the higher ratings. Since, the share of such resources is rising day by day, the ratings of protective devices cannot be changed every time with the addition of such generations in the system. Thus, in this thesis, a fault current limiter (FCL) application is proposed to solve this problem. This thesis also aims at making the FCL adaptive in nature to the changing system conditions so that it can act effectively even when the share of DGs increases. The hardware of FCL need not be changed even the system conditions change. The working of the FCL has been tested and examined on a radial distribution test system. Then genetic algorithm is employed to search for the optimal number, locations and size of the above proposed FCL. The numerical and simulations results show the efficiency of the proposed genetic algorithm based FCL placement and sizing method in terms of minimization of the cost involved in protection of the distribution system. Further, the effect of integration of large wind farms in power system on 230kV transmission grid is studied. The challenge in operation of v wind farms is the uncontrolled and variable wind speed which leads to fluctuation of system voltage and frequency. Thus, the protection issues become critical as the transmission lines connecting wind farms are subjected to continuously changing environment. This thesis also aims at protecting such a transmission line through the use of distance relays having quadrilateral trip characteristics. The variation in the ideal trip characteristics of the relay is studied with changes in the parameters of the wind farm. A simple method is proposed to adaptively set the boundary of the trip characteristics. The effectiveness of the proposed methods has been examined and validated via simulations that have been carried out in RSCAD/ RTDS environment.

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Title : ***Comparative study of dc-link capacitor banks using Physics-of-Failure approach***

Author(s) : ***Kumar P Nandha***

Roll No : ***12807460***

Supervisor(s) : ***Anand Sandeep***

Abstract

Due to the flexibility in the control of power electronic converters (PECs), they are routinely used to interface energy sources and electrical loads with different characteristics. These PECs consist of semiconductor switches and passive elements such as inductors and capacitors. Capacitors are used to minimize voltage ripple in the dc-link and to balance the power difference between output load and input source. These banks, typically consisting of Aluminum Electrolytic Capacitors (AEC), are prone to early failure due to various stresses. With time, the electrical parameters of the individual capacitors degrade. Prolonged usage of the capacitor bank will lead to increase in the electrical stress, thereby leading to malfunction of the converter. Existing literature focuses on reliability improvement of single capacitors in the dc-link rather than a capacitor bank. This work uses a Physics-of-Failure based approach to assess the reliability of a capacitor bank. The method incorporates the circuit, thermal and degradation models in an integrated way to find the time to failure of the bank. With the given constraints, different capacitor bank configurations are simulated and the most reliable capacitor bank is found. Monte Carlo analysis is used to estimate the mean time to failure of specific capacitor banks. A grid connected solar PV inverter is chosen for simulation studies. Monte-Carlo simulations are used to account for variations in the physical parameters of the system. The analysis is validated on a laboratory prototype. The capacitor banks are aged using a combination of accelerated life testing methods. The experimental results are in close agreement with the simulation results

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Title : ***Multi-Sensor Based Kinematic Control of a Non-Holonomic Robot***

Author(s) : ***Shukla Santosh***
Roll No : ***15104052***
Supervisor(s) : ***Behera Laxmidhar***

Abstract

In this thesis, we provide techniques to solve certain challenges that arise while operating a mobile robot. We begin with mobile robot telecommunication. To solve the problem of system instability, due to communication delays and disturbances, we propose a passivity based design. The fact that a passive system is always Bounded Input Bounded Output (BIBO) stable is used to develop a robust communication network. Our objective is to design a system, so as to control the mobile robot from a base station, such that the entire system is ensured to be passive. A passive model of the mobile robot is utilised, and a passive sliding mode controller is designed, which makes the system stable in the presence of traffic disturbances. Furthermore, the concept of wave variable is used for stable bidirectional teleoperation over a wireless communication channel to compensate the effect of fixed time delays and preserving system passivity. Next, information from various sensors is fused using Extended Kalman Filter (EKF) to estimate the robot's location. Once the location of the robot is estimated, the designed guidance system drives the mobile robot towards the tagged location points in the world. After it reaches those points, the robot uses a vision system to reliably follow the desired path. We, then, propose a novel approach for position based visual servoing. The challenge of controlling a mobile robot along with estimating the camera to mobile robot transformation is solved. This is done using Gradient Descent (GD) based estimation technique and sliding mode approach. The GD based estimation technique allows online parameter estimation while controlling the robot to achieve a desired position and orientation. The adaptive nature of the parameters is demonstrated by changing the camera to robot transformation, while the robot is operating. Finally, a Dynamic Movement Primitive (DMP) based trajectory tracking is proposed. Given the desired trajectory, the proposed strategy models it using DMP. This strategy is shown to work well with limited perturbations in the path specification. Further, fuzzy logic based obstacle avoidance approach is proposed that steers the mobile robot around an obstacle of asymmetric nature. Simulation and real-time experimental results are provided to validate the efficacy of the proposed techniques.

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Title : ***Design and Control of Distributed Generation Systems for Microgrid Applications***

Author(s) : ***Tiwari Jatin***

Roll No : ***12807314***

Supervisor(s) : ***Das Shyama Prasad***

Abstract

Abstract Fossil fuels are depleting and hence we need renewable energy. In far flung villages where there is no grid, there can be a low voltage dc microgrid that provides basic electricity. These microgrids consist of renewable sources like pv, wind, fuel cells etc., storage system and grid, if possible. Converters of different kinds are used to connect to dc microgrid. In this thesis, a Wind Energy Conversion system is simulated. A wind turbine plus mass drive system provides torque to a induction generator and connected to grid through ac to dc and dc to dc converters. Majority of grid connected wind power systems reported in the literature, employ permanent magnet synchronous generators. Self excited induction generators are mostly operated in stand-alone mode. In the present thesis, a self excited induction generator is connected to the microgrid using rotor flux oriented vector control. A PV system using a particular PV array and MPPT algorithm is simulated and then it is joined to dc microgrid through a current controlled converter. A battery storage system is simulated and controlled. Vector control methods are also used in controlling the utility grid. All of these four independent converters are then joined and simulated by implementing an algorithm based on state of charge of battery. Changes in currents and voltages on a load change are also simulated.

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Title : Optimal Design of Dual Active Bridge Based Converter
Author(s) : Pant Bhavit
Roll No : 15104072
Supervisor(s) : Sensarma Parthasarathi

Abstract

In present times, renewable energy sources i.e. wind, solar and tidal etc have gained prominence due to environmental and health hazards caused by conventional sources such as fossil fuels. Since power from the renewable sources cannot be directly fed to the conventional grid, it has become necessary to upgrade the present distribution system. Various systems based on both DC and AC microgrids have been proposed in the recent literature. Therefore smart power processing devices are needed which can bridge different microgrids and thus provide an unified grid architecture. Solid state transformer is one of the most researched topics which can be that bridge by interfacing multiple microgrids operating at different frequencies and voltage levels. Apart from its fundamental role as a transformer, it is also expected to perform operations like reactive power compensation, fault isolation, power flow control, voltage sag compensation and voltage regulation etc. Size of conventional transformers is also an issue for applications where high power density is required. Limited availability of space in traction application, distributed electric propulsion and electric vehicle charging etc makes it necessary to employ high frequency switching. The size of transformer and passive elements is inversely proportional to the frequency of operation. With the advent of fast switching semiconductor devices, it is possible to design converters which can operate at frequencies above 100 kHz. This thesis work presents detailed analysis and design of a Dual Active Bridge (DAB) based single phase inverter with inherent galvanic isolation. A resonant tank network and high frequency transformer are cascaded with two active bridges on either side. Two topologies, one having series tank while another having parallel tank, are separately analyzed for their use in this application. The operating frequency is chosen as 200 kHz which is above the resonant frequency. A steady sate analysis using fundamental harmonic approximation is utilized to calculate the magnitude of output voltage and current. Finally a relationship between peak tank current and average input current is analytically derived to obtain the maximum overhead in tank current. Theoretical analysis is verified by simulating the designed inverter circuit in PLECS. Experimental results obtained from the laboratory prototype are in conformity with simulation and analytical results. Additionally in this work, an optimal design approach is presented for bidirectional isolated DC-DC series resonant converter (SRC). Both the active bridges undergo zero voltage switching (ZVS) during bidirectional power flow. ZVS of one and zero current switching (ZCS) of other is ensured during partial load operation. The basic operating principle of DABSRC is detailed to explain both bidirectional power flow and soft switching mechanisms. Frequency domain analysis is performed in normalized form to derive characteristic equations of DABSRC. Further an optimization function for efficiency is derived by carrying out power loss analysis. Using these characteristics, the converter operation is explained for different parameters. Particle swarm optimization is used to obtain optimum parameters. Comparison is done with previous work on DABSRC. Significant improvement in part load efficiency is observed. Experimental results from a 120 W lab-prototype are presented to validate the proposed design approach.

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Title : ***Rotation Invariant Descriptor for Disparate Images using Line Segments***

Author(s) : ***Sahoo Piyush***
Roll No : ***12807481***
Supervisor(s) : ***Verma Nishchal Kumar***

Abstract

This thesis modi es the already existing feature descriptor to make it invariant to rotation. Feature descriptors are the most widespread method employed for image related processing in computer vision. Among them, the most prominent feature detectors are the scale invariant feature transform (SIFT) and the speeded up robust features (SURF). These detectors depend on the information about the image texture for identi cation and formation of feature vectors. However, due to their dependency on texture information, SURF and SIFT are sensitive to changes in the disparity of the image, i.e. change in illumination, contrast etc. To deal with these problems, the Duality Descriptor (DUDE) was proposed. This descriptor makes use of line segments in a scale invariant feature transform like fashion to get rid of sensitivity to disparity between images. However, while DUDE is robust for disparate images, it is not invariant to rotation and scaling. The goal of this thesis is to modify DUDE algorithm to make it rotation invariant as well. This is done by two changes during formation of the descriptor. The first is the fixing of the line-segment breakage. The final change makes use of multiple points of interest while limiting line-segments for each point. These two changes provide rotation invariancy to the already existing DUDE, making it more practical.

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