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Oral Presentations-Abstracts

23rd January 2014

9:10 to9:30 Key Note Speech by Mr Dave Hankey, BAE Systems

Hiding in Plain Sight

The 21st century has witnessed the arrival of complex yet increasingly affordable mobile electronic devices, miniature quantum sensors and the internet of things is only a decade away.

Is the future arriving too fast? What does this trend mean for academia, for R&D and industrial agility?

Bio

David Hankey has over 30 years experience in nuclear power and propulsion plant design in both civil and military sectors joining BAE systems 13 years ago. He has received two BAE Systems Chairman's Silver awards for Innovation, has provided expert advice to STFC, EPSRC, DSTL and the Royal Academy of Engineering and is co-author on a number of patents. He is currently Future Capability Manager with BAE Systems Maritime – Submarines. In this role his focus spans threats and opportunities from current and emerging science and technology through to novel concepts with advanced capabilities.

Presentations in Hall 1

Research Group: Communications, Sensors and Signal Processing

9:30 to 9:50 Mr Arslan Ahmed

Parallel Block Structuring Technique for fast GPS Signal Acquisition in a Software Receiver.

The Global positioning system (GPS) is a satellite-based navigation technology, using long pseudorandom code sequences at L1 (1575.42 MHz) and L2 (1227.60 MHz) frequencies to provide a wide range of applications such as aviation and marine navigation as well as lifesaving services. However, a GPS receiver may require a long exhaustive search using already existing zero padding (ZP) and

improved zero padding (IZP) acquisition algorithms to detect signals with low signal-to-noise ratios and this sometimes lead to unavailability of the navigation services. Then, in order to improve the detection performance, a new acquisition method is proposed which uses an innovative block repetition technique for GPS signal acquisition. This new method is then compared with the ZP and IZP methods and it is found, in particular, from the numerical results that the proposed acquisition method outperforms the ZP and IZP methods both in terms of speed and detection performance.

9:50 to 10:10 Mr Zheng Chu

Secrecy Rate Optimization for a MIMO Secrecy Channel with a Cooperative Jammer

In this paper, we study secrecy rate optimization problems for a MIMO secrecy channel where a cooperative jammer is employed to improve the secured communication in the presence of an eavesdropper. Specifically, we consider two optimization problems, namely, power minimization and secrecy rate maximization. However, these original problems are not jointly convex in terms of the transmit covariance matrices of the legitimate transmitter and the cooperative jammer. To overcome this non-convexity, we approximate these problems based on the Taylor series expansion. For these approximated problems, we propose two iterative algorithms by deriving the associated dual problems and base them on a subgradient method. The simulation results are provided to validate the performance and the convergence of the proposed algorithms.

10:10 to 10:30 Mr Kongjing Li

State detection of bond wires in IGBT modules using eddy current pulsed thermography

Insulated gate bipolar transistor (IGBT) modules are important safety critical components in electrical power systems. Bond wire lift-off, a plastic deformation between wire bond and adjacent layers of a device caused by

repeated power/thermal cycles, is the most common failure mechanism in IGBT modules. For the early detection and characterisation of such failures, it is important to constantly detect or monitor the health state of IGBT modules, and the state of bond wires in particular. This paper introduces eddy current pulsed thermography (ECPT), a non-destructive evaluation (NDE) technique, for the state detection and characterisation of bond wire lift-off in IGBT modules. After the introduction of the experimental ECPT system, numerical simulation work is reported. The presented simulations are based on the 3-D electromagnetic-thermal coupling finite-element-method (FEM) and analyse transient temperature distribution within the bond wires. This paper illustrates the thermal patterns of bond wires using inductive heating with different wire statuses (lifted-off or well bonded) under two excitation conditions: non-uniform and uniform magnetic field excitations. Experimental results show that uniform excitation of healthy bonding wires, using a Helmholtz coil, provides the same eddy currents on each, whilst different eddy currents are seen on faulty wires. Both experimental and numerical results show that ECPT can be used for the detection and characterisation of bond wires in power semiconductors through the analysis of the transient heating patterns of the wires. The main impact of this work is that it is the first time electromagnetic induction thermography, so-called ECPT, has been employed on power/electronics devices. Because of its capability of contactless inspection of multiple wires in a single pass, and as such it opens a wide field of investigation in power/electronics devices for failure detection, performance characterisation and health monitoring.

10:30 to 10:50 Tea Break

10:50 to 11:10 Dr Zhiguo Ding

Energy Harvesting Wireless Cooperative Networks

Low cost mobile devices have been recognized as crucial components of various wireless networks with important applications. Energy harvesting, a technique to collect

energy from the surrounding environment, has recently received considerable attention as a sustainable solution to overcome the bottleneck of energy constrained wireless networks. Conventional energy harvesting techniques rely on external energy sources that are not part of communication networks, such as those based on solar power, wind energy, etc. In this talk, we will focus on a new concept of energy harvesting which involves collecting energy from ambient radio frequency signals, so that wireless signals can be used as a means for the delivery of information and power simultaneously. Particularly we will investigate the application of such a new concept to wireless cooperative networks, and characterize the impact of different cooperation strategies, energy distributing schemes, as well as the random location of wireless nodes on the system performance and complexity.

11:10 to 11:30 Mr Susanto Budi Sulistyo

Colour constancy using neural network and its application to plant images

One of the challenging tasks in image analysis of objects which are captured under direct sunlight is how to equalise images due to various illumination intensity. The source of illuminants is a very significant factor in the world of imaging systems since it will dominantly affect the appearance of an image. In this paper a back-propagation neural network is applied to perform colour constancy and is implemented to plant images captured by a common digital camera. This research is the beginning step of a whole research of nutrient prediction on plants using computational image processing technique.

11:30 to 11:50 Mr Yuanyi Zhao

Performance of Turbo Codes Combined with Physical-Layer Network Coding on Impulsive Noise Channels

Physical-Layer Network Coding (PNC) employed on a two-way relay channel (TWRC) is an active research area due to the potential doubling of the throughput compared with

traditional routing. In the literature, the noise added at the receivers of a TWRC is generally assumed to have a Gaussian distribution. However, in environments that cause impulsive noise, such as power line communications or industrial areas, the noise has a non-Gaussian distribution and this can severely degrade performance. In this paper, we simulate the performance of a TWRC employing PNC at the relay combined with turbo codes on additive impulsive noise channels, where the Gaussian mixture model is chosen to model the impulsive noise added at the receivers. Simulation results are presented evaluating the performance of the system for different mixtures of impulsive noise and the convergence behaviour of the turbo decoder is analysed using extrinsic information transfer charts.

11:50 to 12:10 Mr Tong Chen

Secrecy communications under network coding with diversity

Network coding with diversity (NCD) helps us to achieve a form of selection diversity and can be extended to cooperative multiple access channels. The outage probability, as an important criterion to measure whether users' predefined quality of the service can be met, is considered to evaluate the performance of the system. Information theoretic security has recently regarded as an effective physical layer method to provide secure communications. It is assumed that the legitimate receiver and eavesdropper have the same noise power, many existing secure communication systems cannot achieve outage probability approaching zero, no matter how large the transmission power will be provided. In this paper, we introduce the NCD into secrecy communication systems. Exact expressions of the achievable outage probability will be obtained to demonstrate the performance of the proposed scenario.

12:10 to 13:10 Lunch Break

13:10 to 13:30 Dr Dave Graham

Development of a low cost ultrasound scanner

This presentation will describe the development and testing of an extremely low cost ultrasound scanning device which connects via USB to any available PC or mobile device. Drawing on innovative signal processing and circuit designs from decades of sonar research in the School, the device could be manufactured for as little as £30-40 and it has the potential to have a major impact on healthcare in underdeveloped regions of the world. A new phase of work has recently started in collaboration with Delft Imaging Systems and Cordaid with the aim of improving image quality and automating image analysis.

13:30 to 13:50 Waleed Amer

Nowadays, wireless devices are used everywhere, and they may be placed at very short distances from objects such as metallic objects. This may affect the received signal strength (RSS) and therefore the functionality of such devices will be affected. This paper investigates the placement of a planar metallic object at various locations within and beyond the near field of a 2.4GHz omnidirectional antenna connected to a network analyzer, in order to quantify its effect on both RSS and antenna return loss. The experimental results show that changes in RSS depends on the distance between the object and the antenna as well as the object location relative to the line of sight (LOS) between two communicating antennas. On the other hand, antenna return loss and its resonant frequency were found to be affected by the object placement within and around the near field, and varied as a function of the distance between the object and the antenna only regardless of its location to the LOS. Future work will investigate the effect of different object materials and sizes as well as considering the use of the ultra-wide frequency bandwidth.

13:50 to 14:10 Mr Hengda Ding

Investigation of OFDM based Novel Communication Schemes applied to Underwater Acoustic Communication

Underwater wireless communication has been an area of great interest today. The main reasons of slow transmission rate in this area are frequency selectivity, multipath, noise and Doppler Effect result from the nature properties of UWA channel. This project presents an application of a novel orthogonal frequency division multiplexing (T-OFDM) system in Underwater Acoustic Channel, leading to reliable high speed data transmission with improved multipath tolerance and low computational complexity. Use of the proposed transform with OFDM has been found to attain high frequency diversity gain. Consequently, the detrimental effect arising from channel fading on the subcarrier power is minimized.

14:10 to 14:30 Mr Charles Ukpai

Hybrid 2-D Discrete Wavelet Transform and Specialized Log-Gabor Filter Banks for Iris Feature Extraction

In this paper we present a combined approach to iris feature extraction using discrete wavelet transform (DWT) and Specialized Log-Gabor filter banks. The algorithm combines the multi-scale ability of the Haar discrete wavelet transform with the multi-dimensional characteristics of Gabor filter bank for better performance. The non-strictly band pass filter drawback of Gabor filter was overcame by the introduction of a specialized Log-Gabor filter. Our experiment shows that our method is better compared to the 2-D complex Gabor filter.

14:30 to 14:50 Mr Riki Mukhaiyar

Core-Point, Ridge-Frequency and –Orientation Density Roles in Selecting Region of Interest of Fingerprint

In fingerprint recognition technology, ridge-frequency and –orientation step are utilized to identify trait pattern of ridge/valley features of the fingerprint by separating foreground and background of the fingerprint image and specifying the directional pattern of the ridges and valleys.

The ability to determine the patterns help us as well to select a particular area to be utilized forth. Meanwhile, core-point is needed as a reference point in region of interest (RoI) cropping process. For example, if a desired region is a square-form area, core-point can be as a central of the RoI. Thus, we just need to lay down two diagonal side of the selecting area. In conclusion, it is obvious that the superiority of these three steps can be exploited in RoI step.

14:50 to 15:10 Tea Break

Newcastle University

23rd January 2013

Presentations in Hall 3

Research Group: Power Electronics, Drives and Machines

9:30 to 9:50 Prof Bernhard Hopfensperger, Regensburg University

Doubly-fed machines – applications, types and their control

Slip-ring induction machines used to be installed for heavy start-up load torque applications. Nowadays such machines are most popular in conjunction with power electronic converters as doubly-fed induction generators in wind power plants. The control of such a doubly-fed induction generator is briefly explained. Further special doubly-fed machine types without slip-rings are furthermore highlighted.

9:50 to 10:10 Mr Ivan Castro Leon

Towards Autonomic Control in Decentralised Power Systems via Distributed Type-2 Fuzzy Systems

Real-time control and operation of future power systems demands substantially different approaches from the conventional. Inherent short-term uncertainty and complexity in power systems will be notably increased. In order to deal with these two challenging attributes, this paper introduces a preliminary autonomic control scheme formed through the conjunction of type-2 fuzzy systems and a multi-agent architecture. Results are also presented addressing voltage control on an 11 kV UK distribution network.

10:10 to 10:30 Mr Jialiang Yi

Distribution Network Voltage Control Using Energy Storage and Demand Side Response

ARC 2014

This paper presents a new application of electrical energy storage (EES) systems and demand side response (DSR) operating collaboratively to enable voltage control within distribution networks. This work has been carried out as part of the Customer Led Network Revolution (CLNR) project which is funded by Ofgem's Low Carbon Networks Fund. Modelling and simulation work is presented, which demonstrates the operation of the control system. Field trials have been carried out in 2012, to implement and evaluate the control systems on the case study network.

10:30 to 10:50 Tea Break

10:50 to 11:10 Mr Zheng Tan

Optimization of Doubly Fed Induction Generators (DFIGs) for Wind Power System

This paper presents the optimization of doubly fed induction generator (DFIG) for higher efficiency. There are several methods to improve the machine performance and efficiency, such as polynomial regression model (PRG), kriging modelling (KRG), and radial basis function (RBF). In this paper, doubly induction generator was designed based on the magnetic energy conversion loop, which is required by application system. It can be found that the shape of components, and even different winding selection have a great influence on the electric and magnetic excitation. As a result, these influential parameters are optimized by using the method of response surface method in the surrogate model to formulate the objectives. Besides, all the calculation and tests are based on the IEEE standard 112-B. Also, the wind speed data is taken into account to match the specific site of development during optimizing the DFIGs.

11:10 to 11:30 Mr Pangfei Wang

Cuckoo Search Algorithm Based Optimal Voltage Control for Smart Grids

Advanced voltage control algorithms are required for future smart grids, due to the projected proliferation of low carbon technologies (LCTs), such as PV and Electric Vehicle, and the application of smart grid technologies, such as electrical energy storage. In this paper, an optimal voltage control algorithm is proposed for future smart distribution networks. This voltage control algorithm is based on a modified Cuckoo Search algorithm. Cuckoo Search algorithm is a novel meta-heuristic algorithm, originally developed by Yang and Deb in 2009. Previous research shows that it has a better performance over genetic algorithm and particle swarm optimisation algorithm. This optimal voltage control algorithm is tested with a 69-busbar test network, based on which a future scenario is proposed with LCTs and smart grid technologies. Test results demonstrate that this algorithm is able to facilitate the integration of LCTs and smart grid technologies.

11:30 to 11:50 Mr Peter Davison

Very Short-Term Forecasting of Power System Real-Time Thermal Ratings

The ratings of power system components such as overhead lines, power transformers and underground cables are dependent upon the ambient meteorological conditions surrounding them. In order for safe, economic and reliable operation of the power system to date, highly conservative values of these ratings have been used, with single ratings often enforced for months at a time.

Real-Time Thermal Ratings (RTTRs) of these components aim to increase these so-called 'static' ratings, through monitoring of the necessary ambient conditions in real-time, thereby exploiting any available headroom.

A drawback of this approach is a lack of future visibility of the RTTRs. This research aims to address this issue by forecasting the necessary meteorological variables to give a future rating value. A combined wavelet-transform neural network approach has been investigated and gives high accuracy results when predicting the future rating. This has

been carried out for overhead lines at present, but can be easily extended to both power transformers and underground cables.

11:50 to 12:10 Mr Sana Ullah

Permanent Magnet Assisted Segmental Rotor Switched Reluctance Machine

This paper presents a Permanent Magnet Assisted Segmental Rotor Switched reluctance Machine (Magnet SSRM). It is found that by placing the magnets at the stator tooth tip we get much bigger flux linkage without having higher cogging torque because the flux from the magnets is short circuited by the stator core back. The machine is then compared with another machine of the same size for the given power loss and current density by using Finite Element Infolytica Magnet software. It is found that the Magnet SSRM gives 23.5% more torque than the conventional Segmental Rotor Switched reluctance machine (SSRM) for same power losses i.e. 500 watt and 30% more torque for the same current density i.e. 10 Amps/mm^2. Different magnets of the same size are then used to see the effect on the output torque. This is done to give us an idea of which of the magnet is suitable for particular operation as the prices of the Neodymium Iron Boron (NdFeB) magnets are high as compared to other magnets of the same size.

12:10 to 13:10 Lunch Break

13:10 to 13:30 Mr Congqi Yin

Simulation of a SPWM switched seven-level MMC

This presentation underdevelopment is to provide a timely reference on the simulation results of a seven-level Modular Multilevel Converter (MMC), and to contribute to the knowledge sharing on the modelling skills and module capacitor voltage balancing strategy. The simulations results are obtained through the Simpowersystem implemented within Matlab, and they have shown that the inner and

outer voltage/current control loops developed for conventional VSC are also applicable to MMC. This paper mainly gives the step responses of the active power and reactive power of a 7-level MMC used in the HVDC transmission system during power transmission. It also explains the generations of the SPWM strategy and the capacitor voltage balancing during the operations. Based on the results, it concludes that with conventional inner and outer control loops, SPWM control and capacitor voltage balancing, the HVDC system is capable of responding to the rapid active and reactive power changes with the total harmonic distortions under the international standards. In that case, no additional filter will be required.

13:30 to 13:50 Miss Varvara Alimisi

Zoning for secondary voltage control

Voltage control in transmission level is organized hierarchically. Secondary voltage control is solved regionally, due to the nature of reactive power and the time frame of this control layer. The way the areas are defined affects the performance of the Secondary Voltage Controller. This paper would introduce a methodology that is control problem specific but zoning algorithm agnostic to assess the appropriateness of a zoning scheme. The New England 39 IEEE would be used as a test network.

13:50 to 14:10 Mr Yaman Zbede

Optimization of Sensorless Control of Induction Machines

A considerable development of sensorless vector controlled induction motor drives has been done during the last two decades especially for high performance industrial applications. The advantage of such control strategies is that they reduce the cost of the drive, its size and the most important, the maintenance requirements. In addition, they increase the system's reliability and robustness. Unfortunately, because of sensorless control parameter sensitivity, instability at low and zero speed and high computational effort the use of this technique was limited

for only limited number of applications, which include medium and high speed operation, but zero and low speed operation is still a considerable problem. The recent research focused on improving the operating in the region of speed close to zero.
My research aims to improve the performance of the existing sensorless drive systems, especially at low speed and zero speed regions. This improvement can be achieved in various design levels, such as using novel control techniques for current and speed control, or improving the resolver design which is responsible for speed estimation

14:10 to 14:30 Mr Phil Surman, PPM Power

Real time, high fidelity hardware in the loop for high reliability HEV/EV drive development
Main propulsion drives are one of EVs (electric vehicles) and HEVs (hybrid electric vehicles) safety-critical systems. A configuration with only a DC-link current transducer instead of two phase-current transducers promises improved sensor reliability when matched with equally reliable software implementation of the phase-current reconstruction algorithm. With a new ultra-low-latency (ULL) hardware-in-the loop (HIL) emulator, it is now possible to develop, debug, optimise and type-test such safety-critical real-time software functionality within one integrated environment.

14:30 to 14:50 Mr Guillaume Pissinis, OPAL_RT

Applications and benefits of Rapid Control Prototyping and Hardware-in-the-Loop for Research & Development
RCP and HIL simulation processes let engineers quickly test and iterate their control strategies in order to decrease development costs and time. These processes, used by all industries, allow corrections to be made early in the product development. Thus, mistakes can be corrected and optimization can be made while they are still inexpensive.

14:50 to 15:10 Tea Break

15:10 to 15:30 Mr Mohammed Ahmeid

Parameters Estimation of Dc-Dc Converter Using Kalman Filter

Switch mode power converters are widely used in a variety of applications, including; dc motor drives, computers, home appliances, and portable electronic devices [1]. All of these applications require efficient and cost effective dynamic and steady state power regulation over a wide range of operating conditions. Fixed gain PID controllers are often used to achieve the required dynamic performance in these systems. However, a poor knowledge of the power converter parameters (which may also vary over time) is considered a major cause of inaccurate controller design [2]. For this reason, adaptive and auto-tuning controllers, based on system identification are now attracting increased attention in these applications. This has been facilitated by the greater sophistication, and competitive cost, of microprocessor devices [2]. In much of the existing literature, a Recursive Least Squares (RLS) approach is used to establish the real-time parameters of the system and update a parametric model of the power converter system. This paper presents a different system identification approach, based upon a Kalman Filter, which offers good parameter estimation accuracy, but with reduced mathematical complexity. Matlab is used to validate the proposed approach via simulation; a step down dc-dc converter system is modelled and is then subjected to abrupt changes in load. Results demonstrate that the Kalman filter is a favourable alternative to the RLS scheme, in terms of parameter estimation convergence time and accuracy.

15:30 to 15:50 Mr Chen Wang

Fast Affine Projection for System Identification of a DC-DC Converter System

This paper presents a real time system identification technique in DC-DC power buck converter. In order to achieve on-line identification and digital control within a

power electronics system, fast convergence speed and low computational burden are required. The proposed algorithm—Fast Affine Projection exhibit both of these requirements. It is applied in the field of power electronics for the first time, and is shown to offer superior performance to alternative techniques such as Least Mean Squares and Recursive Least Squares methods.

15:50 to 16:10 Mr Zheng Liu

Intelligent condition monitoring of doubly fed induction generator

The doubly fed induction generator (DFIG) plays an important role in the wind power generation. With the ever-increasing demand for improving the reliability and energy efficiency whilst reducing the maintenance and operational costs, there is a trend to develop the state-of-the-art condition monitoring technologies in wind applications especially for offshore applications. Winding short-circuits faults are among major electrical failures in DFIGs and can be caused by many reasons and can lead to undesirable heating to impact on the performance of the machine. They have not been fully understood due to the complexity of the problem which requires 3D electromagnetic and thermal fields to understand the fault mechanisms. This paper presents coupled electromagnetic and thermal field analyses of DFIGs with a focus on winding faults. Finite element tools are used for analyzing the characteristics of magnetic field, temperature distribution and heat flow during the healthy and faulty operations. This work can provide an insight into the DFIG's stator and rotor winding faults and suggestions for improvement in thermal design of the DFIG machines. The developed ideas have been verified in simulation whilst the test rigs are been set up for experimental validation. The technologies can be embedded in the motor driver circuitry. By doing so, induction machines winding faults can be monitored online.

16:10 to 16:30 Mr Francis Mulolani

Space Vector Modulation based Direct Power Control of Grid-Connected Photovoltaic Converter with Reactive Power Compensation

Solar photovoltaic (PV) is one of the fastest growing renewable energy resources. Most PV units are connected to the distribution or transmission grid by voltage source converters (VSC). As the number and size of grid-connected PV units increase, the requirements placed on them by grid operators are changing. Among the new requirements by some grid codes is that PV units should help with voltage regulation at the point of common coupling by reactive power compensation. Reactive power compensation can be achieved both during the day and the night. In this paper, the control of a grid-connected PV converter with reactive power compensation is presented. The controller is based on direct power control with space vector modulation. Simulation results for both daytime and night-time operation are presented. The results show good dynamic and steady-state performance, decoupled control of active and reactive power, low distortion in the output voltage and current, and constant switching frequency over a wide range of conditions.

16:30 to 16:50 Mr James King

Improving Power Flow Management by Network State-Based Algorithm Selection

Power flow management, a function within active network management schemes, actively curtails the outputs of generators within an electric power network in order to alleviate branch overloads. This paper compares the performance of several power flow management algorithms applied to a case study network over a number of network states. It is found that which algorithm gives the best performance – in terms of reducing overloads while minimising the amount of curtailment applied to the generators – depends on the state of the network. By selecting and using the most appropriate algorithm for each network state, performance can be improved over always using the same algorithm.

Newcastle University

24th January 2013

Presentations in Hall 3

Research Group: Power Electronics, Drives and Machines

9:00 to 9:20 Key Note Speech by Mr Enzo D'Alessandro, Imagination Technology

SoC Development in IMGworks

IMGworks provides SoC development within and outside IMG, primarily for demonstration ASICs, but also for product-led devices. This talk will highlight the latest developments in IMGworks for flexible SoC generation and the challenges posed by an environment dealing with multiple projects, clients, vendors and technology nodes.

9:20 to 9:40 Mrs Roziah Binti Aziz

Thermal and Performance Analysis on Different Sizes of Automotive Permanent Magnet Machine with different Types of Rare Earth Magnet

Permanent Magnet (PM) machines are a very promising design alternative because of their better efficiencies, power factors, and utilisation factors in comparison to the other types of electrical machines. But, on the other hand, PM machines have a much more complex rotor construction. The smaller size of the machine, which is considered to be an advantage, can appear as a disadvantage from the thermal point of view because the smaller size contributes to a higher loss density and this makes the cooling of the machine more difficult. . The machine under study is an interior permanent magnet synchronous motor (IPM), which is generating maximum power and torque, 80kW and 280Nm respectively. This machine can achieve the maximum speed of 10,000rpm. The rotor has eight sets of three permanent magnet arranged in an inverted triangle shape. This machine adopts distributed type for winding. In order to create a design that will ensure the safe operation

of a PM machine, the methods used for the thermal and mechanical analysis of the machine should be very reliable. The goal of the study is to predict the limitation of temperature and heat transfer behaviour on few sizes of PM machines (from big to smaller), which is, must be hotter but still can allow it to operate safely by finding the suitable coolant method and some modifications on machine design.

9:40 to 10:00 Miss Maede Besharati

Investigation of the Mechanical Constraints on the Design of a Super-high-speed Switched Reluctance Motor for Automotive Traction

Permanent magnet synchronous motors (PMSM) have been a primary research area in electrical machines for many years. However, a recent (2009) increase in the price of rare earth materials has prompted research in alternative technologies.

SRM motors are simple to construct, robust and cost effective. The concentrated winding used in these machines reduces the copper loss by virtue of having short end-windings. Furthermore, the rugged structure of the rotor makes it suitable for very high speed operations.

The novel design of an SRM to operate at a speed of 40-50krpm is presented here. As a result, the required torque is considerably smaller than an equivalent motor with the same output power running at lower speed and hence, this approach allows for much smaller frame sizes. This feature of SRMs, alongside other advantages such as robustness and low copper loss, make them a suitable research area for future automotive applications. However, the design of these types of motors, especially in mechanical aspects, needs careful consideration in order to tolerate the various mechanical stresses imposed upon the rotor.

Problems

At very high speeds, stresses that can be neglected at lower speeds become significant. In order to mitigate the stresses, the design of the motor is carefully considered. The obtained results are used to propose designs that optimise

the topology for high speed operation, whilst maintaining the required torque. The electromagnetic and mechanical simulations consider the effect of: adding fillets; tapered poles; core back thickness; shape of the outer part of the core back; and height of the rotor poles on the electromagnetic performance and mechanical stress. In this new design, the shaft of the rotor is removed and instead, the laminations are bolted to each other, applying a special shape to the bolts.
A super-high speed switched reluctance machine for future automotive applications can be realised. This is achieved through rotor design and changes that minimise stress through good mechanical design, whilst maintaining electromagnetic performance.

10:00 to 10:20 Mr Christopher Spargo

A Semi-Numerical Finite Element Post-Processing Torque Ripple Analysis Technique for Synchronous Electric Machines Utilizing The Airgap Maxwell Stress Tensor

A novel method to calculate the harmonic torque components in synchronous machines is presented. Harmonic torque components create a torque ripple, which is undesirable in many applications. This torque ripple is a major cause of acoustic noise and vibration and can limit the machine's application range. A semi-numerical method is developed to calculate and analyse harmonic torque components based on Maxwell stress tensor theory. Development of the Maxwell stress expressions leads to a simple algebraic expression for the calculation. Finite element (FE) analysis is required to determine the equation variables. It is shown that post-processing of the FE solution provides valuable information regarding the composition of the torque waveform, based upon field harmonics, which was previously unavailable. A deeper insight can be gained into more direct electromagnetic design changes to reduce torque ripple in synchronous machines, improving their torque quality.

10:20 to 10:40 Mr Peter Allan, Hyper Drive

Comparison of Active Cell Balancing Circuits For Lithium Ion Cells

Li-ion batteries are used extensively in electric and hybrid electric vehicles and require cell balancing provisions in order to operate safely. Most cell balancing solutions found on the market today are passive and waste energy. The aim of this project is to develop an active cell balancing system that can redistribute charge between cells leading to a more efficient balancing solution.

Bio

I began working for Hyperdrive Innovation in July 2013 as a KTP associate between Newcastle University and the company. The role of a KTP associate is to implement research from the university into a viable product for the company.

10:40 to 11:00 Tea Break

11:00 to 11:20 Mr Nabeel Ahmed

Flux Switching Modulated Pole Machine topologies which offer greater mechanical simplicity

This paper will present two new Flux Switching Modulated Pole Machine (FS-MPM) topologies which have a similar structure to a Modulated Pole Machine. It aims to address the complexity of the rotor, by introducing a FS-MPM design in which the magnets are removed from the rotor and placed on the stator. Furthermore the number of magnets in the FS-MPMs is greatly reduced when compared to a standard MPM; reduction in component count and simplification of the rotor will offer a significant benefit in terms of cost and ease of production.

11:20 to 11:40 Mr Ahmed Mohamed Alturas

On the Identifiability of the Induction Motors in Measurements-Based Approaches Using Particle Swarm Optimization

The identifiability of induction motors (*IMs*) deals with the uniqueness of the solution for the unknown parameters of the model and is, therefore, a prerequisite for *IM* parameter identification. Some researchers try to estimate all parameters of the *IM* simultaneously based only on the external measurements, voltage, current, speed, and torque. Using such approaches, it is only possible to find one of the infinite mathematical solutions depending on the used algorithm and its initialization. A common solution to solve this problem is to modify the standard equivalent circuit (*T* equivalent circuit) so that the number of parameters will be minimized. In this paper, Particle Swarm Optimization (*PSO*) is employed to study and analyse the identifiability of the *IM* parameters based on external measurements

11:40 to 12:00 Mr Haimeng Wu

Stability analysis and control of nonlinear phenomena in bidirectional boost converter based on the Monodromy matrix

In this paper we investigate the nonlinear dynamics of a bidirectional boost converter by employing a nonlinear analysis method based on the Monodromy matrix. This approach can be used to study the influence of system parameters for the stability of power electronics systems. Specifically, it is applied to address and control the fast-scale instability phenomena of power converters for different input and loading conditions. This can be achieved as all the necessary information, such as system input, load, converter parameters and coefficients of the control loop are utilized in the derivation of the Monodromy and Saltation matrices. Moreover, the adopted approach is design-oriented which operates in a more straightforward way compared to other nonlinear analysis methods. Based on the derived matrices, a supervising controller is designed to control the nonlinear behaviour of the system, which improves the system performance significantly. Simulation results show the effectiveness of this method.

12:00 to 12:20 Mrs Tahani Al-Mhana

Novel duty cycle control for single phase FCSC converter as a variable frequency converter.

Forced Commutated Controlled Series Capacitor (FCSC) is used in power systems where the frequency is constant to provide line series compensation. Recently an FCSC converter has been applied to standalone buoys' wave converters to improve the operating power factor. It was demonstrated for the first time that FCSC can handle variable frequencies ranging from 1Hz to 3Hz which is common in wave power generation. This paper proposes a control method that allows FCSC circuits to be operated at a larger frequency range with a maximum frequency of 50Hz which is common in standalone, small-scale generator applications such as diesel generators. The approach taken for the new controller is to re-adjusting the OFF period of the two switching devices. This re-adjustment allows better timing of the on and off state for the switches and the turn-off state is held for a given period depending on the maximum circuit current. With the introduction of the new turn off angle, the FCSC can cope effectively with machine frequency variations by controlling the turn off duty cycle.

12:20 to 13:20 Lunch Break

13:20 to 13:40 Mr Musbahu Muhammed

A Non Isolated High Step-Up Interleaved Boost Converter with High Voltage Gain

A high step up Non-isolated interleaved dc-dc boost converter with active clamp is presented in this paper. The proposed converter employed two coupled inductors in the input side with the same winding turns in the primary and secondary sides to share the input current, the secondary windings of the coupled inductors, a switched capacitor and two diodes at the output side served as voltage multiplier cell to achieve high voltage gain without operating at extreme duty cycle. The transformer action of the couple

inductors under high step up application reduces the voltage and current stresses significantly, which makes low voltage rated MOSFETs with low R_{DS_ON} suitable to reduce the conduction losses and improves reliability. Furthermore, zero voltage switching transition soft switching performance is realized for the main and clamp switches. Switching losses are therefore reduced and conversion efficiency enhanced. In addition the active clamp recycles the leakage energy and absorbs the switch turn-off voltage spikes. The output diode reverse recovery problem is alleviated because of the leakage inductance. Finally a 1KW 40-380V is designed and simulated to demonstrate the effectiveness of the proposed converter. It is feasible for low –input voltage such as solar photovoltaic, fuel cell and battery power conversion.

13:40 to 14:00 Mr Jacob Varughese

Using Genetic Algorithms for PID controller tuning on a DC motor speed control system

This paper gives an overview of genetic algorithms (GA) and highlights the advantages of using this paradigm against traditional PID controller tuning techniques by using speed control system of DC motor as an application example. The GA treats the system in use as a black box wherein, only input and output information are known and together with an objective function, undergoes a process of selection and elimination of individuals based on the mechanism of 'natural selection'. The key to a desirable outcome using this approach lies with the definition of the objection function. Various performances indices such as Integral Time weighted Absolute Error, Integral Time weighted Square of Error, Integral Square of Error, Mean Square Error and Integral Absolute Error are applied as objective functions and compared against results obtained using Ziegler-Nichols and manual tuning methods.

14:00 to 14:20 Mr Mingzhe Hu

Motor Design Optimization to Minimize Total Motor Loss

The first part of this paper illustrates a general analysis for predicting three major motor loss elements: DC copper loss, AC copper loss and iron loss respectively. Each loss element is initially calculated from a mathematical model which is based on a set of improved non-linear analytical equations. In terms of the iron loss, The original lamination loss data measured by the manufacturer is also introduced as a reference to validate the iron loss calculation equation. A genetic algorithm (GA) approach is used to calculate the loss coefficients. In the second part of this paper, all loss elements are validated in Finite Element Analysis (FEA). The FEA results are regarded as a comparison to improve the accuracy of non-linear analytical equations. The third part of this paper discusses the influence of the motor dimensions on motor losses. Permanent magnet synchronous motors (PMSMs) with varied number of poles and speeds are used as the investigation models.

14:20 to 14:40 Mr Calum Cameron

An Evaluation of Smart Grid Data Flow Architectures

The manner in which energy consumption and production is evolving requires new decentralised solutions for electrical power system control. Smart grid techniques and technologies are seen as a potential solution, therefore the design of effective distributed data flow architectures are of growing importance. This paper utilises Multi Agent Systems (MAS) to investigate and demonstrate the significance of appropriately designed data flow architectures in facilitating decentralised power system control. Taking into account the influences of scalability (increases in number of control points) and communications traffic (data volumes), reactivity (detection of errors) and robustness (continued operation in the presence of errors) on the ability to perform a control task; the paper illustrates that data flow architecture is a key design consideration.

Many current power system components and control systems are not fit for purpose when considering the radical

changes anticipated in the period up to 2030. Projected plans for decarbonisation of the electrical network will increase the volume of variable generating units and network control points on the grid. In a move towards smarter grids it is rational to consider that these generators and control points will need to communicate relatively large volumes of information. This quantity of information can lead to data congestion and control performance loss if not managed effectively; presenting a need for effective data flow architecture solutions to manage the transfer of information.

This paper will present results which demonstrate the relevance of aggregation to minimise communication congestion as control system scale increases. Furthermore the use of multiple aggregation points improves robustness and increases reactivity and detection rates of anomalous data. The analysis undertaken shows that data flow architectures play a vital role in enabling effective decentralized power system control.

14:40 to 15:00 Tea Break

15:00 to 15:20 Mrs Bharti Srivastava

IMPROVED IRON LOSS CALCULATION AND ANALYSIS IN PERMANENT MAGNET MACHINES

This paper presents an improved approach for iron loss calculation in permanent magnet (PM) brushless machines. The paper discusses the iron loss calculation methods using the standard Steinmetz equation and its modified forms. The standard Steinmetz equation contains hysteresis and eddy current losses; however, its generalized form has an extra part known as anomalous or excess losses. These excess losses caused by the induced eddy current concentration around moving magnetic domain walls and are neglected by the conventional iron loss calculations. PM machines with power electronics drives are subjected to more losses due to PWM switching frequencies. How these PWM switching frequencies add in the iron losses of the machine along with fundamental frequency, are explained in

detail in the paper. This paper also focuses on the effects of minor loops within the hysteresis loop of the B-H curve which results in an increase of hysteresis loss.

15:20 to 15:40 Mr Andreas Neumeier

High-speed two-phase switched reluctance machine supplied by dual voltage converter

The technology of switched reluctance machines (SRM) and their application have made great progress within the last decade. Particularly the utilization of the SRM in household applications and hand-held tools due to cheap production costs, robustness and reliability. On the other hand the disadvantage of the SRM is that a suitable power converter is required for their operation.

In general the operational behaviour of the converter depends on its electrical control and the connected load. To maximize the SRM torque the period of rising and declining phase current need to be limited to the area of positive torque production. However, the time constant of rising current and current decay depends on the interior resistance and angular dependent inductance, hence, as a result, the maximum velocity is limited.

A new converter concept was proposed in a previous paper. This double voltage converter enables a higher voltage level than standard topology power converters to be used to power the SRM.

The higher voltage shortens the duration of rising current and current decay, thus higher speed operation is achievable. Before applying the double voltage converter to drive a two phase SRM with a rated speed of 15000 rpm, the operation of the SRM and the power converter are examined elaborately by a MATLAB Simulink simulation.

15:40 to 16:00 Mr Sichao Yang

Rotor Topology Investigation and Cost Reduction Study for an In-wheel Motor used in Electric Vehicles

The project is the cooperation between PEDM group at Newcastle University and Protean Electric. This paper analyses the influence of various rotor parameters on the predesigned In-wheel motor PD 16 from Protean Electric Inc. and investigates the potential rotor topologies, in order to reduce the magnet volume while maintaining the torque performance through the complete operating range. The Semi Surface Permanent Magnet (SSPM), I-shaped tangential PM (IPM) and V-shaped interior PM (VPM) are compared in terms of peak torque performance, magnet volume, power factor, operating range and demagnetization issue. Both IPM and VPM give advantageous torque performance due to the increased inductance on both Q and D axis. Equivalently, magnet volume can be reduced while maintaining the same torque. Meanwhile, because of the iron shielding protection from IPM and VPM, both of them have a better demagnetization resistance comparing to SSPM. However, the poorer power factor and consequently short operating range are discovered and needs to be further analysed. The manufacturing cost comparison is also addressed within this paper.

Newcastle University

24th January 2013

Presentations in Hall 1

Research Group: Emerging Technology and Materials

9:20 to 9:40 Mr Ammar Karkar

Leveraging Wire-Surface Wave Interconnects Architecture for one-to-many traffic in Network-on-chip

Network-on-chip (NoC) is a communication paradigm that has emerged to tackle different on-chip challenges and has satisfied different demands in terms of high performance and economical interconnect implementation. However, merely metal based NoC pursuit offers limited scalability with the relentless technology scaling, especially in one-to-many (1-to-M) communication. To meet the scalability demand, this paper proposes a new hybrid architecture empowered by both metal interconnects and Zenneck surface wave interconnects (SWI). This architecture, in conjunction with newly proposed routing and global arbitration schemes, avoids overloading the NoC and alleviates traffic hotspots compared to the trend of handling 1-to-M traffic as unicast. This work addresses the system level challenges for intra chip multicasting. Evaluation results, based on a cycle-accurate simulation and hardware description, demonstrate the effectiveness of the proposed architecture in terms of power reduction ratio of 2 to 12X and average delay reduction of 25X or more, compared to a regular NoC. These results are achieved with negligible hardware overheads.

9:40 to 10:00 Mr Musa Al-Yaman

Scene Simplification For Retinal Prosthesis Stimulation

Optogenetic prostheses do a neuron photosensitizing using the gene therapy method, to help patients with Retinitis Pigmentosa (RP). However, to restore mobility and scene recognition to the patients, the transferred visual

information to these patients should be optimized. In this paper a new algorithm for scene simplification for retinal prosthesis is presented, it removes the background texture, smooth the image and prepare it to be displayed optoelectronic arrays of CMOS controlled Gallium Nitride µLEDs.

Research Group: Microelectronic System Design

10:00 to 10:20 Mr Graeme Coapes

A Neural-Network-on-Chip for Next-Generation Neural Prosthesis

A neural network-on-chip (neural-NoC) system allows for modelling of large-scale brain regions, improving our understanding of brain functionality, providing state-of-the-art computational algorithms, and potentially delivering novel treatments for a wide-range of neurological conditions. For instance, a neural-NoC may be able to interact with nerve cells to repair, restore or replace the functionality of damaged brain regions, providing a treatment for conditions such as epilepsy. This work presents a design for a reconfigurable neural-NoC platform, with a focus upon a single-chip implementation suitable for implantation in a patient. The area, power and performance constraints are considered, both theoretically and experimentally. Innovative techniques are introduced for reducing power consumption through a clock-gating mechanism and decreasing area overhead by implementing a simplified packet routing strategy. A novel built-in self-test procedure for detecting faults within the NoC is also described.

10:20 to 10:40 Mr Michael Scott Evans

Enhancing impaired visual perception using electronic visual aids

To date, retinal prostheses have returned poor visual acuity. Optogenetic retinal prosthesis approaches hold much

stronger potential, but may still fall far short of normal vision. This paper will therefore investigating whether the use of real time image processing techniques could improve the remaining vision of patients with retinal prostheses. Despite numerous retinal prostheses having been surgically implanted e.g., Retina Implant, Second Sight, and Argus II – the number of patients and geographical location are few and far between. Therefore, in order to investigate the potential benefits of real time image processing techniques (i.e., scene enhancements), clinical trials were paramount. It was felt that wet-age related macular degeneration (wet-AMD) NHS patients were a strong cohort model for retinal prostheses, as both wet-AMD and retinal prostheses patients have no macular. Through these clinical trials, the image processing that delivers the greatest visual improvements could be utilised to provide feedback to the engineering efforts in order to develop more accurate image processing algorithms that would best benefit retinal prostheses patients.

10:40 to 11:00 Tea Break

11:00 to 11:20 Mr Haider Alrudainy

Nano-Electro-Mechanical (NEM) Relay based Asynchronous logic circuits for low power design

Nano-Electro-Mechanical (NEM) relay is a promising device overcoming the energy-efficiency limitations of CMOS transistors operating at or near the sub-threshold voltage. Many exploratory research projects are currently under way investigating the mechanical, electrical and logical characteristics of NEM relays. One particular issue that this paper addresses is the need for a scalable and accurate physical model of the NEM switch that can be plugged into the standard EDA software. This paper also presents the designing and implementing of C-element based NEM relay, as a one of the basic building block in several asynchronous design. Results show that NEM relay can achieve over 8X power saving than CMOS counterpart at low operating frequency.

11:20 to 11:40 Mr Athanasios Grivas

Multi-Layer Network Decomposition Boosting Acceleration of Multi-core Algorithms

Complex networks are a technique for the modeling and analysis of large data sets in many scientific and engineering disciplines. Due to their excessive size conventional algorithms and single core processors struggle with the efficient processing of such networks. Employing multi-core graphic processing units
(GPUs) could provide sufficient processing power for the analysis of such networks. However, commonly designed algorithms cannot exploit these massively parallel processing power for the analysis of such networks. In this paper, we present the Multi Layer Network Decomposition (MLND) approach which provides a general approach for parallel network analysis using multi-core processors via efficient partitioning and mapping of networks onto GPU architectures. Evaluation over real world networks of
small-world, scale-free, random structure by using a 336 core GPU graphic card demonstrated a 11x speed-up in complex network analysis relative to a CPU based approach.

11:40 to 12:00 Mr Johnson Fernandes

Power-Performance Tradeoff Analysis for Optimal GALS Partitioning

Globally asynchronous locally synchronous (GALS) design is a promising approach to reduce the design complexity of modern system-on-chip (SoCs). One of the main benefits is a simplified clock distribution network (CDN) offering significant power savings. However the GALS methodology introduces certain design overheads such as latency penalty between clock domain which impose restrictions on the partitioning granularity.
In this paper, we investigate the impact of GALS partitioning on power and performance of a generic design over various process technologies. A parametric model is presented to design the CDN according to specific design constraints and

power consumption is estimated. Also several metrics are discussed to model the penalties paid due to GALS overheads. Using this scheme, statistical analysis is conducted to determine optimum number of GALS partitions by trading off power and performance of the design

12:00 to 12:20 ---

12:20 to 13:20 Lunch Break

13:20 to 13:40 Mr Neal wood

High Temperature Modelling of 4H-SiC Junction Field Effect Transistors

A thermal model for 4H-SiC lateral epitaxial junction field effect transistors suitable for circuit simulation is presented. Parameters have been fitted to electrical measurements of devices designed and fabricated at Newcastle University at temperatures between 25 and 400 °C, to theoretical equations and to other published works. A donor ionisation model provides dopant activation as a function of temperature and doping concentration. The thermal stability of Ni_2Si contacts is investigated; with specific contact resistivity as low of $6.31x10^{-3}$ $\Omega.cm^2$ and $3.89x10^{-4}$ $\Omega.cm^2$ for n-type contacts and $5.40x10^{-5}$ $\Omega.cm^2$ and $8.42x10^{-4}$ $\Omega.cm^2$ for p-type contacts at 25 °C and 400 °C, respectively. N-type contacts exhibit a linear temperature coefficient of 93 Ω/□/°C for R_{sh} and 2.4 Ω/°C for R_c. P-type contacts exhibit Arrhenius behaviour for R_{sh} and R_c with energies of 90 meV and 87 meV, respectively. The models are subsequently compared to measured device values.

13:40 to 14:00 Mr Sandip Kumar Roy

SiC Gas Sensor Arrays for Extreme Environments

For the first time SiC-based gas sensor arrays have been demonstrated, which are capable of discriminating gas

species under harsh environments. The structures utilise either a TiO_2 or HfO_2 dielectric layer and a Pt or Pd catalytic contact. We show that the defects in the dielectric dominate the response to hydrogen and oxygen, resulting in array behaviour, without the need for large numbers of catalytic metals. Simple multiple linear regression techniques can be used with the array to provide a real time prediction of the gas contents of a mixture.

16:00 to 16:20	Closing Reception
16:20 to 16:30	IET Student Representative Presentation, IET Best Poster Award
16:30 to 17:00	Award Ceremony

Posters-Abstracts Hall 2

23rd January 2014

Research Group: Communications, Sensors and Signal Processing

1. Mr Yue Tao

Game Theory for Cooperative Wireless Communication

My research is focused on the optimization of the operation of cooperative communication system. In relay channel, which is a three-terminal channel and widely used in cooperative communication, the desired share of resources (power, computation, spectrum and so on) is always accompanied with severe conflicts of interest and interferences. To minimize these undesired side-effects, we adopt convex optimization to compute and balance the operation of network locally and use game theory to coordinate the performance among each subpart globally. As powerful mathematic tools, the above two algorithms can be applied to solve many practical problem and optimize many thorny situations. For example, the secrecy rate optimization in MIMO secrecy channel and the energy-distribution optimization in energy harvest network. Overall, my current research is to apply these two mathematic tools to those fields where conflicts exists but may be solved by convex optimization and game theory.

2. Mr Shiyang Hu

Motor Design Optimization to Minimize Total Motor Loss

Abstract—The first part of this paper illustrates a general analysis for predicting three major motor loss elements: DC copper loss, AC copper loss and iron loss respectively. Each loss element is initially calculated from a mathematical model which is based on a set of improved non-linear analytical equations. In terms of the iron loss, The original lamination loss data measured by the manufacturer is also introduced as a reference to validate the iron loss calculation equation. A genetic algorithm (GA) approach is used to calculate the loss coefficients. In the second part of this paper, all loss elements are validated in Finite Element Analysis (FEA). The FEA results are regarded as a comparison to improve the accuracy of non-linear analytical equations. The third part of this paper discusses the influence of the motor dimensions on motor losses. Permanent magnet synchronous motors (PMSMs) with varied number of poles and speeds are used as the investigation models.

3. Mr Ali Jaber Abdulwaham Al-Askery

Low Complexity Transceivers for Coded Massive MIMO-OFDM

The main requirements for mobile communication systems are high data rate with good link quality. These requirements should be achieved in spite of the impairments introduced by the mobile communication channel and the limited available resources. Multi-Input Multi-Output (MIMO) based communications have demonstrated the ability of higher throughput compared Single-Input Single-Output (SISO) systems. On the other hand, Orthogonal Frequency Division Multiplexing (OFDM) offers the advantage low complexity multi-carrier based detection. OFDM converts the frequency selective multipath channel into parallel flat fading channels, which can be compensated with simplified equalizer structures. The combination of MIMO with OFDM will result in wireless communication systems with high capacity that is robust to frequency selective channel effects. Currently, these types of systems are being widely used in modern 3G/4G wireless mobile communications. Recently, the attention has been focused in increasing the number of MIMO antennas at the base station in the uplink. The resulting system is referred to as Massive MIMO-OFD which is currently under development by investigating the performance of different channel codes, selecting the optimum MIMO estimators and by trying to determine the optimal number of antennas at the receiving end. However, the complexity and the cost which include energy dissipation and hardware per each extra antenna will increase dramatically. This implies longer processing time and extra cost for each antenna. The aim of this research will be to obtain an optimal receiver with low complexity and improved better bit error rate (BER) performance using spatial multiplexing Massive MIMO-OFDM techniques utilizing Turbo codes with different concatenations and iterations to decrease the complexity of the system and improve the efficiency

4.Mr Ghanim Abdulkareem Al-Rubaye

Coded OFDM using Low-Density Parity-Check Codes for Power Line Communications

Power line communications (PLC) are very attractive for achieving high transmission rate on a home network. However, the main drawback of the PLC is its bad channel characteristics due to multipath fading and impulsive noise. Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier modulation technique that is widely used to combat inter-symbol interference

ISI and multipath fading. Irregular repeat accumulate (IRA) codes are a class of low-density parity-check (LDPC) codes that perform close to the Shannon limit on the AWGN channel with relatively low encoder complexity. When impulsive noise is added to the received signal, the concatenation of IRA codes with OFDM is expected to be an effective technique to improve the performance on impulsive noise channels, while maintaining a low complexity. Therefore, this research will investigate the design of low complexity, coded OFDM receiver architectures to overcome the severe effects associated with PLC

5. Mr Harith Fakrey Tahir Al-Shwaily

Efficient Algorithms for Secure Routing and Key-Management in Wireless Sensor Networks

This thesis discusses some of issues related to security of wireless sensor networks (WSNs) as an emerged type of networks with a wide variety of applications. The safety of critical information broadcasted between large numbers of sensor nodes that constitute these networks should be maintained, especially when they are used within a critical field such as military information or vital statistics.

Regarding to such type of networks with plenty of constraints related to their limited resources, performing of expensive cryptography is significantly difficult. Subsequently, secure routing, authenticated broadcasting and key management seem to be more applicable in this case.

New schemes will be proposed to secure base station or third party in centralized dynamic key management schemes (e.g. STKM, heterogeneous network-based). On the other hand, some schemes will be modified in order to improve their scalability and efficiency by reducing the exchanged information between nodes. For instance, cluster-based group key management and PCGR might be modified in this manner.

Moreover, one of the important parameters in WSNs security is the period of update keys; while it was not mentioned in the existing.

6. Mr Raid Al-Nima

Pattern Classification Using Different Artificial Intelligence Techniques

It is clear that there is currently a big focus on the biometric systems. Also, there are many publications in these fields. Therefore, this investigation constraint on the novelty of fusion and merging different types of biometric stamps by using artificial intelligence platforms. Furthermore, this fusion will have many benefits such as predicting biometric features from other biometric

or establishing a high security system based on multiple biometric imprints. These problems have been addressed in a number of different ways.
There are several stages to achieve the aim of the pattern classification. The first stage will be the acquisition of the feature extraction. The second stage will be arranging the inputs and the outputs into two pairs (training and testing pairs). The third stage will deal with the artificial intelligence techniques. Moreover, a database file will be created to save and compare the stamps in order to reach the final decision.
The artificial intelligence techniques are represented by the artificial neural networks such as Backpropagation or Cascade-Forward neural networks. The weights of these neural networks will be used to predict the targets. As well as, establishing the fusions between different stamps. The best results can be attained after the comparisons between the different techniques

7. Mr Musab Tahseen Al-Kaltakchi

SPEECH RECOGNITION
Speech Recognition is also known as automatic speech recognition ASR or computer speech recognition which means understanding voice of the computer and performing any required task or the ability to match a voice against a provided or acquired vocabulary.
One of the important challenges for researchers is ASR accuracy. The Speech recognition System focuses on difficulties with ASR, basic building blocks of speech processing, feature extraction, speech recognition and performance evaluation.
In a speech recognition system, many parameters affect the accuracy of the Recognition System. These parameters are: dependence or independence from speaker, discrete or continuous word recognition, vocabulary, environment, acoustic model, language model, perplexity, transducer etc. Problems such as noisy environment, different pronouncing of one word by one person in several times, dissimilar expressing of one word by two different speakers, incompatibility between train and test conditions led to made system without complete recognition. Resolving each of these problem is a good step towards this aim.
This project presents a new feature extraction algorithm called Power Normalized Cepstral Coefficients (PNCC) that is based on auditory Processing. Major new features of PNCC processing include the use of a power-law nonlinearity that replaces the traditional log nonlinearity Used in MFCC coefficients. Experimental results demonstrate that PNCC processing provides substantial Improvements in recognition accuracy compared to MFCC and PLP

processing for speech in the presence of various types of additive noise and in reverberant environments, with only slightly greater computational cost than conventional MFCC processing, and without degrading the recognition accuracy that is observed while training and testing using clean speech

8. Mr Mohammed Majed Fakhir

Harvesting 3D information from 2D images

The three-dimensional (3D) displays require depth information which is unavailable in the conventional (2D) content. In general, image processing works on 2D images of an object so it misses the depth parameter of that object. Moreover, there much research effort needed to calculate the third dimension information of position the objects in plan which depend on stereo image (2D) or more.

The aim of this project is to investigate a novel algorithm that automatically harvests the 3D information from a 2D perspective projection of objects that are unknown in terms of size and position to determine the camera angle parameters relative to plans of the objects. Consequently, we can determine the third dimension from a single 2D image by computing the exact 3D coordinates.

In addition, this research will enable a low cost surveying of a home and allow an older/ disabled person living at home or care provider to select the most appropriate items of technology to meet need of self-care by a single camera with moving objects in the scenes depth information of an object is very useful and plays a significant role in many decisions.

9. Mr Mohammed Abdulmuttaleb Abdulla

Bimodal Recognition System with a Protected Biometric Template

Biometric systems allow identification of human persons based on physiological or behavioural characteristics. The use of the human iris and fingerprints as a mean of identification has proved to be one of the most reliable methods.

Unimodal biometric systems have various problems, such as illumination variation, environmental conditions, and device variations. Therefore, multimodal biometric systems have been used to overcome these limitations.

However, one major issue pertinent to multimodal system. If a user's biometrics is compromised, it might be impossible to replace it. Therefore, cancelable biometrics has been proposed.

The concept of cancellable biometric is to transform a biometric data into a new one such that when it is compromised, the biometric signal itself is not lost forever, and a new one can be reissued.
The work will carry on iris and fingerprint recognition in terms of enhancing recognition rate and reducing the template size. Besides, the problem of protecting biometrics in bimodal system will be tackled

10. Mr Zhen Mei

Iterative Soft Distance Decoding of LDPC Codes on Non-Gaussian Channels
In current wireless communications, powerful iterative error-correcting codes such as turbo codes and LDPC codes are included in wireless communication standards, due to their excellent performance and low complexity. However, these decoding algorithms generally assume that the noise added at the receiver has a Gaussian distribution. This assumption becomes invalid when the transmitted signal is affected by impulsive noise due to interference, resulting in the incorrect initialisation of bit or symbol likelihoods at the input of the decoder. In this paper, we present an alternative decoder strategy, called "Soft Distance" decoding, which only operates on squared Euclidean distances between the received symbols and constellation points and does not require knowledge of the noise statistics. Simulation results show that LDPC codes utilizing the soft distance decoder outperform conventional likelihood-based decoding algorithms on impulsive noise channels and achieve the same performance on the Gaussian channel, without increasing complexity.

11. Mr Akachukwu Belusolisa Okoli

Hip Fracture Computer Assisted Surgery – A DSP Approach
In the surgical management of hip-fractures, various implants are utilised. Each has different characteristics and opinion is divided over which is more suitable. However, both suffer "cut-out"- where the lag-screw loses purchase within the femoral head(with fixation failure likely). Most studies cite patient-related variables and implant-design as major contributors to cut-out. Tip-Apex distance(TAD) is a reliable metric used in predicting cut-out. Lower TADs are associated with minimal cut-out rates. Experienced practitioners favour a "central-deep" placement of the screw which supports the TAD concept. However there is inherent "trial and error" on the surgeon's part due to manual estimation.
The project aim is to formulate a novel computer-assisted-system to augment theatre fluoroscopy. The system will determine an optimal location for the

guidewire during implant-insertion and satisfy conditions of a central-deep placement/TAD. This will lessen dependence on surgical experience, obviate trial and error, afford improved surgical technique whilst minimising potential adverse outcomes.

12. Mr Benjamin Sherlock

Environmentally Friendly and Covert Underwater Acoustic Communications
Use of carrierless pseudo-noise spread spectrum symbols for underwater acoustic communications is a relatively new area of research. Previous work shows carrierless PN system perform considerably better, with reduced Bit Error Rate (BER), than BPSK with the same Bandwidth-Time product.

This work looks at cross-correlation properties of aperiodic code-sets, Doppler tolerance techniques and multipath exploitation. Concern is paid to computational-efficiency and intended implementation of a real-time battery-powered system.

Key targets for the design of the communication system and receiver structure are:
Environmental concerns through a Low Probability of Detection;
Covert communications through both Low Probability of Detection and Low Probability of Interception;
Increased reliability and decreased transmission power by taking it closer to the Shannon Limit;
Optimised design of the overall communications system to produce a low-power, realtime hardware implementation;
Reliable operation with a received SNR of -20dB and transmitted power of less than 1Watt or 170.8dB source level.

13. Mr Alaa Hussain Ahmed

FAST ADAPIVE ALGORITHMS FOR PHYSICAL LAYER NETWORK CODING BASED COMMUNICATION SYSTEMS
One of the most difficult channels for reliable wireless communications is the underwater acoustic channel (UAC). Such channels have multipath propagation that causes severe Inter-symbol Interference (ISI). The use of Physical Layer Network coding (PLNC) will be studied. PLNC is a way of establishing a communication connection between two points via an intermediate node or relay node. With the existence of ISI the scheme cannot directly work which

provokes the need for studying ways to cancel the ISI and this will be done using the decision feedback equalizer (DFE). In a varying environment the channel will be time varying so the mentioned DFE must be made adaptive and to improve its performance recursive algorithms will be used. A new system is proposed and the lattice structure realization will be used for better results and reduced computational complexity. The results of the study will help develop underwater communications.

14. Mr Yasir Ahmed Abdullah Al-Mathehaji

Self-Organized Routing in Cognitive Radio Ad-hoc Networks

Demand for space on the wireless spectrum has recently increased due to the wide deployment of high speed wireless networks. Researchers have been investigating Cognitive Radio Networks (CRN) as one solution to increase the capacity. The licensed nodes will be called Primary Users (PUs), the unlicensed nodes will be called Secondary Users (SUs), and the available spectrum bands will be called spectrum holes. Basically the idea is the unoccupied license spectrum bands can be used by SU. The most important condition is that SU must immediately leave spectrum holes when PU starts. In CRN, most recent researches have focused on the physical and data link layers. These layers can provide the best point to point performance. However, they do not provide end to end performance. Thus, it is essential to also focus on the network layer by integrating the routing with spectrum information via cross-layer design.
The basic concept of cross layer design, is passing the information occurred at lower layers forward to the higher layer. The path selection lies on information pass up through MAC/PHY layer to network layer. In addition, route discovery/maintenance must flawlessly be completed without interfering with licensed user activities. We proposed a spectrum-aware on-demand ad-hoc routing protocol to meet the challenges requirement of CRN.

15. Mr Di Wu

Deep Neural Network for 3D object Recognition

Deep Learning (DL) is a new research field of Machine learning. The aim is to discover multiple levels of distributed representations that can be used for visualization, detection, recognition and prediction such as speech recognition, signal separation, pattern recognition, etc. It has achieved great success in the fields of speech recognition and pattern recognition. Recently, researchers have turned their attention to the field of object recognition especially 3D objects recognition. A recent paradigm is the use of deep hierarchical

representations. In this project, we plan to develop a deep neural network that capable of learning a hierarchical representation of 3D objects that can be used for recognition.

16. Mr Ahmed Sattar Hadi Al-Tmeme

Blind Separation of Convolutive Non-stationary Sources using Nonnegative Matrix Factorization

In this research a blind separation method to separate non-stationary sources (i.e., either the speakers or microphones are moving) that convolutively mixed (i.e., the reverberant of the signals will be considered, in other words; the delayed signals due to their reflections will be mixed with the signals) will be developed. The nonnegative matrix factorization (NMF) will be developed to solve the above problem.

The research will be divided into three parts; the first one will address the convolutive mixture with non-stationary sources, but without noise and with a prefixed number of components for each source. The second part, will estimate the number of components of each source automatically. Finally, the noise will be considered. The system performance will be assessed by using Signal-to-Interference ratio (SIR) and Signal-to-Distortion ratio (SDR) with real audio signals.

17. Mr Mohamad abdulrahman Ahmed

Self-interference Cancellation for Full-duplex MIMO-MRC Based Relay in The Presence of Channel Estimation Errors

In this research, the full-duplex, multiple-input-multiple-output maximum ratio combining (FD-MIMO-MRC) based relay with self-interference cancellation (SIC) is proposed and its performance analysed. The effects of channel estimation errors for the source to relay and self-interference channels are considered, where the latter represents the channel between relay's output to its input. Firstly, we exploit MRC to increase the SNR of the source-to-destination path. Furthermore, the null-space projection (NSP) is achieved as SIC, which mitigates SI using singular-value-decomposition (SVD) of the channel state information (CSI) of the self- interference channel. Secondly, the performance of the system is investigated in the presence of additive-white-Gaussian-noise (AWGN) over Rayleigh fading channels. Moreover, analytical results are presented for the self-interference cancellation by exploiting a singular-value-decomposition (SVD). Eventually, exact, closed-form solutions for the signal-to-interference-plus-noise-ratio (SINR) distribution and outage

probability are derived and evaluated along with the average symbol-error rate (ASER) for M-ary phase shift keying (MPSK) modulation schemes.

18. Mr jamal Ahmed Hussein

Performance analysis of the Multi-Relay Cooperative Network with the presence of co-channel interference

In this work, we investigate and analyse the performance of the multi-relay amplify-and-forward cooperative communication network with the presence of co-channel interference (CCI). Precisely, we consider the CCI existence at the relays. Exact equivalent average signal-to-interference-plus-noise ratio (SINR) is derived. Closed form expressions for both cumulative distribution function (CDF) and probability density function (PDF) of the equivalent SINR are presented. These expressions are used to calculate the asymptotic average error probability and outage probability of the system. Numerical results and Matlab simulations are also provided to sustain the correctness of the analytical calculations.

19. Miss Yadi Yuan

Single Channel informed Separation on using Pseudo-Stereo Mixture and Complex 2D Histogram

Recently, the Blind Source Separation has become a hot research topic in the field of signal processing, because this approach responds to extensive demand in various fields such as conference call, machine and influence, hearing aids on portable devices, and speech recognition, and other fields. Many techniques have been unveiled to separate a set of independent source signals given only an observed signal based on signal processing and statistical independent probability, for example, independent component analysis (ICA), sparse component analysis (SCA), and non-negative matrix factorization (NMF). In recent trend, some methods have been extracted the human auditory system or the human speech recognition then merged with signal processing such as speech model with hidden Markov model (HMM) [12], DUET , and Cochleagram with informed source separation. However, many practical problems for realistic environments there have been continuous development SCBSS methods to fill the gap. Extension of existing approaches to more efficient SCBSS are not straightforward. Therefore this project will address the issue of develop new algorithms based on statistical signal processing and matrix factorization for SCBSS.

20. Mr Hasan Mohammad Kadhim

Informed Speech Separation Based-on Speaker Stochastic Model and Machine Learning

Speech Separation is called Informed Speech Separation (ISS) When an enough information (Database, Library, and/or Dictionary) of one or more speakers is available and be used to facilitate separation task.

ISS researchers used different approaches to recover the original signal(s). one is by utilizing information of coding-stage of this/these signal(s), then its used to restore original signal(s) during decoding-stage. Exemplar approach employed traditional word(s) or rhythm to chase the pitch pattern of specific word. It depends entirely on situation, time and location of the conversation between the speakers.

Speaker Stocastic Model with Machine-Learning is a research approach which is dealing with speaker(s) database whole and/or isolated pitch segments.

At the first step, RAPT algorithm has been used in order to isolate the segments of database speech focusing on its pitch or silent content (i.e. voiced or unvoiced). Time warp useful to normalize different speech speed.

Second step is extracting features and parameters of those by more than one method. Frequency-domain scaling (Linear, MFCC, Bark, ERB, Logarithmic, Cochlear) is used to choose best features.

Third step is forming the stochastic model of speaker(s) by refurbishing the results of second step, and producing feasible model (GMM, HMM and/or Non-linear Regression).

By next step, observation (mixed signal) is compared with database then masked. Simplest and quickest comparison uses Euclidean-distance. Classification algorithms can be exploited to perform more efficient comparison.

Finally, Optimization step (by feedback Objective Test), helps for choosing optimal segmentation, features, and classification.

21. Mrs Kabita Adhikari

Active Cancellation of Tremulous Hand Motion in Microsurgical Procedures

Microsurgical procedures (e.g. retinal surgery) involve surgeons operating on very small tissues or blood vessels and hence require high precision of hand movement. However, physiological tremor (an unintentional and oscillatory movement at 8-12Hz) leads to significant imprecision in hand motion.

Simultaneous processing of multi-dimensional signals often leads to a more detailed description of the process of interest than processing each dimension separately. However, the task of removing tremor from intended movements is conventionally carried out on x-y-z independently. The aims of this project are to develop a novel theoretical framework that enables 1) distinguishing between tremor and intended motions and 2) real-time cancelation the undesired motion accurately.

The aim of this project is to design a multi-dimensional adaptive filter mechanism for tremor cancellation and conduct a comprehensive study to measure the gained improvements. The study will be conducted on synthetic and real-data recorded from micro-surgeons during pointing, reaching, and tracking a virtual target.

Posters-Abstracts Hall 2

24th January 2014

Research Group: Emerging Technology and Materials

1. Mr Mohd Marzaini bin Mohd Rashid

Nonradiative Energy Transfer from Quantum Dots to SiC for Solar Cell Application in Extreme Environment

SiC has proven thermal stability as high as 873K with a melting point of 3103K. It had attracted the space power community as potential material for photovoltaic solar cell, operating in high temperature, high light intensity conditions.

4H-SiC (Eg=3.2eV), has a limited light absorption spectrum only absorbing in the ultraviolet (UV) region. We hypothesize that light absorption in 4H-SiC can be increased if it is covered in quantum dots (QD). The QD (donor) being efficient light absorbers could then transfer the harvested energy nonradiatively to the adjacent SiC at nanometre length scales. By design, the deposited QD can be positioned as close as possible within 4H-SiC p-n junction's depletion region accessible by the formation of nanopillars or trenches close to the junction by means of reactive ion etching (RIE). Experimentally, this can be verified by steady state photoluminescence and time resolved photoluminescence decay.

2. Miss Chloe Victoria Peaker

A First Principles Study Of The Vacancy-Hydrogen Defect In Diamond

Diamond is well known for its superlative properties, for example its high carrier mobilities (μ_e=4500 $cm^2V^{-1}s^{-10}$ cf. Si μ_e=1450 $cm^2V^{-1}s^{-1}$) which are desirable for fast-response and high-frequency electronic devices. Diamonds high thermal conductivity of 24$Wcm^{-1}K^{-1}$ (cf. Si=1.5$Wcm^{-1}K^{-1}$) can also be utilised to out-perform conventional materials in areas such as power-electronics, where large amounts of heat are generated.

Defects may be introduced accidentally or intentionally during the manufacturing process of diamond and they are found in natural diamond too. As defects influence the electrical and optical properties, it is imperative to gain an understanding of their properties in order to successfully exploit the material.

Synthetic diamond grown from the gas phase is known to incorporate both hydrogen and lattice defects. One example of a grown-in defect is the vacancy-hydrogen complex which compensates donors. The aim of the project is to employ density-functional theory, to accurately determine experimentally observable properties of the vacancy-hydrogen and related defects.

3. Mr Srinivas Ganti

Atomic Layer Interface Engineering for Nanoelectronics (A.L.I.E.N.)

One of the main setbacks in scaling of semiconductor devices is increasing contact resistance. With the escalating density of devices on integrated circuits follows a rise in power consumption - which seriously limits the efficiency and reliability of electronic devices. Contact resistance arises from the formation of an energy barrier at the metal-semiconductor junction. The classic Schottky-Mott model suggests that the size of this barrier can be tuned by the metal workfunction, a characteristic unique to every metal. However, interface effects described by the more recent MIGS / dipole hypothesis result in a pinning effect leaving the barrier height nearly independent of the choice of metal; rendering this effort ineffective. Our research aims to find novel methods of getting around this issue known as Fermi level pinning using atomic level interface engineering tools like Atomic Layer Deposition, Sputtering and annealing supported by sophisticated characterization and measurement techniques.

4. Mr Bo Xu

Investigations of the interface in interconnect technology for ICs

The effective cross-sectional area of metal tracks carrying current between different parts of IC chips is reduced with increasing operation frequency. This is because carriers are pushed towards the surface. This effect is known as the ‘skin effect’ and arises from the interaction between electric and magnetic fields. At high frequencies the skin effect plays an even greater role in determining the interconnect performance. Any non-uniformities in the topography of the metal track generates a variation in the electromagnetic field. The surface morphology of the metal requires detailed analysis. Several roughness parameters have to date been omitted from transport models of interconnect. Furthermore most studies of conduction in metal tracks have been performed at low frequency. New methodologies and test structures may be required to improve transport in interconnect at high speed. Alternative

materials for conductor dielectric, barrier layers will be explored to improve the overall speed of ICs.

Research Group: Power Electronics, Drives and Machines

5. Mr Junnan Wang

Integrated design and control of a linear machine for a free piston engine
In this prospective paper, there may include two hot topics relevant to the design of permanent magnet linear machine. Configuration design and arrangement of accessories system. (controller, converter)

There will be three main ways involved in the design: analytical field solutions (AFS); finite element method (FEM); and experiment measurement. They can validate each other, however the former two are used designing in concept before construct the latter is a verification. From the AFS combined with FEM, the accurate influence of leading design parameters on the performance of a radially magnetized, iron-cored, tubular permanent-magnet machine and its drive system, like the open-circuit electromotive force, the thrust force, the iron loss, and the winding resistance and inductances, force density, as well as the converter losses. The force density, the machine and drive system efficiencies, and the power factor and converter volt–ampere (VA) rating are established as functions of a set of machine dimensional ratios, with due account of magnetic saturation and subject to a specified thermal constraint.

Finally, it is expected to show that the design optimization of such a linear drive system must account for the losses and VA rating of the converter as well as the design parameters of the tubular machine.

6. Mr Aslan Sabahaldeen Jalal

Design Aspects of Permanent Magnet Tubular Linear Induction Machine for External – Combustion Free Piston Engine Applications
The project is focused on the design of the Permanent Magnet Tubular Linear Induction Machine (PMTLIM), its integration with the External – Compustion Free Piston Engines (EC-FPEs) and the integrated system performance. It starts by introducing a comprehensive study concerning the main PMs' arrangements according to their magnetic flux direction within the topology of the TLIM. Then, each arrangement is to be investigated using the MagNet 3-D finite

element package and the machine performance parameters are to be obtained.
There are, basically, two arrangement types of PMs usually used in these types of induction machines. Namely are the radially magnetized and the axially magnetized arrangements. Two arrangements has been derived form combining the basic ones resulting further two arrangements, and are known as Halback and quasi-Halback PMs arrangements.
The MagNet package is used for illustrating the effect of these different types of PMs' arrangemnts on the machine bahaviour and the benefits and drawbacks of each arrangement are to be compared to adopt the most suitable arrangement for the aforementioned application.

7. Mr Liam Alexander Naugher

Loss Analysis and Redesign of a Tidal Generator
The project is to design an electrical generator for the purpose of extracting tidal energy. The initial task is to complete a loss analysis of an existing permanent magnet synchronous generator, which is manufactured by the company OpenHydro. The OpenHydro generator is an open centred turbine that provides safe passage for marine wildlife. After the loss analysis the project investigates the suitability of other generator topologies as an alternative to the OpenHydro generator. The different topologies will be simulated using the 3D Finite Element Analysis software MagNet 7.4, the results will then be compared to identify the topology that provides the best performance. The chosen topology will be constructed to scale for collection of experimental data for comparison to the simulated results.

8. Mr Ruchao Pupadubsin

Low Noise Switched Reluctance Machine Drives
This research project will investigate the magnetic force production and develop both active and passive vibration cancellation techniques to eliminate high acoustic noise and vibration in switched reluctance machines (SRM). Acoustic noise and vibration is a crucial drawback of the SRM that limits a range of the SRM applications. The major source of noise in SRM comes from the deformation of the SRM stator lamination stack that is caused primarily by radial magnetic forces acting on the stator poles. To reduce these problems in the SRM, two main strategies have been proposed: (I) an active vibration cancellation technique is a noise reduction method using modified control algorithm techniques and (II) a passive vibration cancellation technique is a

procedure to decrease noise level by structural machine design techniques. However, these cancellation vibration techniques have negative effects to the machine performance. The challenge of the project is to design and develop the most effective and convenient method to achieve a low acoustic noise and vibration switched reluctance Machine drives with high performance. In this project, vibration behaviour of SRM will be analyzed by using Finite Element numerical software tools to calculate magnitude, mode shape and natural frequency of the machine vibration.

9. Mr Muhsien Mohammed Yazid

Investigation and Demonstration of a Recycled NdFeB Permanent Magnet Material in a Prototype Motor.

In recent years, most modern technology has come to depend on permanent magnet (PM) machines, used in many electric and electronic devices. The PM motors have good magnetic properties and high performance, because of the permanent magnet material used. However, the high demand for rare earth PM materials during recent years and the expected short supply lead to a considerable increase in the rare earth prices. Therefore, this increase is not only a problem for consumers and manufacturers; it offers the opportunity to address the issue of today's rare earth supply in more depth. In the past, the low prices of the rare earth generate a significant waste of resources, and until now there has been almost no recycling of this waste. The current increase in the prices opens up the chance to build recycling systems for rare earth materials. One important factor for understanding and improving the coercivity of the materials is to investigate the magnetic microstructure of the materials.
Therefore, the main aim of this project is to use the magnetic force microscopy (MFM) for imaging the domain structure of the recycled Nd-Fe-B magnet material, and to measure the magnetic properties of the materials by using Vibrating Sample Magnetometer device (VSM). After that, to apply the available recycled material to a designed brushless DC motor by using finite element software (FE) in order to investigate the impact of recycled permanent magnet materials upon the performance of the designed motor and compared with the original used materials**.** Finally, building a prototype motor with the offered materials if the material has provided a good result.

10. Mr Osama Sh Mohamed Abushafa

A modular multilevel converter for medium and high voltage applications

A modular multilevel converter (MMC) is one of the promising multilevel converters for medium and high voltage power conversion. It has several features over the conventional multilevel converter because of its scalability, flexibility, low switching losses, and low harmonic distortion. Therefore, it can be preferable for high voltage direct current transmission systems (HVDC), connecting some renewable sources to the grid or medium voltage motor drives connection. Based on the applications, this poster classifies MMC into different circuit configurations. The poster focuses on some existing issues related to this topology. One of the main challenging issues linked to the MMC is the capacitors voltage balance in each sub-module (SM), when none proper control is applied to the system a large circulating currents will flow through the converter's arms which might cause damage in some components. To overcome this issue a voltage balancing control algorithm is presented. The poster also offers a performance comparison of interleaving and non-interleaving carrier signals between the two arms in the same phase, a phase disposition (PD) pulse width modulation (PWM) is examined for this task. The investigations of this work have been tested by using MATLAB/Simulink software.

11. Mr Abdelbaset Mnider

Five-level diode clamped multilevel inverter based photovoltaic system

Abstract

The rapid evolution of renewable energy in the recent years has resulted in the design of efficient power converters suitable for medium and high-power applications such as wind turbine and photovoltaic (PV) systems. Today, the industrial trend is moving away from heavy and bulky passive components to power converter systems that use more and more semiconductor elements controlled by powerful processor systems. However, it is hard to connect the traditional converters to the high and medium voltage grids, as a single power switch cannot stand at high voltage. For these reasons, a new family of multilevel inverters has appeared as a solution for working with higher voltage levels. Beside this important feature, multilevel converters, have the capability to generate waveforms. Consequently, in comparison with conventional two-level inverters, they present lower switching losses, lower voltage stress across loads, lower electromagnetic interference (EMI) and higher quality output waveforms. These properties enable the connection of renewable energy sources directly to the grid without using expensive, bulky, heavy line transformers. Additionally, they minimize the size of the passive filter and increase the durability of electrical devices.

However, multilevel converters have only been utilized in very particular applications, mainly due to the structural limitation, high cost and complexity of the MLC system and control. New developments in the field of power semiconductor switches and processors will favor the MLCs for many other fields of application.
The main application for multilevel converter presented in this poster is the front-end power converter in photovoltaic (PV) systems. Diode-clamped and cascaded H-bridge converters are the most commonly used multilevel converters in PV system applications. However, some drawback such as capacitor voltage imbalance, number of components and complexity of the control systems – still exist. In this poster, the capacitor voltage imbalance of a single-phase five-level diode clamped multilevel inverter based PV is investigated using a high frequency multi-winding transformer to supply an equal voltage across the dc link capacitors.
Various simulations using Matlab simulation tools are undertaken, and the process of developing an experimental test rig for the system is in the way.

12. Mr Christopher Mullen

Revenue flows in the GB Electricity Network
The GB electricity network was designed such that power flows are uni-directional from generation side to demand side. The network now faces challenges from: distributed generation (which may generate power flows from the demand side); expected increased demand from e.g. heat pumps and electric vehicles; and unpredictability of renewable generation. These may cause voltage and network capacity limit problems. “Demand Side Response” (DSR) is any action on the demand side which shifts demand in time by e.g. deferring loads; storing energy electrically or thermally; or by using on-site generation. DSR can mitigate voltage and capacity problems by shifting demand away from peak times and by utilising less predictable renewable generation.
This poster describes the current electricity system in terms of revenue flows to uncover the value of different services which could be offered by DSR to the various network actors, in order to assess the business cases for DSR.

13. Mabasa-Ashe Richard Mandeya

HEALTH MONITORING APPLIED TO POWER CONVERTERS
This research involves the use of health monitoring techniques to improve the reliability of power converters. Power converters are essential for power

supplies and are becoming increasingly common in most systems. Health monitoring techniques have traditionally been applied mostly in mechanical systems but are now as essential in electronic systems since their reliability is as critical. Effective health monitoring is achieved when a device/system is in operation where it is exposed to its operational, performance and environmental loads; this is referred to as in-situ/online health monitoring, and is the approach used in this research. The research work will include investigation of a power converter system/device failure mechanisms and associated failure precursors; development of a system to monitor/measure the parameters that can be used to define failure (failure precursors); and using the measured data to assess the health and estimate the remaining life or reliability of the power converter system/device.

14. Mr Sichao Yang

Rotor Topology Investigation and Cost Reduction Study for an In-wheel Motor used in Electric Vehicles

The project is the cooperation between PEDM group at Newcastle University and Protean Electric. This paper analyses the influence of various rotor parameters on the predesigned In-wheel motor PD 16 from Protean Electric Inc. and investigates the potential rotor topologies, in order to reduce the magnet volume while maintaining the torque performance through the complete operating range. The Semi Surface Permanent Magnet (SSPM), I-shaped tangential PM (IPM) and V-shaped interior PM (VPM) are compared in terms of peak torque performance, magnet volume, power factor, operating range and demagnetization issue. Both IPM and VPM give advantageous torque performance due to the increased inductance on both Q and D axis. Equivalently, magnet volume can be reduced while maintaining the same torque. Meanwhile, because of the iron shielding protection from IPM and VPM, both of them have a better demagnetization resistance comparing to SSPM. However, the poorer power factor and consequently short operating range are discovered and needs to be further analysed. The manufacturing cost comparison is also addressed within this paper.

15. Mr Jamie Lamb

Sensor-less Induction Motor Drive with Multilevel Converter and Output Filtering

Some applications and operating environments such as downhole drilling in the oil and gas industry demand the use of a remote induction machine. A

complication that arises with remote machine control comes from long supply cables between the inverter and the machine, long cabling and square PWM waveforms give rise to reflected waves.

A low pass inductor-capacitor filter can be connected to the output of an inverter to filter the PWM waveform so that a smooth sinusoidal waveform is presented to the machine.

Sensor-less vector control with output filter is not a common practice and few publications deal with an induction motor drive using an output filter. The impact of filter cut off frequency upon the dynamic response of the system is not clear.

Research Group: Microelectronic Systems Design

16. Mr Jordan Morris

Non-Volatile Bipolar Resistive RAM for Internet of Things Applications

As the world's desire to monitor and record its surroundings grows ever larger, the necessity for machine to machine communication has become tantamount, spawning the concept of the Internet-of-Things (IoT). Imperative to the functionality of such an infrastructure, low power design has become the driving force behind contemporary VLSI research. The perpetuation of Moore's Law has led to a substantial rise in leakage currents in modern VLSI processes. Frequently constituting the majority of an IC's power consumption, this problem is compounded when an application calls for infrequent active periods interspersed with extensive periods of inactivity. A recent technological breakthrough aimed at eliminating this issue is non-volatile memory structures. Although several technologies have been proposed, Bipolar Resistive RAM (ReRAM) is currently the most promising due to its scalability and Back-End-Of-Line integration into the modern CMOS fabrication process. The benefits and feasibility of Bipolar ReRAM is illustrated for IoT and energy-harvesting applications

17. Mr Khaled Al-Ma'aitah

Investigation and Implementation of Approximate Computing in Asynchronous Systems and Soft Error EDEC

Given the claim that approximate computing can be applied within hardware in order to get smaller and low overhead circuits or using software as programming language extension that can control the classification of the precise and approximate parts of the application, this research paper aims at investigating the approximate computing availability within some applications. It also intends to propose new approximated techniques to solve particular problems related to them. These problem include in general the following: reducing the complexity of the soft errors error detection and correction circuits in terms of replicated circuits and computations time, proposing a new approximated design for fundamental elements in asynchronous system like C-element which suffers from power leakage because of applying the event Anding process, and proposing new approximated type extensions in circuit design programming languages like Verilog.

18. Mr Ibrahim Ismael Ahmed

One of the many challenges in designing for a low-power, highly-parallel, reconfigurable and dependable systems with many-cores is the issue of power-proportionality chip and the development of models and theory that aids it. At present such a chip is currently challenging due to many issues that come in to play in the many-cores. The task of designing such a chip, also involves developing a power-aware operating system (OS), as well as determining the parameters for the appropriate quality of service (QoS) at the application level. Due to a lack of holistic approach that encompasses all three layers (Application, Operating System, Hardware) and their impact is required before the issue relating to a power-chip is tackle. In this paper we will attempt to address some of the issue relating to the designing of power-aware chip for the many-cores issues, as well as ascertain the possibility of power-models at the hardware level.

19. Mr Nabeel Abdulrazzag Fattah

MRI compatible wireless control of neural implant

The human nervous system can be damaged as a result of disease or trauma causing conditions such as Parkinson's disease. This latter ailment can be treated with electronic neural prostheses.

In such treatments, stimulation of the nervous system can be achieved by electrical or optical means. In the latter case, the nerves need to be rendered light sensitive via genetic means (optogenetics). High radiance photonic devices are then required to deliver light to the target tissue. Such optical approaches hold the potential to be more effective whilst causing less harm to the brain tissue. As these devices are implanted in tissue, we need to use wireless means to communicate with them. For this, IEEE 802.15.6 or Bluetooth low energy (BLE) protocols at 2.4GHz are potentially most compatible with MRI. I am developing a combined optical microsystem controlled via an ARM Cortex M0 microcontroller utilising these wireless protocols.

20. Mr Austin Junior Ogweno

Ultra Low Power Electronics for Biomedical Applications

Implantable biomedical electronic devices are rapidly emerging, targeting applications such as optogentic and neural prostheses. A basic device consists

of an energy delivery system, analogue to digital converters, signal processors and some communication subsystem. As these devices are to be deployed as implants and are expected to work for longer periods on limited energy supply, it is trivial that the subsystems be designed to consume minimum energy. Prior work in our Research group on asynchronous design has shown that systems can be designed to work proportionally on the available energy. Most of the work has been done using circuits operating at just well over the transistor threshold voltage. In this poster we explore various techniques intended to lower the power consumption of biomedical signal processors by examining low level sub threshold CMOS circuits as well as asynchronous circuit design techniques.

21. Tarun Kumar C

Design of a Multi-mode Memory controller for Intel 8051 microprocessor.

The Asynchronous 8051 processor is Intel based architecture which is designed to work under full power mode and low power mode. The objective of the Memory controller design is focused on building a Multi-mode memory controller which functions at full power mode and also switches to function at low power mode. As part of the entire design, the function of the memory controller is to handle all the operations between the Main core controller unit, external SRAM and the internal register bank. Additionally in building a low power memory controller, it is vital that the processor continue to work at voltages as low as 0.2 V. But, the primordial issue is that the external SRAM stops to work below 0.9V. Hence, the internal bank of registers is implemented to counter this problem. The internal bank of registers hold only the most essential data, when working under low power conditions, and the rest of the data is discarded. When the system is working in full power mode the data acquired or processed is stored in the internal register bank and the external SRAM. But, as soon as the supply voltage begins to drop, all the operations are limited by power and performance dependent and only a few core operations are enabled to conserve energy and persist to continue working for a longer time. During, this time the processor only uses the internal bank of registers to store the most important data. The select registers are identified by the address requested by the main controller unit and the data is read or written into these registers. Once, the processor is in full power mode, it resumes all operations yielding best performance and uses the external SRAM and the internal bank of registers.