## MEng 4 / MSc Project Proposals from Staff

## 2014/15

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| **Member of Staff** | **Project Proposal** | **Suitability** |
| **CCC** | **Radio frequency amplifier for a two-port antenna**  In order to excite a two-port antenna it is required that two "locked" amplifiers inject currents of a given amplitude ratio and relative phase into each of the antenna ports. The technical challenge lies in that the load impedance "seen" by an amplifier at the first antenna port depends on the injected current by the other amplifier at the second antenna port and vice-versa |  |
| **CCC** | **Lens-Horn Antennas**  Adding a dielectric lens in front of a standard microwave, millimetre, or submillimetre wave horn antenna in order to increase antenna efficiency, increase the gain and lower the sidelobe levels and VSWR while providing an integral radome is standard antenna design for a broad range of applications, such as space communications, radar and remote sensing, plasma diagnostics, etc. The type of lens design has been traditionally constrained by manufacturing technologies and this has been mainly a conventional thin lens design or a Fresnel lens design. Additive manufacturing (3D printing) technology provides new lens design opportunities that have received little attention to date. This project will concentrate on the design of graded refractive index radome lenses to be fitted onto the aperture of pyramidal or sectoral horn antennas at a variety of frequency bands. |  |
| **CCC** | **Metasurface Waveguides**  Surface Waveguides are open structures that bind electromagnetic waves to a surface, with the wave amplitude decreasing exponentially on both sides of the waveguide surface and enabling wave propagation in the surface plane. Recent advances in artificial materials called metasurfaces (a two-dimensional version of metamaterials) have shown that metasurface waveguides can support surface. This project will simulate, design and test metasurface waveguides patterned on a printed circuit board (PCB) and will investigate the wave confinement properties both in the presence and absence of a ground plane. |  |
| **DJ** | **Optimal sizing and location of distributed generation in a distribution network with Plug in Hybrid Electric vehicles (PHEVs)**  Case: Some of the distributed generators are inherited with intermittent effects when they are to deliver power to share a load demand. Majority of distribution networks were not designed to absorb a large volume of intermittent distributed generation, including Wind and PV. Presence of distributed generation is not always certain and it is necessary to determine threshold limits at connection points when they are to deliver power to limit impacts on operation of a distribution network. On the other hand, determining the optimal location and sizes of distributed generation in a network can enhance the intake of renewable power generation and can potentially reduce the volume of greenhouse gas emissions by conventional power generation. Therefore, the project will investigate these issues in detail and proposes a new algorithm to determine the optimal location and sizes in a distribution network by incorporating the supports of PHEVs.  Objectives:  • Critical analysis of literature  • Detailed modelling and simulation of a Micro Grid, PHEVs, Wind, PV and PHEVs  • Defining the optimisation problem and identifying the solution methods  • Proposing a methodology for a generic distribution network  • Case studies using realistic scenarios to justify the methodology |  |
| **DJ** | **Congestion management in a distribution network with dynamic line ratings**  Case: Power systems were traditionally designed with the aim of passive operation in which the central generation supplied the consumer demand through power transmission and distribution systems. However, the passive networks were transformed into active distribution networks with the presence of embedded generation and active distribution network controls. Active distribution network operation provides benefits while introducing new problems for planning and operation of a power distribution network. One of them is the congestion due to influential factors. Therefore, the project is aimed at determining the benefit thresholds with the release of latent network capacity in a distribution network utilising dynamic ratings. Some of the challenges of the project involved modelling dynamic ratings of assets and defining a metric that can robustly quantify the level of congestion in detail.  The objectives:  • Critical review of literature  • Defining a matric to quantify the congestion in a distribution network  • Modelling dynamic line ratings incorporating weather effects and ageing conditions of assets  • Modelling and simulation of a distribution network  • Proposing a new algorithm to assess congestion in a model of a distribution network  • Scenario studies to quantify the benefit thresholds by releasing the latent network capacity through dynamic ratings |  |
| **DJ** | **Splitting distribution networks with the supports of strategic Micro Grids**  Case: Splitting a power system in the event of emergencies creates significant challenges for the healthy operation of the network. Some of them include variation in fault currents, voltage levels, power flows, tap operation of transformers, and frequency deviations. This project will look at minimising the impact on active parts of the network by incorporating strategic Micro Grids following emergency conditions in a semi-meshed power distribution network.  Objectives:  • Critical review of literature  • Modelling and simulation of a semi-meshed distribution network  • Defining criteria to split a semi-meshed distribution network by limiting the variation in fault levels, voltage thresholds, and power flow of branches  • Designing Micro Grid models incorporating Wind, PV, and energy storage  • Proposing an algorithm to apply the splitting - technique to a model of a distribution network  • Scenario studies to justify the proposed splitting criteria |  |
| **DJ** | **Value of energy storage in security constrained Micro Grids**  Case: Majority of Micro Grids facilitate integration of intermittent distributed generation including wind and PV. These generating units/systems provide intermittent power outputs, which need standing reserve supports to mitigate impacts on security of supply to customers. Standing reserve can be supplied by using embedded generating units including diesels and energy storage technologies by incorporating power electronics technologies. However, fossil fuel generating technologies contribute to greenhouse gas emissions. On the other hand, use of energy storage technologies can limit the presence of greenhouse gas emission effects although such an alternative can also carry a considerable cost with level of penetration of intermittent distributed generation. This project looks into develop a methodology to quantify the value of energy storage technologies in a Micro Grid in the context of mitigating impacts on security of supply to electricity customers. In addition, the project will explore a framework to justify a business case for energy storage technologies in a model of a Micro Grid.  Objectives:  • Critical review of literature  • Modelling energy storage technologies  • Designing a proto-type Micro Grid  • Defining valuation criteria for Micro Grids incorporating security constraints  • Assessment of value of energy storage incorporating realistic scenarios  • Justifying a business case for energy storage technologies in a typical Micro Grid |  |
| **DJ** | **Ferro-resonance in Micro-Grid-connected distribution networks**  Case: Ferro-resonance is a phenomenon that can create over voltages and damage distribution transformers. Published literature reports that one of the requirements to experience Ferro resonance over voltages is to have a lower power demand that facilitates resonating conditions. In general, Micro Grids are interfaced to the utility grids via distribution transformers and auxiliary units. Therefore, there is a chance that the emergency operating conditions in a Micro Grid can also facilitate resonating conditions with the utility grid connected transformer, resulting Ferro-resonance conditions. This project will investigate how likely such an event experience in a transformer connected with a Micro Grid and propose design guidelines to avoid circumstances that facilitate Ferro-resonance conditions.  Objectives:  • Critical literature review  • Detailed analysis of distribution transformers connected to Micro Grids  • Modelling and simulation of Ferro-resonance  • Investigation of detection and mitigating techniques  • Propose guidelines for Micro Grid designs |  |
| **DJ** | **Security constrained integration of wind and PV in power systems**  Case: Primary objective in a power system is to secure supply of electricity to customers economically. Increased integration of intermittent power generation including Wind and PV potentially impacts security of power supply to electricity customers due to intermittent power outputs, combinatorial events, and associated constraints. This project is aimed at developing a software program that can be used to assess the security constrained integration levels of wind and PV in a power system.  Objectives:  • Critical review of literature  • Modelling and simulation of a wind/ PV integrated power system  • Writing a software program to assess security impacts with wind/PV, random outages, combinatorial events in a power system  • Case studies using realistic scenarios to quantify threshold penetrations of Wind/PV |  |
| **DJ** | **Stochastic modelling of a Micro Grid for reliability assessment in a distribution network**  Case: Majority of components in a Micro Grid involve stochastic processes and the entire operation of a Micro Grid can be modelled stochastically by capturing realistic features. Among the many alternatives, the Markov-Chain modelling of a Micro Grid can potentially capture realistic Micro Grid operation and such a model can be used to assess detailed impacts on reliability of power distribution network. In that context, the project is aimed at proposing a Markov-Chain model to capture stochastic processes in a Micro Grid and to assess the reliability performance against varying levels of uncertainties.  Objectives:  • Critical review of literature  • Stochastic modelling of a Micro Grid using Markov-Chains  • Modelling and simulation of a distribution network  • Integration of Markov-Chain Micro Grid model to assess reliability performance  • Case studies using realistic scenarios to justify the performance of a model of Micro Grid |  |
| **DJ** | **Demand characterisation and management in a smart city**  The aim of the project is to characterise the demand of smart appliances and electric vehicles and to identify the demand management strategies in order to maximise the utilisation of renewable power generation, including Wind. The project involves modelling, simulation, and critical analysis of various scenarios.  Objectives:  • Critical review of literature  • Modelling and simulation of demand of smart appliances and charging and discharging of electric vehicles  • Defining a demand management criterion in the context of maximum utilisation of renewable power generation  • Scenario studies using realistic cases of smart cities | MSc |
| **DJ** | **Protection coordination in a smart Micro Grid**  The aim of the project is to coordinate the protection system through a central controller in a smart Micro Grid in order to mitigate adverse impacts on healthy operation from distributed generation. The project involves modelling, simulation, and critical analysis.  Objectives:  • Critical review of literature  • Designing a smart Micro Grid  • Defining protection coordination strategy  • Designing central controller  • Scenario studies with realistic operating conditions in a Smart Micro Grid | MSc |
| **DJ** | Reliability in a distribution network with change in weather conditions and intermittent generation of power  The aim of the project is to model change in weather conditions, include adverse weather, on the component failure rates in a power distribution network and to assess the intermittent generation thresholds that can be set in order to mitigate adverse impacts on the reliability performance of the power network.  Objectives:  • Critical review of literature  • Modelling and simulation of a distribution network with intermittent power generating sources  • Modelling weather conditions and change in weather patterns  • Simulating impacts of weather conditions on failure rates of components  • Scenario studies using realistic operating conditions to assess the sensitivity of change in weather conditions on the reliability performance of a distribution network | MSc |
| **DP** | **Mammography Screening (available for two students)**  X-ray mammography images are routinely taken to check for early signs of cancer or conditions that require further investigation. The structures that must be detected are often either very small and high contrast or larger and very low contrast. In both cases they are rare events that are likely to occur in around 2%-3% of mammograms. This makes this a very difficult task for manual observation and one that seems well suited to automation. The goal in automation is not to eliminate manual inspection but to pre-screen and remove from consideration images that clearly contain no abnormality. This means that all abnormal cases should be detected and that it is also acceptable to detect a small proportion of cases as containing potential abnormalities when they do not.  The aim in the project will be to investigate methods for detecting mass lesions and micro-calcifications. You project could seek to do both or focus on one of these issues. It will be necessary to compare performance with methods published in the literature. I will describe novel methods based on maximum-likelihood criteria but many approaches are possible. Ability to programme in C, C# or Java is essential.  A number of image databases are available on-line. There is a list at http://www.mammoimage.org/databases/ |  |
| **DP** | **Counting Tree Canopies**  Last a year an M.Eng student undertook a project to count tree canopies from low-level aerial images. This time I would like a student to develop a statistical variant of the colour hit or miss transform (a form of mathematical morphology) developed in this project. The colour based method of mathematical morphology that will form a basis of this project was developed by a PhD student under my supervision. There will be a need to evaluate performance in comparison with manual counting. Ability to programme in C, C# or Java is essential. Aerial images of tree canopies will be provided. |  |
| **DP** | **Heating Boiler Controller for Buildings with a Large Thermal Mass**  Most heating controllers do not take into account the long thermal lag of buildings with a large thermal mass. Modern buildings are designed to be well insulated and to have a relatively low thermal mass. However there are many heritage buildings, such as churches that have a large thermal mass and where on limited degrees of thermal insulation can be applied due to the method of construction and listed building status.  This means that more care is needed in designing a predictive controller that can take into account recent weather trends and plan a heating cycle to get the building to a suitable temperature with a heating period that might be 48 hours or longer. The need is to be able to specify the temperature need by a certain time and for the controller to determine when the heating should turn on to achieve this.  A common requirement for such buildings is to raise the temperature for a few hours 2 or 3 times a week and to let the building rest at a lower temperature in the intervening days.  This project will require ability to think creatively about the design of a controller, ability to simulate a design and implement an embedded system that could be connected to a heating system replacing an existing thermostat. |  |
| **DP** | **Semi-Autonomous Motorised Model Bicycle**  The aim in this project is to produce an autonomous, self-balancing bicycle powered by an electric motor that can be programmed to run a course. Balance can be achieved using the steering and a reaction wheel or a gyroscope. This involves a careful consideration of the dynamics of the control system, the construction of an embedded system with sensors and motor drive circuits. There is also a need to construct a chassis. Attention should be given to the power to weight ratio when selecting motors, designing the chassis and selecting batteries. There are a number of reports in the literature (Ghaffari, 2010), (Ghaffari, 2008), (Ghaffari, 2008) and (Yamakita, 2006) describing such systems and You tube videos.  (Ghaffari, 2010)  Ghaffari, KT and Kövecses J, Improving Stability and Performance of Digitally Controlled Systems: the Concept of Modified Holds, IEEE Int Conf.on Robotics and Automation, pp 5173-5180, 2010.  (Ghaffari, 2010)  Ghaffari. KT, “Design of a self-balancing two wheeled path finder robot,” M.S. thesis, Budapest University of Technology and Economics. Sep. 2008.  (Ghaffari, 2010)  Ghaffari, KT, “Design of a self-balancing motor bike robot,” IEEE 2008 International Student Experimental Hands-on Project Competition on Intelligent Mechatronics and Automation, Taiwan National University. (awarded first prize).  (Yamakita, 2006)  Yamakita M, Utano A and Sekiguchi K, Experimental Study of Automatic Control of Bicycle with Balancer, Proc. IEEE Int. Conf. on Intelligent Robots and Systems, Bejing, China, pp 5606-5611 2006. |  |
| **MA** | **Human echolocator signal properties**  Medium/High complexity. The project looks at how humans are able to echo locate from a remote sensing point of view. It involves radar theory and signal processing applied to this particular field, and contains analytical modelling as well as experimental data processing. Possible continuation on the Ph.D level. |  |
| **MA** | **Classification of wind turbine faults with Doppler radar**  Medium complexity. The project investigates the use of Doppler radar to automatically classify wind turbine faults. It involves background radar theory, experimental data collection in an anechoic chamber, and the development and testing of suitable classification algorithms. A Ph.D student will assist with this topic. |  |
| **MA** | **Near-range MIMO radar beamforming with uniform linear arrays**  Medium/High complexity. The project is about MIMO radar, and in particular its capability to form beams for object detection in near ranges using linear arrays. It involves MIMO radar theory, analytical modelling, experimental data collection in an anechoic chamber and the development and testing of the appropriate near-range beam formation signal processing algorithms. A Ph.D student will assist with this topic. |  |
| **MA** | **2-D scanning MIMO radar**  Medium/High complexity. The project is associated with MIMO radar, and in particular how it may scan for objects in two dimensions (azimuth and elevation) in much the same way as a radar phased array but with essentially reduced number of antenna array elements. It involves 2-D MIMO radar theory, simulation of 2-D MIMO arrays and their experimental confirmation. A Ph.D student will assist with this topic. |  |
| **MAB** | **Sensorless Field Oriented Control with Joint Flux and Rotor Speed Observer for rotor speed and flux reference trajectories tracking in Induction Motor**  Field oriented control (FOC) methods achieve high dynamic performance of control of the flux speed/position of induction motor required in variety of applications including robotics. Practical implementation of FOC typically requires further enhancements of its algorithms. Key information regarding the rotor flux cannot be practically available from hard sensor. Sufficiently accurate speed measurements required in case of a high accuracy tracking can be provided by very expensive hard sensors but only for large enough speed values. The project will develop a soft sensor of the flux and speed utilizing the motor dynamics model and hard measurements of the motor stator currents and voltages. The sensor will be developed based on the theory of state estimation in dynamic systems. Performance of this practically viable high dynamics FOC will be assessed by simulation. |  |
| **MAB** | **Field Oriented Control with Reduced Order Rotor Flux Observer for rotor flux reference trajectories tracking in Induction Motor.**  Field oriented control (FOC) methods achieve high dynamic performance of control of the flux speed/position of induction motor required in variety of applications including robotics. Practical implementation of FOC typically requires further enhancements of its algorithms. Key information regarding the rotor flux cannot be practically available from hard sensor. The project will develop the flux soft sensor utilizing the motor dynamics model and hard measurements of the motor stator currents and voltages. The sensor will be developed based on the theory of state estimation in dynamic systems. Under fast varying rotor speed the observer becomes a truly time varying dynamical system and tuning its gains needs to be done on-line depending on the actual speed range. For large speed variation a number of observers will be tuned accordingly and then combined into one observer, which will automatically adapt the gains when the motor operates over a large speed range. This will be done by applying the fuzzy logic and fuzzy Takagi – Sugeno system. As the motor dynamics is highly nonlinear the separation principle doesn’t hold and coupling well designed observer with ideal FOC, which was tuned assuming accurate flux values available, may not achieve expected high dynamics controller performance. This will be carefully checked by simulation and if needed, the tuning strategy of the FOC and observer parameters will be modified. |  |
| **MAB** | **Sensorless Field Oriented Control with Joint Rotor Resistance and Rotor Flux Observer for rotor speed and flux reference trajectories tracking in Induction Motor.**  Field oriented control (FOC) methods achieve high dynamic performance of control of the flux speed/position of induction motor required in variety of applications including robotics. Practical implementation of FOC typically requires further enhancements of its algorithms. Key information regarding the rotor flux cannot be practically available from hard sensor measurements. Also a rotor time constant, the key parameter in the motor dynamics model needed to implement a feedback linearization mechanism in the FOC algorithm is unknown and time varying. This is because the time constant depends on the rotor resistance, which is affected during motor operation by time-varying temperature. The project will develop a soft sensor of the rotor flux and resistance utilizing the motor dynamics model and hard measurements of the motor stator currents and voltages. The sensor will be developed based on the theory of state estimation in dynamic systems. Performance of this practically viable high dynamics FOC will be assessed by simulation. |  |
| **MC** | **Simulation of ultrasonic signals reflection from the rough surfaces**  The goal of the project is the simulation of ultrasonic signal backscattering from the rough surface. This is a part of a bigger project of remote road surfaces identification. Simulation can be made in Matlab. The input parameters are the type of transducer, distance to the surface, grazing angle and surface parameters. The simulation is based on the theory of wave scattering from rough surfaces which can be characterised as random Gaussian processes. The results are verified by comparison of the simulated echo signal with the signals which have been received during the experiment. |  |
| **MC** | **Study of the statistical methods of surfaces classification**  The goal of the project is a comparative analysis of common statistical methods, used for automatic classification of surfaces. This is an important task in improving road safety. The supervised classification algorithms, such as k-means, k-nearest neighbour, maximum likelihood, should be applied to the collected database. This database consists of the features, extracted from radar and sonar signals, backscattered from different road surfaces. The study should provide recommendations for choosing the classification method with the best performance. |  |
| **MC** | **Remote road surface identification using radar and sonar sensors data**  This project examines the method of road surface recognition, based on the analysis of backscattered radar and ultrasonic signals. The input data are recorded radar (with different polarization) and sonar signals, reflected from various road surfaces. One of the most common classification methods, such as k-nearest neighbour, applied to the extracted signal features. The aim of the project is to test the effectiveness of this method for different combinations of features. |  |
| **MC** | **Designing surfaces recognition system, based on the analysis of the reflected radar signals**  To improve safety of driving is necessary to obtain information about the type of road surface. The aim of the project is to develop a radar system for surfaces classification. The project includes the analysis of the system requirements, the choice of signal parameters and development of a block diagram of the system. In the practical part, the signals reflected from various surfaces will be recorded, using the existing (already developed in the laboratory) equipment. |  |
| **MJL** | **Candled powered phone charger.**  Heat can be converted to electricity directly using the thermoelectric effect. This project will use an expensive thermoelectric generators to convert the heat from a candle to a direct current and voltage suitable for charging a mobile phone. During the project not only the application of a phone will be studied but also the full capabilities of the thermo electric generator will be assessed, with not only a candle as a heat source but also other easily available sources. The efficiency and cost of the thermoelectric phone charger will be studied |  |
| **MJL** | **Stepper motor controlled tuneable waveguide filter**  Tuneable microwave filters are becoming increasingly important in communications and radar systems and there are many ways to achieve tuneability of both the centre frequency and bandwidth of a filter. Research in the Emerging Device Technology (EDT) research group has produced a tunable waveguide filter with excellent performance. However, this filter is currently tuned by hand. This project will attach steeper motors and a controller to the filter and write software to control the frequency response of the filter. The software will take full filter specifications and move the tuners to achieve that specification. |  |
| **MJL** | **Study of small microwave resonators.**  The trend in technology is to make circuits smaller and smaller. This has been the goal of integrated circuits over many years, and the density of components has increased enormously. However, with passive microwave circuits there is a problem because as the size of the components is reduced the performance becomes worse. The microwave resonator provides and indication of this reduction in performance characterised by the resonator quality factor (Q). By designing a resonator and evaluating it quality factor one aspect of the performance of any filter or other component based on resonators can be predicted. The reduction in performance (reduction in conductor Q) as the size decreased will be evaluated in this project. This will be done by looking at a large number of resonators, evaluating their Q, and seeing which resonators are able to use the volume most efficiently. Both analytical and CAD methods will be used for the work. |  |
| **MJL** | **Temperature dependence of the response of microwave waveguide filters**  Microwave waveguide filters are made of metal and their frequency response depend heavily on the size of the resonators and coupling gaps in the filter structure. Because of this dependence on the size and shape of the metalwork, the frequency response is expected to change with temperature as the metal expands and contracts. This effect will depend not only on the temperature, but also on the particular specification of the filter. This can be a serious problem with some filters and it may be that the materials with low thermal expansion coefficient have to be chosen. The project will consider novel materials for filters such as metal coated plastic used in 3D printing or injection moulding as well as different metals used in additive manufacturing equipment.  The project will:   * Consider the linear expansion coefficient of different materials and give a simple prediction of the resonant frequency change of a resonator. * Design a simple waveguide filter and predict the changes in response with frequency * Have the filter made * Set up a measurement system to measure the temperature variation of the response and compare with the predictions. * Discuss the effect of filter specification on the temperature and suggest materials or other things which may overcome it. |  |
| **MO** | **Control of spherical omidirectional robot**  The project aims at investigating theoretical motion model and control of an omnidirection robot that can move in all directions. Matlab simulation platform will be employed to test the performance and the control of elaborated motion models in the presence of disturbances. Discussion on a possible low scale implementation using available micro-controller and actuators will be carried out.  Requirements: Maths and Control skills + matlab programming |  |
| **MO** | **Implementation of a client-server architecture with customer profiling**  The project aims to design and implement a client-server architecture where a user is defined through a set of interests (music, sport, specific activity…), which constitute the profile of the user. Each interest is then connecting to a given service, usually website, and a set of recommendations according to user position, past activities, will be fed back to the user. The application should be portable on mobile and makes use of Google map and GPS information for positioning calculus and updating  Requirements: good programming skills either Java or C# |  |
| **MO** | **Object Tracking From video sequences**  This project aims to implement a  new model of object tracking based on level set approach for tracking multiple objects on video sequences. The project will make use of either OpenCV package and/or image processing library in matlab. Performance of the tracking algorithm with respect to a set of predefined metrics will be established though a set of publicly available videos with predefined ground truth  Requirements: matlab programming skills if using image processing toolbox;  C programming skills if using OpenCV library |  |
| **PAS** | **Modeling of a waveguide circulator**  Ferrite materials can be used to create a non- reciprocal device called an isolator or circulator. To do this a low loss microwave ferrite ceramic must be employed along with a biasing magnet. The biasing magnet, generates a static magnetic field, which makes the ferrite non-reciprocal. Matlab or CST can be used to look at how different parameters of the circulator (bandwidth, temperature stability, input impedance etc) can be controlled by proper choice of biasing field, ferrite materials etc. |  |
| **PAS** | **Improved Resonators for use in Klystrons or Magnetrons**  Resonators are widely used as key elements in either kylstrons or magnetrons (both electron devices). Klystrons for example are widely used as the accelerating element in particle accelerators, e.g. CERN. If these resonators could be improved, to reduce their loss, then considerable energy savings could be achieved. Even a few percent improvement in the efficiency of magnetrons would make a significant world-wide energy saving.This project could involve a significant amount of Matlab, Superfish or possibly CST modelling. |  |
| **PAS** | **Coupled Cavities for use in Travelling Wave Tubes (TWT)**  Resonators are widely used as key elements in coupled cavity TWT’s (electron devices). Modern filter theory may allow these cavities to be coupled together much more efficiently with a corresponding increase in bandwidth. This project could involve a significant amount of Matlab, Superfish or possibly CST modelling |  |
| **PAS** | Gain Phase Meter & Directional Couplers This project is to create a measuring instrument for the testing of the gain & phase delay of high power amplifiers. It may be used in a future student group project, next year. The instrument must cover the VHF & UHF PMR bands along with the LTE bands up to 2.7 GHz. It must display the gain & phase delay simultaneously. The unit will need calibrating for both power level (absolute) and phase delay. The power levels involved, for the amplifiers to be tested, is likely to exceed +43dBm. So it will need to be used in conjunction with directional couplers. |  |
| **PAS** | Energy Harvesting using Piezo Devices This project will look at the idea of using piezo devices to harvest energy from vibrations in the local environment. Piezo devices often produce significant voltages but tiny currents, also they have very large input impedances. So careful consideration, of the electronics is needed, to extract this power efficiently from the piezo device. The project will use measured data on devices previously manufactured at Birmingham. Please note, whilst we will try to provide an actual Piezo device, we cannot guarantee that one will be available. |  |
| **PJ** | **Automatic Detection and Identification of Non-Speech Sounds (1 or 2 projects)**  During recent years, there has been a huge increase of the amount of various types of multimedia data (music, speech, and video) available in digital format. This has created a large demand for development of automatic intelligent tools that could organise and search through this data, or extract knowledge from this data.  This project is concerned with developing of an automatic sound processing tool that could assist activities of human life or could assist in assessing any abnormalities in a given area. In a given real-world environment, there may be a variety of speech and non-speech sounds present during normal operation / circumstances. However, when any abnormality happens in the area, the type of sounds is likely to be very different. The type of sounds associated with an abnormality depends on the area/environment and situation, but could be, for instance, sounds of sirens, buzzers, sounds of distress (human scream, shouting, cry), sounds of collisions, etc. |  |
| **PJ** | **Music Pattern Processing (1 or 2 projects)**  Folk music has always been an important part of oral culture. This project will investigate structures and patterns in traditional music (e.g., Irish) and singing (e.g., Turkish) with the aim of characterising stylistic interpretations. The ability to accurately represent and analyse stylistic features will allow for the development of discourse related to several key ethno-musicological questions surrounding music making, musical heritage and cultural change.  In Irish traditional music, while `tunes’ are usually of simple and regular structure, the tradition allows for and applauds the creativity of the individual musician. The perceived skill, creativity and musicality of musicians in the Irish tradition are often related to the use of ornamentation and variation in performance. The project aims at developing signal and pattern processing techniques that will be able to detect ornaments, find what type of ornaments were used and where in the tunes they are realised. It will then investigate whether there are usage patterns of ornaments that are favoured by a particular performer and if exist, where and the frequency with which performer applies them. The aim is to explore developing a dictionary of patterns for a particular player and make comparison across several other notable performers' recordings to ascertain whether they have unique dictionaries. |  |
| **PRA** | **Electromagnetic Cable Location Technology**  Traditional electromagnetic cable locators operate by sensing the magnetic field emitted by the sheath of a cable. This may be related to the mains generation frequency, or it may be due to re-radiation of ELF radio transmissions. The aim of this project will be to design and build a software define electromagnetic cable locator. The electromagnetic magnetic field will be sampled at a 192 kHz rate using a high-quality analogue-to-digital converter and transferred to a data storage device using an Ethernet connection – possibly using a Wiznet Wiz550io module. The software functions will be performed in Matlab |  |
| **PRA** | **Underground Communication Link**  Caving and potholing is generally considered to be a safe sport. However, when things go wrong cave rescue teams are called out. Communication is generally maintained with the surface by using low-frequency analogue modulation techniques. The aim of this project is to investigate and develop very low bit-rate communication systems suitable for digit underground communications. |  |
| **PRA** | **Dual-Channel Arbitrary Function Generator**  Modern active sonar systems transmit a variety of signal transmission types – e.g. pulsed sinusoids, linear frequency modulated chirps and linear period modulated chirps. The requirement for a submerged aquatic classification sonar is to be able to transmit two signal channels with a 1 MHz bandwidth and exceptionally low spurious frequency components (requiring a large number of bits in the D/A converters). The signals would typically be stored in a static RAM and output under the control of an FPGA. The academic and analytic deliverables required of any good project will be addressed by consideration of the phase and amplitude sampling errors required for low spurious signal output, coupled with the evaluation and verification of performance. |  |
| **PRA** | **Receive Signal Digitisation**  Modern active sonar systems digitize the signal as physically and electrically close to the transducer as possible (in the wet end). The requirements for good signal-to-noise ratio and low-distortion require a large number of bits in the analogue-to-digital converter. Current devices are capable of quantizing 24-bits at a 4 M samples per second rate – an equivalent of 96 M bits per second. To avoid data communication bottlenecks in the Ethernet link, a FIFO buffer will be required – probably implemented using static RAM and an FPGA. The academic and analytic deliverables required of any good project will be addressed by consideration of the signal-to-noise ratio achievable, coupled with the evaluation and verification of performance. |  |
| **PRA** | **Sonar Receive Signal Processing**  Modern active sonar systems use matched filters within the receive chain. If implemented in the time-domain, these require of the order of O2 operations – approaching 1016 bits per second. If implemented in the frequency domain, this drops to the order of O1 operations – hence implementation often being performed at the surface on standard processing engines. FPGA implementations are normally impeded by lack of on-board RAM. This project could either concentrate on Matlab signal processing, or on the implementation on an FPGA. . The academic and analytic deliverables required of any good project will be easily addressed by consideration of the underlying science and the verification of performance. |  |
| **PRA** | **FPGA Data Fusion and Separation**  Many environmental sensors require low-speed navigation data to be fused with high-speed A/D data. This often has to be recorded and post-processed at a later date. Thus it would be desirable to use an FPGA to fuse compass heading and tilt data with multi-channel analogue signal data. This should be recorded using the lowest-cost method of bulk storage and separated for analysis by a Matlab script. The use of NAS storage devices should be examined. |  |
| **PRA** | **Bicycle mounted road condition monitoring**  Local councils would like to be able to measure the degradation over time of urban road surfaces. Unfortunately, they do not have enough money to conduct this task. However, many commuters cycle the same path on a daily basis and are thus ideally placed to autonomously measure the condition of the road surface. The aim of this project will be to develop a low-cost road texture sensor that is insensitive to the yaw angle of the bike and to transmit the data via an Ethernet link to some form of GPS-enabled storage device. The capabilities of an existing commercial lorry-mounted sensor called ‘Scanner’ should be examined. |  |
| **PRA** | **Any Form of Underwater of Underground Geophysical Sensor**  Geophysical sensors for underground and underwater applications provide a rich environment for generating practical and analytical projects to suit a wide range of student abilities. These could include acoustic, magnetic, gravity, electromagnetic and NMR devices. |  |
| **PT** | **High-voltage DC/DC converter with digital output voltage monitoring**  High voltage DC-DC converters are widely used in several industrial processes; typical applications are some parts of e-beam soldering equipment, X-Ray generation, and so on. Whatever the application will be, the output voltage value implies that not only is necessary to build up a high voltage transformer, but implementing a power topology that can cope with the transformer parasitic elements as well. The present project is aimed to study a DC/DC converter suitable for kV voltage levels. The selected topology needs a great flexibility at design time, including the high-frequency transformer. The proposed converter should extend its operation mode in terms of frequency, exploring the possibility of using Silicon Carbide MosFETs as switching devices. |  |
| **PT** | **Power converters for electric substations of AC railways at 25kV, 50Hz**  AC systems are widely used around the world for the electrification of railways. Such railway systems are usually fed by bespoke traction substations, whose designs include either a single phase 25 kV or 2x25 kV systems. Train sets are fed either by boost transformers and autotransformers in the traction substations, respectively. This feeding arrangement creates voltage and current unbalancing of primary power networks supplying the railway. This project aims to study alternative solutions based on power electronics converters to supply the single-phase power line without unbalancing the three-phase network. This can be done using indirect conversion topologies with intermediate DC-link or direct AC/AC conversion topologies (modular multilevel converters or matrix converters) The influence on the voltage unbalance factor and the reduction of the current negative sequence will be evaluated. The possibility of power factor and/or harmonic compensation will be also considered. |  |
| **PT** | **Condition monitoring systems of power converters of wind turbines**  Condition monitoring of electrical systems are critical for the healthy operations of wind turbines and are essential to limit downtime costs and expensive repairs due to unexpected failures. The project will develop a condition monitoring for the power converter, with particular reference to the power semiconductor modules and the electrolytic capacitors. The method will use the measurements of voltages, currents and temperatures of the power converter to estimate the status of the electrical devices on the basis of a mathematical model of the system. The estimation of the remaining life will be mainly based on the identification of factors indicating ageing effects of the components. |  |
| **PT** | **Harmonic compensation with the active front-end converters of renewable power sources**  Although present standards impose limits on the magnitude of harmonic currents injected into the grid, the presence of several power converters can still result in a distorted voltage at the point of common coupling, particularly for weak grids or resonant conditions This project will explore the opportunities of improving the control of power converter used to interface renewable power sources with the grid in order to compensate for the harmonics and inter-harmonics of the grid. The approach for harmonic compensation will be based on a multi-Park synchronous reference frame to decouple the harmonics and compensate for them effectively using proportional-integral controllers. |  |
| **PT** | **Design of traction converters with wide-bandgap switching devices**  This project undertakes a feasibility study on the use of wide-bandgap devices for railway traction converters to improve the efficiency and availability of electric trains. The new concept of converter has the potential to transform current design of traction drives and will be highly exploitable in view of the compelling need of introducing more sustainable trains that can reduce carbon footprint. The main objectives of the project are to identify suitable module topologies for the introduction of wide-bandgap devices in electric trains; comparison of the conduction and switching losses of new devices in comparison with silicon IGBTs for the full frequency range of the traction drive, including field-weakening operations of traction motors; evaluation of the losses of the converter at system level, including the line filter and the traction motors and estimation of the reduction in weight and volume of the line filter. |  |
| **RJS** | **Development and evaluation of mobile Augmented Reality techniques for aircraft maintenance and component location awareness**.  Requires students with basic knowlegde of 3D modelling and an interest in games-based simulation. |  |
| **RJS** | **A miniaturised metal detection / magnetometer system for small ground-based robot vehicles.** |  |
| **RJS** | **Further development of a head-slaved miniature telepresence unit for ground-based robot vehicles** |  |
| **RJS** | **Development of a breathing-controlled interface for "incentive spirometry" and early ventilator weaning applications for patients in Intensive Care**. |  |
| **RJS** | **Visualising Radiation Sources from Small Unmanned Air Vehicles**.  As small UAVs - hexacopters, quadcopters and small drones - become more technologically capable, their use in conducting specilaised environmental surveys is on the increase.  Recent trials with the EESE's hexacopter demonstrated the feasibility of flying low-cost special-purpose sensors, including a thermal imaging camera, and there is now interest, in conjunction with the School of Nuclear Physics, in investigating the use of low-cost radiation sensors with these aircraft. Using a low-cost Geiger Counter (the bGeigie Nano), this project requires the student to work with EESE academic and other postgraduate students to implement a flyable version of this sensor and to develop a prototype ground-based real-time graphical display system capable of mapping basic radiation features of the environment (within the known limitations of Geiger Counter technology), with the capability to be developed further in the future to be integrated with other radiations sensor types. |  |
| **SH** | **Electric Railway power supply condition monitoring using high frequency time delay reflectometery**  This project will work within the traction systems research group in the Birmingham Centre for Railway Research and Education. |  |
| **SH** | **Fuel Cell Hybrid Railway Vehicle Power System Optimisation.**  This project will work within the traction systems research group in the Birmingham Centre for Railway Research and Education. |  |
| **SH** | **Performance Analytics applied to large energy datasets in the railway sector.**  This project will work within the traction systems research group in the Birmingham Centre for Railway Research and Education. |  |
| **TC** | **Automated Reconstruction of Broken 3D Objects”** (involves C programming, OpenGL, Signal Processing, some maths) |  |
| **TC** | **Audio-band Echolocation Navigation Aid** (involves C programming, OpenGL, Signal Processing, Audio Processing, some maths |  |
| **TC** | **Ambulatory Monitoring of Physiological Data**  (involves electronics, microcontrollers, C programming, data mining) |  |