Microelectronics

&

Semiconductor Simulation

School of Electronics, Electrical Engineering & Computer Science
Final Year Project 2010/2011

Title:- **TUNGSTEN SILICIDE SCHOTTKY BARRIER DIODES**

Supervisor:- Prof B M Armstrong
Moderator:- Dr D W McNeill
Areas:- Microelectronics
Research Cluster: Semiconductor & Nanotechnology

Schottky Barriers are special metal - semiconductor rectifying diodes. They are very simple in structure and are unipolar rather than bipolar (as in n-p or p-n diodes). Their characteristics are strongly dependent on the metal used and on the doping and type of the silicon to be used in this application. If the semiconductor doping level is high, then the contact becomes ohmic. This project seeks to characterise the properties of Tungsten silicide-silicon Schottky Barrier diodes. The barrier height will be accurately extracted from I-V characteristics measured over a range of temperatures. Similar measurements will be undertaken on these contacts manufactured on silicon with increased doping concentrations. The aim is to accurately establish the p and n levels of doping needed to make the diode an ohmic contact. This information is crucial to ensure that contacts of this type do become ohmic when used in power devices.

The objectives of this project are:-

1. Study Metal – silicon contact operation, and understand the Schottky Barrier I-V characteristics.
2. Undertake detailed measurement of existing diodes made on material with various different doping levels
3. Undertake detailed study and comparison of the results gained
4. Design any new structures or processes required

MEng Extension

1. Extend the work to include process design ensure ohmic contact behaviour for silicides included in power bipolar transistors.

Learning outcomes

1. Experience and understanding of specialised electronic measurements
2. Understanding of contact needs for power ICs

This undergraduate project has been designed to contribute to a major DTI funded project entitled HIVICS. This is a collaboration between QUB microelectronics, Plessey Semiconductor (Swindon), Silvaco (Cambridge) and University of Sheffield.

School of Electronics, Electrical Engineering & Computer Science
Final Year Project 2010/2011

Title:- **SOI SUBSTRATES WITH HIGH THERMAL CONDUCTIVITY BOX**

Supervisor:- Professor B M Armstrong
Moderator:- Dr P Baine
Areas:- Microelectronics
Research Cluster: Semiconductor & Nanotechnology

Silicon on Insulator (SOI) technology is being employed for the manufacture of advanced integrated circuits. SOI offers reduced parasitic capacitance, reduced MOS process complexity, greater packing density, faster switching and lower power dissipation. The buried insulator layer (BOX) in SOI is normally silicon dioxide. While this BOX provides excellent electrical insulation, it is also a good thermal insulator leading to overheating of devices. This project will examine alternative material for the BOX. This will concentrate on oxide - polysilicon – oxide BOX structures. The thermal resistance and electrical breakdown characteristics of the structures will be characterised. Novel test devices have been made to permit thermal characterisation. The student may be involved in manufacture of substrates for electrical breakdown testing.

The objectives of this project are:-

1. Study the technology for SOI and the thermal and electrical test structures
2. Become familiar with the measurement procedures and equipment currently available within the semiconductor laboratory at QUB.
3. Design the manufacturing schedule for any new test samples
4. Undertake manufacture of electrical breakdown voltage test structures
5. Undertake all electrical and thermal testing of the samples produced

MEng Extension

1. Develop an analytical model to predict breakdown voltage

Learning outcomes

1. Experience and understanding of specialised electronic and thermal measurements
2. Understanding of SOI, manufacturing process flows and impacts of thermal resistance on IC operation

This undergraduate project has been designed to contribute to a major DTI funded project entitled HIVICS. This is a collaboration between QUB microelectronics, Plesseylus Semi (Swindon), Silvaco (Cambridge) and University of Sheffield.

Electrical & Electronic Engineering

Final Year Projects 2010/2011

Title:- **HIGH-κ DIELECTRICS ON GERMANIUM**

Supervisor:- Dr D W McNeill

Moderator:- Dr S J N Mitchell

Area:- Microelectronics

Research Cluster:- Semiconductors and Nanotechnology

Modern MOS gate stacks are being fabricated using alternatives to silicon dioxide. Whether on silicon or on novel substrates such as germanium, the required silicon dioxide layer is so thin that gate leakage current can no longer be kept under control. The solution is to adopt high-κ dielectrics such as aluminium oxide or hafnium oxide. The physical thickness of a high-κ dielectric doesn't have to be scaled down so aggressively and the result is that leakage current can be reduced.

A key technology for producing high-κ dielectrics is atomic layer deposition (ALD), in which the dielectric layer can be built up one atomic layer at a time. This ensures precise control of layer thickness and uniformity. ALD is normally carried out at relatively low temperatures e.g. 250-300^{o}C. It is of great technological importance to understand the interface between the high-κ dielectric and germanium and to determine the thermal stability of the gate stack.

The Semiconductors and Nanotechnology research cluster at QUB has an ALD system, calibrated for aluminium oxide and hafnium oxide deposition. The aim of the project is to study the properties of gate stacks using these dielectrics both before and after thermal annealing.

The student will:

- Study background literature on high-κ dielectric gate stacks on germanium
- Be trained in physical and electrical characterisation techniques
- Perform initial characterisation of both ALD hafnium dioxide and aluminium oxide capacitors
- Carry out thermal annealing and repeat characterisation
- Make recommendations for ALD process and gate stack optimisation

Electrical & Electronic Engineering
Final Year Projects 2010/2011

Title:- SOURCE/DRAIN FORMATION ON GERMANIUM

Supervisor:- Dr D W McNeill

Moderator:- Prof B M Armstrong

Area:- Microelectronics

Research Cluster:- Semiconductors and Nanotechnology

Over 60 years ago the world's first transistors were made using germanium. Since then, germanium has had to take a back seat as silicon took over. Now, however, interest in germanium is back. Germanium is being added to silicon to enhance the performance of both bipolar and MOS transistors. There is also interest in device fabrication using pure germanium once again, due to its very high carrier mobilities.

The Semiconductors and Nanotechnology research cluster at QUB has successfully fabricated germanium MOS transistors recently, but would like to further optimise the fabrication process, particularly source/drain contact formation. Because it is difficult to form p-n junctions in germanium, an attractive option is to use Schottky source/drain contacts for p-channel devices. For n-channel devices, Fermi level pinning can be alleviated by inserting a very thin ALD layer between the germanium and the metal.

The primary aim of the project is to investigate the use of nickel germanide for Schottky contacts to germanium. However, it is also hoped to look at the use of ALD aluminium oxide interfacial layers for aluminium ohmic contacts to germanium.

The student will:

- Study background literature on source/drain formation in germanium MOSFETs
- Be trained in electrical characterisation techniques
- Undertake electrical characterisation of nickel germanide Schottky contacts to germanium
- Make recommendations for optimisation of Schottky contact fabrication process
- Undertake electrical characterisation of aluminium ohmic contacts to germanium with and without ALD aluminium oxide interfacial layers

Electrical & Electronic Engineering
Final Year Project 2010/2011

Title:- Electrostatic Comb-Drive Actuator for MicroElectroMechanical Systems

Supervisor:- Dr SJN Mitchell

Moderator:- Dr BM Armstrong

Areas:- Microelectronics

Integration of complete electronic systems on a single silicon chip often requires the ability to include miniature moveable structures within that chip. This is possible through the use of Micro-Electro-Mechanical System (MEMS) Technology, which enables the fabrication of moveable devices (sensors, actuators) in silicon. The moveable (or micromechanical) components are fabricated using "micromachining" processes that selectively etch away parts of the silicon wafer or add new structural layers to form the mechanical and electromechanical devices. MEMS devices are manufactured using batch fabrication techniques similar to those used for integrated circuits. MEMS provide the ability to allow microsystems to sense and control the environment and promise to revolutionize a wide range of products.

The comb-drive is a frequently used actuator structure for MEMS devices, electrostatic forces are used to generate movement within the structure. The actuator has a wide range of applications including rf and optical systems. The main aim of this project is to develop a comb-drive structure and linkages that couple to other MEMS structures such as a micro-mirrors. The project will involve the design of a comb-drive actuator with mechanical linkages, fabrication and characterisation of the structure.

The objectives of this project are:-

- Study background information on micromachining technology.
- Review previous comb-drive actuator designs and fabrication.
- Design mask layouts and fabricate comb-drive devices with linkages to other MEMS components.
- Characterise the fabricated devices, with regard to both electrical and mechanical properties.

Learning Outcomes:-

- Enhanced knowledge of micromachined structure design & fabrication.
- Practical experience of micromachining and thin-film processing.

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Electrical & Electronic Engineering
Final Year Project 2010/2011

Title:- Characterisation system for photovoltaic devices

Supervisor:- Dr SJN Mitchell

Moderator:- Dr JH Montgomery

Areas:- Microelectronics

Solar radiation is an increasing important source of renewable energy. Solar energy conversion devices are under continuous development in order to improve their efficiency and reduce the manufacturing cost. A new research programme a QUB aims to produce high performance photovoltaic devices (solar cells). A characterisation system is required to determine the performance characteristics of these devices. This will involve measurement of electrical characteristics of devices under illumination of differing intensity and wavelength. The aim of this project is to establish a suitable system for this and to examine the characteristics of typical photovoltaic devices.

The objectives of this project are:-

- Study background information on photovoltaic device operation.
- Review methods for characterising photovoltaic devices.
- Establish opto-electrical characterisation techniques.
- Characterise a range of photovoltaic devices.

Learning Outcomes:-

- Enhanced knowledge of photovoltaic devices.
- Experience in characterisation of semiconductor devices.

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SCHOOL OF ELECTRICAL AND ELECTRONIC ENGINEERING

BEng/MEng PROJECTS 2010 - 2011

Title : **Junctionless multigate transistor**

Supervisor: **G.A. Armstrong**

Assessor: **B.M. Armstrong**

Indexing Terms: **Microelectronics, Semiconductor device design, Advanced SOI Technology**

Trends in the microelectronics industry require the fabrication of smaller and smaller components, resulting in transistor sizes down to the nano-scale. This presents significant challenges in term of developing new device structures and manufacturing processes. Over the past decades, the size of Metal Oxide Semiconductor Field Effect Transistors (MOSFETs) has continually been scaled down, such that the MOSFET effective channel length is now reaching less than ten nanometers. A classical MOS transistor comprises two PN junctions called the source junction and the drain junction.

The effective channel length is the distance that separates these two junctions, and the source and drain junctions are separated by a region with opposite doping type. For example, a typical nchannel

transistor uses N-type doping at a concentration of 10^{20} atoms/cm^3 in the source and drain and P-type doping at a concentration of 10^{18} atoms/cm^3 in the channel region between source and drain. The formation of such junctions involves extremely high doping concentration gradients, and very low thermal budget processing must be used. Flash annealing techniques are currently used to heat silicon for a very short time period in order to minimize diffusion, but even in total absence of diffusion, ion

implantation and other doping techniques do not achieve perfectly abrupt junctions with infinite concentration gradients. Therefore it would be suitable to use a transistor device structure that overcomes the above-mentioned problems. The full dielectric isolation offered by the Silicon-on-Insulator (SOI) structure allows one to use Accumulation-Mode (AM) devices, in which the channel region has the same doping polarity as the source and drain. Accumulation-mode technology can also be applied to most advanced SOI structures, such as FinFETs, Multigate FETs, and even Gate-all-Around FETs. N-channel accumulation-mode devices have an N+–N–N+ structure and p-channel device have a P+–P–P+ doping for the source, channel and drain region, respectively.

Accumulation-mode devices made in relatively thick silicon films (thicker than 20 nm, typically) exhibit worse short-channel characteristics than classical inversion-mode transistors because the channel (or the peak of carrier concentration in subthreshold operation) is located deeper in the SOI film, and thus further from the gate electrode. This detrimental effect, however, disappears when the silicon film is very thin. In Multiple-Gate MOSFETs (MuGFETs) with a small enough cross section, there is no difference in short-channel effects between accumulation-mode and inversion-mode devices. The devices proposed here are basically accumulation-mode transistors with high channel doping concentration. Since the doping type and concentration in the channel region is equal to that in the source and drain, or at least to that in the source and drain extensions, these devices do not have any source or drain junctions. In this project, he design of a junctionless MuGFETs will be undertaken.

The aim of the project is to use TCAD tools to characterise 2D and 3D transistor structures.

(i) Design n- and p- channel transistors with complementary threshold voltage
(ii) Optimise film thickness to minise short channel effects
(iii) Charcterise AC performance

SCHOOL OF ELECTRICAL AND ELECTRONIC ENGINEERING

BEng PROJECTS 2010 - 2011

Title : **Modelling of thermal effect in trench isolated bipolar transistors on SOI substrates using circuit simulation**

Supervisor: **G.A. Armstrong**

Assessor: **B.M. Armstrong**

Indexing Terms: **Microelectronics, Semiconductor device design, Advanced Bipolar Technology**

Nowadays advanced technologies are based on trench isolation and silicon-on-insulator (SOI) schemes are increasingly employed due to the need of electrically insulating the active devices from both neighboring transistors and substrate. This leads to reduced parasitic capacitances, low leakage currents, and improved immunity to substrate noise and crosstalk As a consequence, faster circuit speeds and higher packing densities can be achieved. Unfortunately, the poor thermal conductivities of materials surrounding the active area make the heat removal from the active regions more difficult, thereby leading to enhanced self-heating effects with respect to bulk silicon devices of comparable size. Hence, an accurate prediction of the thermal behavior of structures characterized by isolation schemes is needed. In principle, one can resort to fully 3-D numerical simulations, which account for all the details of the device structure. However, they are CPU/memory demanding. As an alternative, high-efficiency analytical approaches are sought, since they require a lower computational cost and lend themselves to be easily included in electro-thermal circuit simulation tools.

This project will involve the development of a simple circuit model which can be used to calculate thermal resistance in an array of devices fabricated on DI substrate. It will be tested against 3D simulation of thermal resistance using TCAD tools. The project is related to a current collaborative research project with MHS Electronics and Silvaco on development of high voltage ICs for automotive applications.

(i) Investigate use of circuit simulation techniques to model heat flow in silicon wafers

(ii) Determine thermal resistance by simulation of temperature rise in various QUB test structures and compare with measurement.

(iii) Incorporate new structures in updated transistor layout to maximize device resistance to self heating

High Frequency Electronics

School of Electrical and Electronic Engineering and Computer Science

FINAL YEAR PROJECT 2010/2011

Title: Antenna and Tuning Unit for RFID Applications

Supervisor: Professor V Fusco
Moderator: Dr R Cahill
Areas: High Frequency Electronics

Antennas when used close a body or mounted upon a vehicle can have their electrical characteristics dramatically alternated ain a negative way. This is particularly problematical when the antennas are electrically small. It is important to characterise the de-tuning that can occur and to compensate it.

The objectives of the project are:

1. Experimentally study de-tuning that can occur with an electrically small antenna placed at various locations within a metal automobile body.
2. Develop a method for automatically re-adjusting the optimal impedance match for such an antenna.
3. Produce a simple demonstrator of one single antenna working at different locations with a vehicle.

M.Eng Extension

4. Develop an efficient antenna AND matching circuit which operates at the unlicensed frequency of 433 MHz.
5. Produce a demonstrator that utilises than one such antenna/tuning unit to form an array and tests its performance against simulation.

Learning Outcomes

- Understand how design wire antenna and hybrid RF circuits
- How to measure antenna performance in an anechoic chamber
- How to measure hybrid RF circuits in the laboratory
- How to make in the field measurements

School of Electrical and Electronic Engineering and Computer Science

FINAL YEAR PROJECT 2010/2011

Title: Modulator Backscatter Unit for RFID Applications

Supervisor: Professor V Fusco
Moderator: Dr R Cahill
Areas: High Frequency Electronics

RIFD, Radio Frequency Identification units, are used to track assets ranging from containers to cds in a shop. It is particularly important that at the frequency of use typically 433MHz that this RFID tags be small and consume very little DC power. The purpose of this project is to quantify the behaviour of a backscattering tag that is capable of producing QPSK signals.

The objectives of the project are:

1. Construct an electrically small RFID tag
2. Develop a method for characterising its behaviour
3. Produce a simple demonstrator

M.Eng Extensions

4. Accurately cost the volume production of such a unit

Learning Outcomes

- Understand how design wire antennas and hybrid RF circuits
- How to measure RFID performance in an anechoic chamber
- How to measure hybrid RF circuits in a laboratory
- How to make antenna measurements

School of Electronics, Electrical Engineering and Computer Science

Projects 2010/2011

Title: Probes for mapping of electromagnetic field distributions in printed circuits

Supervisor: Dr A Schuchinsky

Moderator: Dr. A Shitvov

Area: High Frequency Electronics

Basic Description:

Mapping of electromagnetic fields in printed circuits provides a powerful means for visualisation of field distributions and non-invasive identification of hidden defects, hot spots and parasitic couplings in complex assemblies. Near-field probing is usually employed to acquire field patterns nearby printed conductors and circuit elements. One of the major challenges in the near-field probing is concerned with a practical balance between the probe sensitivity and field distortion by the probe. Probe size also imposes additional stringent constraints on the achievable spatial resolution, which also depends upon the probe geometry and distance from the printed circuit. In order to adequately interpret near-field probing data and retrieve the actual field distributions, the probe response should be calibrated against the known fields in the canonical structures.

The objectives of this project are to investigate and design the miniature electric and magnetic coaxial probes. The probes will be simulated, fabricated and applied to the measurements of printed transmission lines and discontinuities. Several probe configurations will be analysed using the full-wave electromagnetic simulator (CST Microwave Studio) and applied to evaluation of the circuit and material parameters.

The main project tasks include:

1. Perform the literature survey of the probes used for near-field measurements.
2. Design the coaxial probes for electric and magnetic field mapping in printed circuits.
3. Devise an equivalent circuit of an electric probe and simulate it in ADS simulator.
4. Perform near-field measurements of the basic printed planar structures.

***MEng Extension*:**

- Optimise the probe performance by incorporating matching elements in the probe layout.
- Estimate the bandwidth and sensitivity of the matched probe tip.

Learning Outcomes:

1. Applications of the near-field mapping to evaluation of printed circuits.
2. The principles of electric and magnetic probe operation.
3. Microwave measurements of the basic printed circuits.
4. The operation of the network simulator ADS and the full-wave electromagnetic simulation tools (CST Microwave Studio) and their application to analysis of electromagnetic fields.

School of Electronics, Electrical Engineering and Computer Science

Projects 2010/2011

Title: Stacked Arrays of Planar Entwined Spirals for Frequency and Polarisation Sensitive Metasurfaces

Supervisor: Dr A Schuchinsky

Moderator: Dr R Cahill

Area: High Frequency Electronics

Basic Description:

Spiral conductors constitute one of the major basic elements of printed circuits and radiating elements. Planar spiral resonators have recently been adopted for the on-chip designs of inductors (instead of coils), miniaturised radiating elements and high impedance frequency selective surfaces. Modelling, design and characterisation of densely packed arrays of stacked planar spiral resonators present an exciting task.

The objective of this project is to investigate the periodic arrays of stacked entwined planar spiral resonators of different shapes which form the Frequency Sensitive Metasurfaces. Several configurations of the spiral conductors and array layouts will be analysed using the full-wave electromagnetic simulators (CST Microwave Studio) to evaluate the scattering and polarisation characteristics of the metasurfaces containing the stacked planar spirals.

The project objectives are:

1. Perform the literature survey of the planar spirals and their applications.
2. Simulate the scattering characteristics of the stacked entwined spiral arrays and investigate the effects of the spiral geometry on the metasurface performance.
3. Design the metasurfaces containing multi-element planar spiral arrays and investigate their scattering characteristics and polarisation sensitivity.

MEng Extension:

Design and fabricate an array of stacked planar entwined spirals on PCB substrates and measure its scattering characteristics.

Learning Outcomes:

1. Applications of spiral resonators and the basic principles of their design.
2. The modelling concepts of designing complex electromagnetic structures, periodic arrays and frequency selective surfaces.
3. The operation of full-wave electromagnetic simulation tools (CST Microwave Studio) and their application to design of complex electromagnetic structures.

School of Electronics, Electrical Engineering and Computer Science

Projects 2010/2011

Title: Tunable nested arrays of dogbone shaped printed conductors

Supervisor: Dr A Schuchinsky

Moderator: Dr. G. Goussetis

Area: High Frequency Electronics

Basic Description:

Metamaterials, artificial electromagnetic media with the physical properties unavailable in natural substances, have recently emerged as a new paradigm for artificial electromagnetic media for advanced microwave and optical applications. A common feature of the metamaterials is that their constitutive elements are densely packed in periodic or quasi-periodic lattices. Even though the periodicity predominantly determines the macroscopic characteristics of such media, the medium properties substantially depend on geometry and intrinsic structure of a representative unit cell.

It has been shown that coupled conducting wires may possess two types of resonances, named electric and magnetic resonances, and exhibit the properties of the medium with negative refractive index (NRI). The new topologies of nested planar arrays made of tightly coupled conductor stripes of complex shapes will be designed to integrate the bias supply lines for electric tuning the array response, and the performance and tunability of the stacked arrays will be explored in the project.

The project objectives include:

1. Literature survey of the planar periodic metamaterials and metasurfaces with particular emphasis on the properties of anisotropic planar structures.
2. Modelling nested planar arrays of dogbone-shaped conductor inclusions to evaluate their performance using the full-wave electromagnetic simulator CST MW Studio.
3. Design the nested arrays with integrated bias strips connected to planar capacitors for controlling the array operational frequencies and polarisation sensitivity.

MEng Extension:

Design, fabricate and measure stacked arrays of nested dogbone shaped resonators and evaluate their scattering characteristics.

Learning Outcomes:

1. Basic principles of wave propagation in periodic artificial electromagnetic media.
2. The methods of modelling and analysis of complex electromagnetic structures using the full-wave electromagnetic simulator.
3. The operation of full-wave electromagnetic simulation tools (CST Microwave Studio) and their application to design of complex electromagnetic structures.

School of Electrical, Electronic Engineering and Computer Science

FINAL YEAR PROJECT 2010/2011

Title : A MMIC Upconverting Mixer
Supervisor : Dr David Linton

Moderator : Dr Robert Cahill

Areas : Microwave simulation and measurement

Research Cluster : High Frequency Electronics

MMIC (Monolithic Microwave Integrated Circuit) Upconverting mixers are a key rf component used in wireless radios to translate modulated signals to the required transmit frequency. The double balanced diode ring mixer using is one widely used circuit. The main performance parameters are conversion gain, linearity and suppression of the unwanted frequency products (eg. Local Oscillator).

The objectives of the project are :

1. Study the double balanced diode ring mixer, and its planar implementation with spiral marchand baluns.

2. Use CAD tools to simulate an example mixer and determine how the performance of the mixer is dependent on the physical layout and process parameters

3. Use CAD tools to complete a MMIC design, and layout a MMIC circuit for fabrication.

M.Eng. Extensions

1. Investigate some new configurations for the Marchand balun couplers to improve the mixer bandwidth eg. Use of Multi-section couplers, use of Broadside couplers, use of compensating lumped elements etc.

2. Complete the design using EM simulation, and take the circuits to layout stage.

Learning Outcomes

1. Understand how to use CAD tools to model the performance of microwave upconverting mixers.
2. Be able to design a MMIC mixer.

3. Be able to layout a MMIC mixer.

School of Electrical and Electronic Engineering and Computer Science

FINAL YEAR PROJECT 2010/2011

Title : Bomb Threat Detection using Antennas
Supervisor : Dr David Linton

Moderator : Dr Robert Cahill

Areas : High Frequency Electronics

At the entrance to buildings and public transport there is an opportunity to stop terror threats if explosive devices can be detected early. This project will consider the use of antennas mounted round doorways to detect modified electronic devices which have been packed with explosives and are primed for detonation.

The objectives of the project are :

1. Study the literature for use of RF technology in bomb detection.
2. Study the electronic signature of everyday electronic devices such as mobile phone, laptops, PDAs, iPODs etc. and see how the signature changes when batteries are removed or altered.
3. Design, build and test a detection system to find altered electronic items as they pass through a doorway.

M.Eng. Extensions

1. Identify remotely how a device has been altered to make it a threat .
2. Study the reliability of your system and how you could overcome countermeasures.

Learning Outcomes

1. Understand how to use CAD tools to model the performance of antennas.
2. Be able to design single and multiple antenna systems.
3. How to measure antenna performance in an anechoic chamber.

School of Electrical and Electronic Engineering and Computer Science

FINAL YEAR PROJECT 2010/2011

Title : Cost-efficient flat absorbers
Supervisor : Dr George Goussetis

Moderator : Dr Robert Cahill

Areas : Microwave simulation and measurement

Research Cluster : High Frequency Electronics

Microwave absorbers are (often structured) surfaces that do not reflect incoming radiation. They are used in stealth technology but also instrumentation and testing. A need to develop flat absorbers has emerged from the unwanted scattering of radar airport signals by windmill turbines. Continuing ongoing funded work within the HFE cluster, the aim of this project is to experimentally demonstrate a low-cost flat absorber.

The objectives of the project are :

1. Design a flat absorber using a commercial electromagnetic simulator
2. Fabricate selected designs using technology patented by the HFE group
3. Experimentally test the fabricated prototypes

M.Eng. Extensions

1. Optimise the design for bandwidth, polarisation and angle of incidence
2. Perform a market analysis

Learning Outcomes

1. Learn how to use commercial electromagnetic software to model periodic structures
2. Develop practical skills in the fabrication of patterned surfaces
3. Understand the principles of anechoic chamber measurements

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Experimental extraction conductive paint surface impedance

Supervisor : Dr George Goussetis

Moderator : Dr David Linton

Areas : Microwave simulation and measurement

Research Cluster : High Frequency Electronics

Conductive paints can be useful for printing circuits using techniques such as inkjet or stencil printing. They can offer reduced cost and high flexibility compared to the etching of metallic circuits. However their surface conductivity is less compared to metals and often not specified at microwave frequencies. The aim of this project is to develop experimental techniques for the estimation of the surface conductivity using one paint available in the HFE cluster.

The objectives of the project are :

1. Design experimental setup for the estimation of the surface conductivity using commercial electromagnetic software
2. Prepare a set of samples using a paint available in the HFE cluster
3. Experimentally evaluate the conductivity of the samples

M.Eng. Extensions

1. Corroborate the results using a different setup
2. Investigate possibilities for tailored conductivity (layer thickness, concentration)

Learning Outcomes

1. Learn how to use commercial electromagnetic software
2. Experience with microwave metrology
3. Learn how to make and analyse measurements in Agilent PNA

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Transmitarray flat lens

Supervisor : Dr George Goussetis

Moderator : Dr Robert Cahill

Areas : Microwave simulation and measurement

Research Cluster : High Frequency Electronics

Traditional lenses are 3D shaped devices with the property to focus an incoming plane wave to a focal point. The 3D geometry of lenses makes them difficult and expensive to fabricate. Flat surfaces compatible with traditional printed circuit board (PCB) technology that focus an incoming plane wave into a point within the same half space have been successfully realised using frequency selective surfaces (FSS) and are known as reflectarrays. The aim of this project is to explore the opportunities to realise transmitarrays using cascaded FSSs.

The objectives of the project are :

1. Extract the requirements for a transmitarray unit cell based on ray optics
2. Simulate FSS unit cells and extract parametric design curves
3. Simulate an entire transmitarray

M.Eng. Extensions

1. Fabricate and test a PCB-based transmitarray
2. Publish the results in the academic literature

Learning Outcomes

1. Understand ray optics and reflect- / transmit-array design principles
2. Learn how to use commercial electromagnetic software to model periodic structures
3. Understand the principles of anechoic chamber measurements

Power Systems

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title: **MODELLING AND SIMULATION OF POWER SYSTEMS**

INSTALLED WITH A UPFC

Supervisor : Prof. Haifeng Wang

Moderator : Dr Tim Littler

Student : TBD

Areas : Electric Power and Energy Systems

Unified Power Flow Controller (UPFC) is one of the newest and most powerful Power system control devices to achieve Flexible AC Transmission Systems (FACTS), which has been tested in power systems in USA. This project aims at the provision of a general model of a power system installed with a UPFC, programmed by MATLAB. The model and programme developed will be used for further investigation, such as the design of UPFC, in future.

The objectives of the project are :

1. Study the operational principle of UPFC.
2. Develop a simulation power system installed with a UPFC.
3. Study and demonstrate the effectiveness of UPFC control.

M.Eng. Extensions

Further investigation of UPFC voltage and stability control

Learning Outcomes

1. Understand how to use SIMULINK to simulate power system dynamics
2. Be able to set up and run power system simulation by using SIMULINK.
3. Understand how the performance of UPFC control can be assessed.

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title: **MODELLING AND SIMULATION OF POWER SYSTEMS**

INSTALLED WITH A SVC

Supervisor : Prof. Haifeng Wang

Moderator : Dr Tim Littler

Student : TBD

Areas : Electric Power and Energy Systems

Static Var Compensator (SVC) is one of the power system control devices to achieve Flexible AC Transmission Systems (FACTS), which has been installed in power systems in many counties, including the UK. This project aims at the provision of a general model of a power system installed with a SVC, programmed by MATLAB. The model and programme developed will be used for further investigation, such as the design of SVC, in future.

The objectives of the project are :

1. Study the operational principle of SVC.
2. Develop a simulation power system installed with a SVC.
3. Study and demonstrate the effectiveness of SVC control.

M.Eng. Extensions

Further investigation of SVC voltage and stability control

Learning Outcomes

1. Understand how to use SIMULINK to simulate power system dynamics
2. Be able to set up and run power system simulation by using SIMULINK.
3. Understand how the performance of SVC control can be assessed.

School of Electrical and Electronic Engineering and Computer Science

FINAL YEAR PROJECT 2010/2011

Title: **MODELLING AND SIMULATION OF GOVERNOR POWER SYSTEM** STABILIZER

Supervisor : Prof. Haifeng Wang

Moderator : Dr Tim Littler

Student : TBD
Areas : Electric Power and Energy Systems

Power System Stabilizer (PSS) is one of the power system control devices to enhance power system stability, which has been widely installed in power systems in many counties, including the UK. Conventional PSS is installed on the side of exciter of the generator. This project aims at the investigation of a PSS installed on the side of governor system of the generator, named Governor PSS (GPSS). The project will establish a general model of a power system installed with a GPSS, programmed by MATLAB.

The objectives of the project are :

1. Study the operational principle of GPSS.

2. Develop a simulation power system installed with a GPSS.

3. Study and demonstrate the effectiveness of GPSS.

M.Eng. Extensions

Further investigation of intelligent GPSS.

Learning Outcomes

1. Understand how to use SIMULINK to simulate power system dynamics

2. Be able to set up and run power system simulation by using SIMULINK.

3. Understand how the performance of GPSS control can be assessed.

School of Electrical & Electronic Engineering

FINAL YEAR PROJECT 2010/11

Title: Impact of Electric Vehicles on the NI Transmission System Operation

Student: Karen Creighton

Supervisor: Dr D J Morrow

Second Supervisor: Dr T Littler

Industrial Supervisor: Dick Lewis (NIE)

Indexing Terms: Power and Energy Systems

The UK electricity system faces challenges of unprecedented proportions. By 2020, according to the Government Renewable Energy Strategy (RES), it is expected that up to 40% of the UK electricity demand will be met by renewable generation. Targets proposed by the UK Climate Change Committee include the reduction of greenhouse gas emissions by 80% in 2050, it is therefore expected that the electricity sector would be almost entirely decarbonised by 2030. The target for the transport sector is that 10% of transport demand must be met with renewable sources, and as road traffic makes up 70.3% of all UK travel; it will have the biggest role to play in meeting this target.

The TSO in Northern Ireland has a licence obligation to analyse the generation adequacy on a yearly basis and produce a document i.e. Generation Adequacy Report, and the Transmission Seven Year Statement which is written to provide any person wishing to connect to the system information to identify and evaluate opportunities and includes information such as transmission capacity and the anticipated future requirements for transmission capacity. Both these documents are generated using forecasts for seven years ahead, therefore an increase in demand due to EV charging will need to be factored in.

The objective of this project are:

1. Quantify the impact EV's will have on the NI demand over a number years
2. Assess EV charging options to utilise this impact to the benefit of the TSO
3. Explore options of managing wind variability using EV charging
4. Determine how placement of charging stations will affect the electricity infrastructure at various voltage levels

Learning Outcomes

1. Experience of practical transmission system operation
2. Knowledge of SMART GRIDS
3. Knowledge of Power Electronics
4. Understanding of battery charging technologies

MEng Extension

Suggest a suitable methodology for the TSO to manage the increase in demand due to the charging of EV's.

School of Electrical & Electronic Engineering

FINAL YEAR PROJECT 2010/11

Title: Phasor Measurement Web-Portal

Student:

Supervisor: Dr D J Morrow

Second Supervisor: Dr M Cregan

Industrial Supervisor: Martin Lee (Scottish & Southern Energy)

Indexing Terms: Power and Energy Systems

Queen's University Belfast is currently deploying a series of 'home designed & built' phasor measurement units (PMUs) across the UK / Irish electrical networks to determine the voltage, current, frequency and phase angle at the various locations in real-time. Such devices are sure to be an essential element of future Smart Grid technology.

What is now required is the development of a system to allow live and archived power system data to be viewed through a web portal.

A student undertaking this project should ideally have experience in web design, Java and/or Flash programming and an understanding of Internet Protocol addressing, routers, web servers, operating systems and general PC hardware. The student will have assistance from research staff in producing the specification for the web portal and for familiarisation with the power systems applications that will use the web portal.

The objective of this project are:

1. Selection of a software environment in which to develop the web portal (Java / Flash or similar)
2. Record live incoming data (UDP packets) to a database accessible from the web portal
3. Create a front end for accessing the data and displaying charts / graphs
4. Create a method of viewing data in real-time
5.

Learning Outcomes

1. Understanding of Power System phasor measurements
2. Knowledge of SMART GRIDS
3. Knowledge of Web programming

MEng Extension

Explore possible techniques for reporting the integrity of data communication with the PMUs

School of Electronics, Electrical Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title: Converter Interface for Photovoltaic and Battery Energy Storage System

Supervisor : Dr Lie Xu

Moderator : Prof. Brendan Fox

Areas : Power Electronics and Energy Systems

Research Cluster : Electric Power and Energy Systems

The power and energy system lab currently has a hybrid generation/storage system which comprises a 1kW wind-turbine (WT), 1kW photovoltaic (PV) panels, a battery bank and a hot water and under floor heating system. The WT charges the battery bank via a DC-DC converter. The energy stored in the battery can be used to heat the hot water and under floor heating system. A DC-AC inverter can also converter back any surplus power to the AC grid. However, due to the voltage difference between the PV and battery system, the PV system has not been used up now.

The aim of this project is to design and build a DC-DC converter suitable for use as the interface between the PV and the battery systems. Thus energy generated by the PV system can be used to charge the battery bank. The objectives of the project are as follows:

1. To study various standard converter topologies which can be used for this application and to select the most suitable one;

2. To design a circuit for controlling the DC-DC converter;

3. Prototype and measurement.

M.Eng. Extensions

1. To implement the system which provides maximum power point tracking of the PV system;

2. System simulation using SIMULINK;

Learning Outcomes

1. Understand how basic power electronics converters operate

2. Hand on experience of building a simple DC/DC converter

3. Basic understanding of how a PV module works.

School of Electronics, Electrical Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title: Control of Doubly-Fed Induction Generator (DFIG)

Supervisor : Dr Lie Xu

Moderator : Dr John Morrow

Areas : Renewable Energy Systems

Research Cluster : Electric Power and Energy Systems

Due to the increased penetration of wind energy, the present and emerging grid connection requirements, or Grid Code, for wind farm connections becomes more and more demanding on the performance of the connection of this renewable form of energy. For a wind farm to be connected to the transmission/distribution network, it must comply with the Grid Code e.g. fault ride through capability, reactive power range, voltage control, frequency range and frequency control, etc. Traditionally, wind turbines were based on fixed speed induction generators (FSIG) whereas most of the newer turbines use doubly-fed induction generator (DFIG) which can potentially contribute to reactive/active power control and provide network support.

The project is aimed at investigating and developing the attributes of a DFIG in order to control the active and reactive power under normal conditions to strengthen the connected network. The main objectives of the project are as follows:

1. To develop a DFIG model including the DFIG and two AC-DC converters, connected to a power network using the power system simulation software Matlab / Simulink;
2. To implement the system control for the DFIG to provide the required active and reactive power control.

M.Eng. Extensions

To extend the above to include the effect of DFIG's active/reactive power flow on the network voltage at the connection point.

Learning Outcomes

1. Experience of using Matlab / Simulink to simulate simple power systems.
2. Understand how DFIG based wind farms are controlled and operated.

School of Electronics, Electrical Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title: Wind Farm Integration Using Static Var Compensator (SVC)

Supervisor : Dr Lie Xu

Moderator : Dr Tim Littler

Areas : Renewable Energy Systems

Research Cluster : Electric Power and Energy Systems

Due to the increased penetration of wind energy, the present and emerging grid connection requirements, or Grid Code, for wind farm connections becomes more and more demanding on the performance of the connection of this renewable form of energy. For a wind farm to be connected to the transmission/distribution network, it must comply with the Grid Code e.g. fault ride through capability, reactive power range, voltage control, frequency range and frequency control, etc.

Although wind turbines using fixed speed induction generators (FSIG) provide a simple, rigid, and cost effective solution, they have difficulties meeting the proposed Grid Code in terms of the reactive power and voltage control requirements. In addition, there is a risk that the FSIG will lose stability during the fault, i.e. transient instability.

Static Var Compensator (SVC) has been widely used for voltage control, system damping control, etc. The proposed project aims at providing cost effective and grid complied connection options for wind farm integration using SVC. The objectives of the project are as follows:

1. To develop wind farm models equipped with FSIG and associated networks using PSCAD/EMTDC software;
2. To develop models of SVC based on the available genetic model;
3. To investigate the use of SVC for providing grid-complied wind farm integration.

M.Eng. Extensions

To extend the above to the use of Voltage Source Converter (VSC) based Static Synchronous Compensator (STATCOM).

Learning Outcomes

1. Experience of using Matlab/Simulink to simulate simple power systems.
2. Understand how wind farms operate and the grid code requirement for connecting them to the power network.
3. Understand how a SVC operates and how it can be used to improve system operation.

SCHOOL OF ELECTRICAL AND ELECRONIC ENGINEERING

FINAL YEAR PROJECTS 2010 - 2011

Title: Measurement of Power System Frequency

Supervisor: Dr. Tim Littler

Moderator: Dr. D. J. Morrow

Areas: Power Systems and Digital Signal Processing

Basic Specification:

The operating frequency of an interconnected AC power system is established by the mechanical operating speed of rotating generators and is normally maintained within strict limits at a nominal frequency of 50 or 60 Hz (depending on geographic location). If generator output is higher than demand, the rotating machines will tend to increase in speed and the frequency will rise, and vice versa. The mechanical speed of rotation is tightly controlled at the generator to ensure accuracy and stability throughout the power system, irrespective of the electrical load. Thus the frequency is not a constant quantity but varies and is continuously monitored by the generating company against standard time-sources. If long-term tendencies to rise or fall are noticed, the control engineers take appropriate action by regulating the generator outputs.

The transmission companies that are fed from the generators independently monitor the power system frequency. The measured frequency is used to assess system stability, power flow, and load variations. The power system frequency is also monitored by distributed frequency protection relays placed at critical load points on the transmission network. The frequency relays are designed to measure the rate of change of frequency (ROCOF) and remove load in the event of frequency transients.

This project will investigate a range of power system frequency measurement methods and implement an optimal algorithm to measure frequency from sinusoidal power waveforms for a range of proposed operating scenarios. The operating scenarios will include: off-nominal frequencies, harmonic distortion, transient distortion, noise components, and incomplete data. The project will require good knowledge of C programming, Matlab, basic digital signal processing and power engineering.

The objectives of this project are to:

1. Investigate a method to measure power system frequency.
2. Develop an algorithm in C or using MATLAB that will measure frequency.
3. Implement a front-end digital filtering scheme using wavelet transforms.
4. Develop a series of test signals for a range of operating scenarios.
5. Test algorithm with front-end digital filtering for the operating scenarios.
6. Investigate ROCOF measurement.
7. Implement real-time measurement of power system frequency.
8. Investigate use of positive sequence component for frequency & ROCOF measurement.

This project would be best suited to a student with an interest in power engineering and software. A high proportion of software programming is expected thus the student should be confident in the use of C/C++ and be capable of generating executable software using an appropriate language.

SCHOOL OF ELECTRICAL AND ELECRONIC ENGINEERING

FINAL YEAR PROJECTS 2010 - 2011

Title: Analysis Tools for Power System Oscillations

Supervisor: Dr. Tim Littler

Moderator: Prof. H. Wang

Areas: Power Systems and Digital Signal Processing

Basic Specification:

Electric power systems are tightly monitored by embedded instrumentation. Local and system wide measurements, often synchronised with GPS precise-time signals, provide parameters which describe the balance of operation between generation and load. Of the many measurements, active power signals provide one source of useful information regarding system stability. Power system networks are coupled in different ways using both AC and DC voltage links. One consequence of interconnection is system - system movement, manifest as oscillations of active power. Measurements of active power reveals background *oscillations, regarded as normal system perturbations, and disturbance events which can give rise to excess oscillation magnitude and lead to system instability if un-dampened.*

This project will investigate and develop time-series analysis tools for power system oscillations. Measured parameters will include amplitude, spectral content, modes and damping. The project will require good knowledge of C programming, Matlab M scripts, power engineering and basic digital signal processing.

The objectives of this project are to:

1. Investigate time-series methods applicable to power system oscillations.
2. Develop algorithms in C or MATLAB to measure particular system parameters.
3. Implement algorithms using related transforms.
4. Develop test signals for different operating scenarios.
5. Test algorithms with test and real signals.
6. Implement a Matlab GUI to encapsulate all analysis tools

This project would be best suited to a student with an interest in power engineering and software. A high proportion of software programming is expected thus the student should be confident in the use of C/C++ and Matlab and be capable of generating executable software using an appropriate language.

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Computer Server Management

Supervisor : Dr Michael Cregan

Moderator : Dr Stuart Ferguson

Areas : Software

Research Cluster : Power and Energy System

Modern businesses rely on computer servers to host shared applications or large data stores. Recent developments in virtualization have enabled a single computer to host many different servers, each running within its own virtual environment but sharing the resources of the host computer.

One such application is OSIsoft 'PI'. This is a data storage computer system used by Microsoft to manage its 'Virtual Cloud' (serve 'farms' dispersed around the world). The software is also used by large utility companies to manage data from power stations, oil pipelines, and transmissions lines. This project will investigate how this software system performs within a virtual environment.

The objectives of the project are :

1. Study the performance of the OSIsoft PI software running within a virtual environment and identify suitable performance monitoring parameters.

2. Investigate OSI PI's compression settings when archiving real-time data and identify settings for optimal performance.

M.Eng. Extensions

1. Investigate other possible compression algorithms for archiving real-time data and compare their performance.

Learning Outcomes

1. Understand computer server visualization.

2. Understand performance monitoring for computer systems.

3. Recognise the difficulties associated with archiving data in real-time.

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Smart Grid Energy Monitor

Supervisor : Dr Michael Cregan

Moderator : Dr Tim Littler

Areas : Electric Power

Research Cluster : Power and Energy System

It is anticipated that 'Smart Grids' will play an important role in addressing the many changes that are impacting electric distribution networks around the world. As the cost of conventional fossil fuel generation continues to increase many utility companies are investing heavily in alternative technologies such as wind generation and smart grids. A 'Smart Grid' is where some form of intelligence is build into the electrical grid to supply energy more efficiently and hence reduce the demand for more generation.

One aspect of the smart grid is the 'Smart Meter'. Which is a device that will allow electricity consumers to make more informed decisions about their electricity usage. For example, how much is this TV, computer …etc costing to run?

Can I reduce my bill if I only use certain machines at night when electricity is cheaper to buy?

The objectives of the project are:

1. Design and construct a simple 'Smart meter' that will measure current usage using a non-contact inductive clamp.
2. Use a microcontroller such as a PIC to interface the current sensor and a LCD display panel.
3. Program the microcontroller to calculate in real time electric power (kW) and energy consumed (kWh) and display this information on the LCD display.

M.Eng. Extensions

1. Incorporate an Ethernet connection in microcontroller circuit to allow simple web access to the data displayed on the LCD.

Learning Outcomes

1. Understand simple current measurement and microcontroller circuits.
2. Develop the skills necessary to program a microcontroller.

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : UK and Ireland Energy Monitoring

Supervisor : Dr Michael Cregan

Moderator : Dr Stuart Ferguson

Areas : Software

Research Cluster : Power and Energy System

As the cost of conventional fossil fuel generation continues to increase many utility companies are investing heavily in alternative technologies such as wind, solar, bio and tidal generation to replace conventional sources of electrical energy. While the UK government may aspire to the lofty goal of 15% of its energy from renewables sources by 2010 the current situation is that less then 1% of electricity demand is generated from renewable sources.

The objectives of the project are:

1. Develop a smart phone application that will aggregate data currently available on the web quantifying the UK and Ireland's electrical demand and renewable generation in real time.
2. Use various charting techniques to display the real-time data graphically.

M.Eng. Extensions

1. Extend the reach of the application to incorporate other European countries were the data is available.

Learning Outcomes

1. Understand and compare various development options that are available for smart phones aplications.
2. Develop the skills necessary to create a simple smart phone application.
3. Understand the various graphical libraries available to present trending real time data.

Intelligent Systems and Control

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title: Optimal Economic Load Dispatch for Power Generation Plants

Supervisor	:	Dr Kang Li
Moderator	:	Prof George W. Irwin
Areas	:	Modelling, Optimization, Power Systems and Plants
Research Cluster	:	Intelligent Systems and Control

Economic dispatch (ED) problem is the process of allocating generation levels to the generating units in the mix so that the system load may be supplied entirely and most economically while meeting the constraints. An optimal load dispatch can help to reduce the waste of primary energy resources and to the pollutant emissions from fossil-fuel power generation plants.

The objectives of the project are:

1. Study and familiarize with the Economic dispatch (ED) problem and understand the problem formulation
2. Investigate a conventional algorithm for optimal load dispatch
3. Apply the algorithm to the load dispatch of a power plant

M.Eng. Extensions

1. Develop an advanced algorithm for Economic dispatch

Learning Outcomes

1. Understand Economic dispatch (ED) problem
2. Be able to apply heuristic tools for constrained optimization problems

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title: Image Classification using Support Vector Machines

Supervisor	:	Dr Kang Li
Moderator	:	Dr Wasif Naeem
Areas	:	Image processing, machine learning
Research Cluster	:	Intelligent Systems and Control

Support Vector Machines (SVMs)], first introduced by Vapnik early in 1990s, are a group of related supervised machine learning algorithms based on statistical learning and widely applied in pattern recognition, regression and density estimation. In this project, SVMs will be applied for image classification which is an important application in many engineering problems.

The objectives of the project are:

1. Study and familiarize with the image processing and classification
2. Study and familiarize with SVMs and new algorithms
3. Apply the algorithm to medical image classification.

M.Eng. Extensions

1. Develop and apply an advanced algorithm for SVM training

Learning Outcomes

1. Understand image classification problem
2. Be able to apply SVMs for image classification

Electrical & Electronic Engineering

FINAL YEAR PROJECT 2010/11

Title: Guidance and Control of an Unmanned Aerial Vehicle

Supervisor: Prof George W Irwin

Second Supervisor: Dr Wasif Naeem

Indexing Terms: Modelling, simulation, control design.

Inexpensive fixed-wing unmanned aerial vehicles (UAVs) have considerable potential for use in remote sensing applications like fire-fighting, land surveying, border surveillance and military operations. The aim of this project is to investigate the guidance and control of a UAV. This will be done using Matlab tools for control design and Simulink for flight evaluation and display.

This will involve the following possible areas of work:

1. General research survey of the UAVs field leading to a classification of those currently available worldwide.
2. A brief investigation of the freely-available Aerosonde UAV platform. This provides a six degree-of freedom model of the flight dynamics to simulate the aircraft motion, coupled to Flightgear, a flight simulation package for visual output.
3. Design, implementation and testing in Simulink of appropriate flight control for different modes of operation such as cruise and take-off landing for a simplified aircraft model.
4. Development of strategies for way-point flight and collision avoidance.

Possible MEng Extensions:

1. Flight control of multiple UAVs

Learning Outcomes

UAVs are a topic of immense interest in the aerospace industry worldwide. The project will provide an opportunity to research the state-of-the art in the field, while gaining experience of dynamical modelling, simulation and flight control. It will be particularly relevant to students studying the Intelligent Systems and Control course where the underlying state-space and modern control concepts will be covered.

Electrical & Electronic Engineering

FINAL YEAR PROJECT 2010/11

Title: State Modelling, Simulation and Linear Quadratic Control of a Chemical Process

Supervisor: Prof George W Irwin

Second Supervisor: Dr Kang Li

Indexing Terms: Modelling, simulation, control design, **process control**

This project will study state-space modelling, simulation and optimal control of a continuous-stirred tank reactor (CSTR). The CSTR is a process plant which is widely used in the chemical, petroleum and food process industries. It represents a highly nonlinear dynamical system, thus presenting a considerable challenge for control design. The aim of this project is to design, implement and test a state-feedback controller for such a plant and to carefully assess its performance against the design specifications.

The project will involve the following steps

1. Brief familiarisation with the CSTR process and its physical model.
2. Development and verification of a suitable CSTR simulator using the Simulink tool and investigation of its open-loop responses to a range of step changes in coolant flow rates
3. Derivation and checking of a linear state-space model for control design at a selected equilibrium point.
4. Design of a linear quadratic (LQ) optimal controller for linear CSTR representation to meet a given specification
5. Implementation and testing of the LQ controller on the nonlinear process to step demands in product concentration
6. Investigation of the robustness of the feedback control law to external disturbances

Possible Extensions:

1. Output feedback control design and the role of an observer.

Learning Outcomes

1. How to use the Simulink tool to simulate a nonlinear dynamical system
2. Understand how to derive a linear mathematical model for control desin
3. Be able to employ Matlab for CAD of a linear quadratic state-feedback controller
4. Greater understanding of the differences between nonlinear and linear dynamical systems and their control

Projects 2010/2011

Motion Capture Module for Virtools

==========

This aim of this project is to develop a plug-in Building Block (BB) module for the Virtools virtual reality and computer game development environment that will acquire position and orientation information from a motion capture system and blend it onto an animated character in real-time. The Motion-Star motion capture system will acquire data from 8 magnetic sensors and broadcast it to the host system running Virtools using the UDP protocol.

The Virtools BB will require to receive this data, apply it to an selection of bipedal characters and collect a sequence of motions such as, walking running, picking something up.

Programming will be in C++ using MSVC as the development tool under the Windows operating system.

Keywords: Motion Capture, Computer Gaming, Robotics, Computer Interfacing, Communications, Software Engineering, Graphics

Project Supervisors Dr. R.S. Ferguson. / Dr. TBC

Projects 2010/11

Evaluation of 'Smart-Phone' SDKs

==========

This aim of this project is to evaluate the Symbian and Android development platforms used to build applications for use on mobile smart-phones.

The project will require the installation of the SDKs and their evaluation, including their emulation environments. The evaluation should determine:

1. Ease of use
2. Features
3. Stability
4. Communications APIs e.g. Bluetooth
5. Hardware interface capabilities, e.g. Serial or USB or 8.2011 wireless.
6. Suitability for use as a graphical output device, e.g. speed of graphics, 3D movies, etc.

Several small demonstrator applications should be written along with running the SDKs own examples.

Keywords: Software Engineering, Computer Interfacing, Communications, , Graphics

Project Supervisor Dr. R.S. Ferguson.

Moderator: TBC

Projects 2010/2011

Robot Motion Planner

==========

This aim of this project is to develop a program that will specify and represent using 3D graphics ,the individual linkage angles in a 7 axis robotic system so that the end effector can take up a given orientation and position.

This will be done using Inverse Kinematics. (Cyclic descent algorithm)

Programming will be in C++ using MSVC as the development tool under the Windows operating system with OpenGL graphics..

Keywords: Robotics, Computer Interfacing, Communications, Software Engineering, Multimedia, Graphics Audio

Project Supervisor Dr. R.S. Ferguson.

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Motion Planning Algorithms for Maritime Vehicles

Supervisor : Dr Wasif Naeem

Moderator : Prof George W Irwin

Areas : Intelligent Systems and Control

Unmanned marine vehicles are now being used in a variety of tasks such as pollution tracking, surveillance operations and mines clearing to name a few. It is imperative that the vessel is able to navigate freely to accomplish a task with minimum or no human intervention. A reliable guidance strategy is thus vital for safe navigation of the craft. Hence the aim of this project is to review and develop motion planning algorithms for uninhabited marine vessels in an obstacle laden environment. Another objective is to integrate this algorithm with COLREGs rules on prevention of collision at sea which are equivalent to the rules of the road for automobiles.

The objectives of the project are:

1. Review various motion planning strategies for marine vehicles

2. Formulate an optimal motion planning algorithm for marine vehicles involving stationary obstacles

3. Integrate the above algorithm with a suitable controller and carry out extensive simulation analysis

M.Eng. Extensions

1. Enhance the motion planning algorithm to take into account of dynamic obstacles

2. Integrate and simulate the above algorithm with COLREGs rules

Learning Outcomes

1. Be able to use Matlab for simulation analysis
2. Be able to understand and analyse navigation, guidance and control systems design

3. Be able to design guidance and control strategies for unmanned systems

School of Electrical and Electronic Engineering and Computer Science

FINAL YEAR PROJECT 2010/2011

Title : Simultaneous Localisation and Mapping through Visual Servoing

Supervisor : Dr Wasif Naeem

Moderator : Dr Kang Li

Areas : Intelligent Systems and Control

Unmanned vehicles or robots are required to move freely with a degree of awareness of their surroundings. This is necessary so that a robot does not collide with obstacles in the path which could physically damage the onboard components. Various sensors can be used to detect an object such as infrared or ultrasonic based detectors. In this project, a camera mounted on a pan and tilt (PT) platform will be utilised for mapping the environment. Image processing techniques will be employed to *sense* the presence and identify the object in front of the vehicle. Knowledge of Visual C or OpenCV will be required (or may be gained for the enthusiast) to successfully carry out the objectives of the project which are as follows:

1. Study and familiarize with the operation of a vision based PT platform
2. Review image processing algorithms for object identification
3. Design a simple controller for the PT platform with manual reference commands

M.Eng. Extensions

1. Develop and implement a simple identification algorithm
2. Design a closed-loop controller for the PT platform with feedback from the vision sensor

Learning Outcomes

1. Understanding of closed-loop control systems
2. Be able to understand and employ a vision-based feedback controller
3. Understanding of image processing algorithms for object identification

Digital Communications

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : High-Speed bit-loading algorithms for Dynamic Spectrum Management in ADSL

Student: **Andrew Bolster**

Supervisor : Prof A Marshall

Moderator : Dr J McAllister

Areas : Digital Comms

Research Cluster : Digital Comms

Digital subscriber lines need to employ bit-loading techniques to improve their throughput; this is known as “Dynamic Spectrum Management” (DSM). Currently all implementations of DSM use level 1 whereby individual lines use a “waterfilling” algorithm to adjust the power allocated to each tone in the spectrum, and a central management station adjusts the waterfilling parameters for each line in the subscriber bundle. However this approach is sub-optimal whenever the capacity of the overall bundle is considered, hence more recent research has proposed (level 2) more intelligent methods to allocate the power for each bit in each tone, considering both near and far end crosstalk in the bundle. A major problem with the level 2 techniques is their computational complexity which currently renders them practically infeasible, e.g. ISB typically takes > 1 week to compute the tones for a 10-line bundle.Graphic Processing Units (GPUs) represent a new approach to massively parallel floating-point computations. Moreover the Compute Unified Device Architecture (CUDA) developed by NVidia, represents a framework whereby new highly parallel algorithms can be developed. The main aim of this project is to apply this approach to level 2 DSM algorithms, many of which are highly parallel in their operation.

The objectives of the project are:

1. Become familiar with DSM techniques for digital subscriber lines.
2. Become familiar with the CUDA environment for GPUs and identify a suitable platform
3. Investigate efficient implementations of level 2 DSM.
4. Develop an implementation of a level 2 bit-loading algorithm using GPUs.

M.Eng. Extensions

1. Analyse the performance of your implementation in terms of speed, cost and scalability (number of lines).
2. Compare your design with existing implementations.

Learning Outcomes

1. Understand how to use CUDA to programme GPUs.
2. Be able to design bit-loading algorithms for DMT.
3. How to analyse the performance of an implementation.
4.

School of Electrical, Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Website fingerprinting

Supervisor : Prof A Marshall

Moderator :

Areas : Digital Comms

Research Cluster : Digital Comms

An Internet user today has access to over a trillion web pages and thousands more websites are being added every day. Due to the decentralized and unregulated nature of how domain names are issued, and the low cost of web hosting, it has become extremely simple for anyone to buy a domain name and host a website on their own. The ease of implementing this has greatly benefited the growth of internet, but it has also meant that anyone can create a fraudulent website with content and URL's stolen from existing genuine websites. These can then be used to extract valuable personal information from clients.The essential problem is that the site domain name, the look and feel of the content, and at times the lock icon (digital certificate) are the ONLY elements used to establish the identity of a website. There are 3 problems with this: (i) Due to the insecure internet infrastructure a user cannot be certain that the address typed in the browser is taking the user to the intended site every time. An unsuspecting web user can end up at a fraudulent (fake) site, where the user might end up giving the credentials to the fraudster, causing immense damage thereafter. (ii) Obfuscated URLs such as http://trustedbank.x.com can cheat the user into believing they are at the authentic website. (iiI) Most users do not know what to check in a digital certificate, as the enterprise never communicates the same to the user. By the time the fake website is blacklisted, victims would have already lost money to fraud. One approach to solving this problem is to identify certain websites by analysis of the traffic the produce when downloading their pages, metrics such as the files sizes contained in a web page and number of connections used by it can be used to create a "fingerprint" of the site which remains reasonably constant over a period of time.

The objectives of the project are:

1. Become familiar with website techniques used to fingerprint websites.
2. Develop a website fingerprinting system and create a repository of a selected number of websites.
3. Create one or more fake websites using the test network in the Advanced Networks Laboratory, and use your fingerprinting system to detect these.

M.Eng. Extensions

1. Analyse the performance of your fingerprinting system in terms of accuracy of detection, (false alarms false positives etc), speed, cost and scalability (number of wesites).
2. Compare your design with existing implementations.

Learning Outcomes

1. Understand how websites are created and deployed.
2. Be able to system to detect rogue websites.
3. How to analyse the performance of an implementation.

SCHOOL OF ELECTRICAL & ELECTRONIC ENGINEERING

PROJECTS 2010/2011

Title: Blind signal detection in 2 channel multiple-input multiple-output (MIMO) communications.

Supervisor: Dr Victoria Stewart

Moderator: Prof C Cowan

Areas: Digital Signal Processing

Basic Specification:

On of the most significant techniques to arise in the area of digital communications in recent years is the use of multi-input, multi-output systems to vastly increase the capacity of through-air communications. These systems are limited (in the case of mobile comms.) to the 2 channel case because of practical considerations. It is fairly simple to structure such receivers in the case of the existence of training signals, however this is wasteful of bandwidth. The objective of this project is to demonstrate the use of a blind space-time adaptive receiver which does not require the use of training by using a decorrelation based objective function in a 2-channel adaptive structure.

The objectives of this project are to:

1. Become familiar with the basic ideas behind MIMO systems and basic space-time adaptive structures.
2. Become familiar with the MatLab simulation environment.
3. Produce a simulation of a 2 channel communications environment which allows full control of the multipath environment in each channel and noise conditions.
4. Produce a simulation of a space-time receiver which makes use of explicit training and evaluate this in various multipath and noise conditions.
5. Become familiar with the ideas behind decorrelation based blind source separation.
6. Implement a simulation which incorporates blind separation into 4 and evaluate.

SCHOOL OF ELECTRICAL & ELECTRONIC ENGINEERING

PROJECTS 2010/2011

Title: Tracking of highly time variant channels in a mobile communications environment.

Supervisor: Dr Victoria Stewart

Moderator: Prof C Cowan

Areas: Digital Signal Processing

Basic Specification:

A fundamental problem in the application of mobile communications is that of multipath causing intersymbol interference (ISI). This can make the received information impossible to detect with acceptable accuracy. The traditional approach to combat this problem is to deploy a linear adaptive equalizer, which proves to be successful as long as the channel concerned does not change too quickly with time. However, in the real-world environment rapid time-variations in the mobile channel can easily occur, leading to mis-convergence of the equalizer and, therefore, failure of the link. The main objective of this project will be to examine time-variant tolerant adaptive structures which are simple enough to facilitate high speed implementation. These structures will take advantage of the duality between non-stationarity and non-linearity by using an amplitude sensitive structure.

The objectives of this project are to:

1. Become familiar with the Matlab DSP simulation environment.
2. Produce a simulation of a simple communications channel which incorporates time-variant multipath elements.
3. Introduce an equaliser controlled by a simple LMS algorithm which is capable of compensating for a time-invariant channel.
4. Evaluate the performance of this equalizer for various degrees of time variation in the channel.
5. Introduce the amplitude sensitive structure and evaluate performance when coefficient selection is controlled by either instantaneous, or averaged, sample amplitudes.

M.Eng extensions:

1. Extend the model to modulation formats greater than binary.
2. Examine the potential to do channel modeling as opposed to equalization.
3. Apply to decision feedback equalization.

School of Electrical and Electronic Engineering

B. Eng / M. Eng Project 2010/2011

Title: Spectrum sensing and interference management for cognitive radio

Supervisor: Dr Tharm Ratnarajah

Moderator: Dr Mathini Sellathurai

Areas: Digital Communications

Basic Specification:

Although there is a high demand for wireless internet services, radio resources such as bandwidth spectrum and transmit power are often scarce. Hence, both power and spectrally efficient techniques are major design objectives for next generation wireless networks. The concept of dynamic spectrum licensing or Cognitive Radio (CR) is one solution to address the spectrally inefficiency of the existing wireless communication systems. The basic operating principle of CR relies on a radio being able to sense whether a particular band is being used or not and, to utilize the spectrum without interfering with the transmission of other licensed users. If the licensed user of the band starts transmission, the radio jumps to another band, or stays in the same band, altering its transmission scheme or transmission power to avoid interference.

The objective of this project is to review and compare the performance of existing spectrum sensing and interference management techniques.

M.Eng Extension:

To propose a new techniques to efficiently manage the spectrum and interference which perform better than the existing techniques.

School of Electronics, Electrical Engineering and Computer Science

FINAL YEAR PROJECT 2010/2011

Title: **Portable Quadrature Measurement Receiver**
Supervisor: Professor W. G. Scanlon
Moderator: Dr S. L. Cotton
Areas: Wireless Communications Research Group (Digital Communications)

Specification:

Recent work at QUB has pioneered ultra-portable channel sounding for narrowband systems at frequencies up to 3 GHz (see http://www.ee.qub.ac.uk/wireless/papers/fullpubs.pdf for a full list of recent publications with weblinks as appropriate). However, one of the limitations of the existing work is that it is based on RF power measurement and so only amplitude information is retained, whereas many applications require information about the phase of the received signal. Therefore, the aim of this work is to develop portable (preferably wearable) quadrature (I/Q) receiver based on off-the-shelf RF integrated circuits. The receiver should have sufficient sensitivity and dynamic range to be useful for channel characterisation and the power consumption should be sufficiently low to allow for battery operation.

The project objectives are:

- Investigate and source quadrature receiver integrated circuits and components.
- Using either evaluation boards or your own circuit design, determine the sensitivity, dynamic range and energy consumption performance of the baseline receiver.
- Develop an enhanced receiver module, including additional RF low noise amplification if required.
- Fully characterise the final I/Q receiver module.
- Integrate the receiver with an off-the-shelf data acquisition module (a commercial device with analogue to digital convertor with SD-card storage).

School of Electronics, Electrical Engineering and Computer Science

FINAL YEAR PROJECT 2010/2011

Title: Wireless fall detection for ambient assisted living

Supervisor: Professor W. G. Scanlon
Moderator: Dr S. L. Cotton
Areas: Wireless Communications Research Group (Digital Communications)

Specification:

With an increasingly aging population and a general move to 'in-home' care of vulnerable groups such as the elderly it is important to develop assistive technologies that will improve the quality of care provided. There are a number of wireless "call" systems available on the market and some of them offer automatic fall detection, often based on accelerometer-based sensing. This project is aimed at developing a lower-cost, lower-power consumption solution for fall detection that uses the wireless data connection itself to indicate a possible event.
The project is associated with the Wireless Communications Research Group (www.ee.qub.ac.uk/wireless/) at the Institute for Electronics, Communications and IT (www.ecit.qub.ac.uk) and is in collaboration with ACT-Wireless, a local start-up company working on assured communication technologies.

The project objectives are:

- Investigate current fall detection alarms for home-care and sheltered housing applications.
- Develop an understanding of indoor wireless channel characteristics including human body effects.
- Using off-the-shelf wireless modules, develop a test system for fall detection.
- Conduct a wide range of controlled measurements in a home environment.
- Develop suitable algorithms to be able to indicate possible falls using only received signal strength information.
- Compare the effectiveness and accuracy of both signal strength and accelerometer techniques.
- Time permitting, use radiowave propagation simulation tools to investigate additional aspects of the problem, e.g. vary the basestation position, different room dimensions.

School of Electronics, Electrical Engineering and Computer Science

FINAL YEAR PROJECT 2010/2011

Title: **Integrated Datalogging Receiver for Wireless Channel Sounding**
Supervisor: Professor W. G. Scanlon
Moderator: Dr S. L. Cotton
Areas: Wireless Communications Research Group (Digital Communications)

Specification:

Many emerging areas of mobile communications such as Vehicle-to-Vehicle (VTV) systems and wireless body area networking (WBAN) require statistical characterisation of the radio channel under dynamic conditions. Furthermore, the equipment used in conventional channel measurement systems such as sliding correlator and vector network analysis is not particularly portable and often not suitable for compact device studies. Recent work at QUB (see http://www.ee.qub.ac.uk/wireless/papers/fullpubs.pdf for a full list of recent publications with weblinks as appropriate) has pioneered ultra-portable channel sounding for narrowband systems at frequencies up to 3 GHz.
However, the existing measurement system uses receivers with limited sampling rate. Therefore, the aim of this work is to re-develop the existing 2.45 GHz datalogging receivers, improving both the power-consumption and the available sampling rate. The RF portion of the receiver will be based on the existing system but there are opportunities for a re-design to improve both sensitivity and dynamic range. Furthermore, extensive field trialling of the receivers will be required, if possible in VTV or WBAN scenarios.

The project objectives are:

- Understand and evaluate the existing 2.45 GHz receiver design. If appropriate, suggest design changes to improve performance.
- Investigate and select a low-power microcontroller for the new datalogger portion, to include mass storage, min. 12-bit ADC.
- Using the existing RF boards, prototype the datalogger, verify the power consumption and demonstrate the limitations on sampling rate.
- Perform extensive dynamic (mobile) testing of the datalogger prototype in conjunction with the transmitter project and/or other RF sources available in ECIT.
- Evaluate the field performance of the new datalogger and make recommendations for future development (e.g. 2.45 GHz re-design).

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Predicting the complex 3D movements for robotic/prosthetic arms

Supervisor : Dr Mathini Sellathurai

Moderator : Prof. Colin Cowan

Areas : Digital Communications

This project will focus on predicting 3-D trajectories of robotic/prosthetic arm movements based on measurements obtained using sensing and network informed intelligent (cognitive) prosthetic/robotic upper limb functions. Emphasis will be upon real time signal processing issues of time series captured by virtual environment (VE) and providing a solution capable of adaptation for various applications and over time.

The objectives of the project are:

1. Study the 3-D trajectory focusing the kinematics and joint synergies using minimum Angular jerk method.

2. Develop a Minimum Angular Jerk (MAJ) method processor in Matlab or simulink to analyse the guided limb movement captured as VE time series.

3. Analyse how the different sets of kinematic error variables change between learned and novel sequences of individual stroke subjects.

M.Eng/MSc Extensions

Produce a simple demonstrator of cognitive limb/robotic arm design based on the analysis in using game theory.

Learning Outcomes

1. Understand MAJ and game theory, virtual reality, time series and basic signal processing.
2. Functional and connectivity analysis of the brain and cognitive science and other methods and correlating those studies with assessment of movement.
3. Good exposure to robotics, biomedical engineering and telemedicine.

School of Electrical and Electronic Engineering

The Queen's University of Belfast

Final Year Project 2010/2011

Game theoretic models and its applications in cognitive wireless networks

Supervisor: Dr Mathini Sellathurai

Moderator: Prof. CFN Cowan

Areas: Digital Communications

Basic Specification:

Game theory consists of a set of analytical tools to predict the outcome of complex interactions or games among rational entities and the notion of equilibrium is achieved in game theory by playing a best response to actions of other players which is given by the solution of Nash equilibrium to a game involving two or more players discovered by John F. Nash. In this project, we will investigate a new game theory model to include learning based on non-cooperative games with direct application to the emerging field of cognitive radio. This project is also model the adaptive transmit power control and spectrum hole selection between users/nodes in a wireless network viewing the problem as game theory and learning problem with emphasis on the Nash equilibrium.

The objectives of the project are:

1. Study the fundamentals of game theory and Nash equilibrium.
2. Develop a method of simulating transmit power control using game theory
3. Produce a simple demonstrator of the above.

M.Eng/MSc. Extensions

Develop adaptive transmit power control between users/nodes in a wireless network viewing the problem as game theory and learning problem with emphasis on the Nash equilibrium.

Learning Outcomes

1. Understand wireless network and game theory
2. Be able to design a wireless network systems
3. Good exposure to future cognitive radio based communications

School of Electrical and Electronic Engineering and Computer Science

FINAL YEAR PROJECT 2010/2011

Title : Simulating Digital Communications Systems and Cellular Phones

Supervisor : Dr Mathini Sellathurai

Moderator : Prof. CFN Cowan

Areas : Digital Communications

This project will give an opportunity to learn and program a complete digital communication system. The focus will be on 3GPP Long Term Evolution (LTE) standard - a complete wireless transceiver will be programmed using MATLAB.

The objectives of the project are:

1. Study the fundamentals building blocks of a communication system.
2. Develop a method for simulating base-station and mobile station algorithms.
3. Write MATLAB code for Turbo coder and decoder

M.Eng/MSc. Extensions

Produce a simple demonstrator for 3GPP LTE transceiver

Learning Outcomes

1. Understand elements of digital communication systems.
2. Be able to design classical error correction codes.
3. Good exposure to 3GPP LTE.

School of Electrical and Electronic Engineering

B.Eng / M.Eng Project 2010/2011

Title: Sensor Data Traffic

Supervisor: Dr Emi Garcia

Moderator: TBA

Areas: Telecommunications

Cluster: Digital Communications

Basic Specification:

The aim of the project is to monitor the traffic generated by applications in a sensor network environment. A range of applications with different bandwidth and latency requirements will be considered for monitoring; they may include for example data acquired from fixed and wireless sensors. Traffic will then captured and characterised and classified according to its profile.

The objectives of this project are to:

1. To prepare a sensor data acquisition test case and testbed
2. To study existing tools for capturing traffic from this testbed
3. To monitor such traffic and to capture traffic samples

MEng Extension:

1. To perform an accurate analysis of captured traffic samples
2. To produce recommendations on how to classify traffic according to observations

Learning Outcomes:

1. To use traffic monitoring tools for sensor networks
2. Be able to understand sensor technologies and applications
3. How to perform analysis of captured samples

School of Electrical and Electronic Engineering
B.Eng / M.Eng Project 2010/2011

Title: Video Traffic Classification

Supervisor: Dr Emi Garcia

Moderator: TBA

Areas: Telecommunications

Cluster: Digital Communications

Basic Specification:

The aim of the project is to characterize the traffic generated by access to high bandwidth internet applications (mainly video). This include video uploads / downloads (non real time buffered MPEG video), real time video (video conferencing), video file sharing and short video clips (i.e. YouTube video).
In order to complete this project, you need to have knowledge of C++ programming and some interest in statistics in order to analyse traffic samples.

The objectives of this project are to:

1. To study existing applications (P2P video, You Tube video) as well as associated protocols and standards.
2. To capture video samples of relevant applications
3. To perform an accurate analysis of these samples

MEng Extension:

1. To perform an accurate statistical analysis of captured traffic samples
2. To produce recommendations for network providers based on traffic observations

Learning Outcomes:

1. Understand how to use traffic analysers: TCPDump, Wireshark, etc.
2. Be able to understand applications, standards and protocol behaviour: P2P, MPEG
3. How to perform statistical analysis of captured data and find discrepancies in the data.

School of Electrical and Electronic Engineering

B.Eng / M.Eng Project 2010/2011

Title: Wireless Traffic Monitoring

Supervisor: Dr Emi Garcia

Moderator: TBA

Areas: Telecommunications

Cluster: Digital Communications

Basic Specification:

The aim of the project is to monitor the traffic generated by access to applications in a wireless environment (e.g. 802.11 WLANs in infrastructure or AdHoc mode). Applications monitored will include Mulitmedia and Peer to Peer applications (e.g. file transfers, video uploads / downloads, music download, file sharing etc). In order to complete this project, you need to have knowledge of C++ programming and some interest in statistics in order to analyse traffic samples.

The objectives of this project are to:

1. To study existing tools for capturing traffic in a wireless environment
2. To monitor traffic from wireless applications and to capture traffic samples
3. To perform an accurate analysis of these samples

MEng Extension:

1. To perform an accurate statistical analysis of captured traffic samples
2. To produce recommendations on how to classify traffic according to observations

Learning Outcomes:

1. To use traffic monitoring tools for wireless networks
2. Be able to understand wireless applications and protocol behaviour: P2P, VoIP, HTTP.
3. How to perform statistical analysis of captured samples

Systems-on-Chip

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Malicious Traffic Generator

Supervisor : Dr Sakir Sezer

Moderator : Dr Paul Miller

Areas : Network security

Research Cluster : SoC / CSIT

The Internet has become a feeding ground for criminals to pollute systems, extract personal data, and launch widespread attacks. Such malicious behaviour has moved on from being initiated by hackers for 'fun' to being used by criminal organisations in activities such as fraud and extortion. There is increasing pressure for this type of activity to be dealt with in the 'core' of the network rather than at the end points. Strong advances have been made in the development of strategies to detect such attacks across high speed networks however these techniques require testing. This project aims to develop a traffic generator than can be used to produce 'real' malicious activity for a test environment.

The objectives of the project are:

1. Investigate and analyse the threats that are present on the modern Internet
2. Determine the syntax of key threats
3. Model and simulate such threats
4. Develop a system that can generate malicious packet flows

M.Eng. Extensions

1. Market analysis of IP traffic generator tools and technologies

2. Experimental results using CSIT traffic analysis tool ITACA

Learning Outcomes

1. Understand network security related threats

2. Be able to design a software tool

3. Understand how deploy security technology within life IP networks

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Implementation of a Traffic Statistics Computation Circuit

Supervisor : Dr Sakir Sezer

Moderator : Dr Kieran McLaughlin

Areas : Network Security

Research Cluster : SoC / CSIT

Botnets are networks of computers infected with malware (bots) that can be remotely controlled by individuals with criminal intent, without the knowledge of the computers' owners. Botnets are used for large scale malicious attacks (Distributed Denial of Service "DDoS" attacks) or for various criminal activities, including the generation of spam e-mails, identity theft and the alteration or destruction of stored data/information. In recent years Botnets have evolved significantly and are now a serious threat.

The objectives of the project are:

1. Investigate essential and desirable IP traffic statistics for botnet and malware detection (e.g. packet size, packet interarrival time, etc.).

2. Investigate methods for run-time capture of traffic statistics.

3. Develop an Internet traffic statistic computation circuit using FPGA technology.

M.Eng. Extensions

1. Market analysis of IP traffic capture tools and technologies

2. Experimental results using captured malware traffic

Learning Outcomes

1. Understand network security related threats

2. Understand botnets and botnet command and control communication

3. Be able to design a complex Hardware circuit using VHDL

School of Electrical and Electronic Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Design and Implementation of a real-time IP traffic anomaly detection plug-in for ITACA

Supervisor : Dr Sakir Sezer

Moderator : Dr Emi Garcia

Areas : Network Security

Research Cluster : SoC / CSIT

Botnets are networks of computers infected with malware (bots) that can be remotely controlled by individuals with criminal intent, without the knowledge of the computers' owners. Botnets are used for large scale malicious attacks (Distributed Denial of Service "DDoS" attacks) or for various criminal activities, including the generation of spam e-mails, identity theft and the alteration or destruction of stored data/information. Emerging threats based on evolving malware uses several methods of obfuscation. Robust malware detection systems require several methods in parallel, combining complex traffic content and behavioural analysis techniques.

The objectives of the project are:

1. To investigate IP traffic anomaly detection algorithms based on Bayesian statistics.
2. To design and implement the chosen anomaly detection algorithm as a "plug-in" in C++ for the CSIT traffic analysis tool called ITACA.
3. To improve the performance of your implementation using parallel programming and multithreading techniques
4. To evaluate the real-time throughput performance of your design using contaminated IP traffic samples

M.Eng. Extensions

1. A survey of IP traffic anomaly detection algorithms

Learning Outcomes

1. Understand network security related threats

2. Understand anomaly detection based intrusion detection methods

3. Be able to design a software tool

School of Electronics, Electrical Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Security of Video Surveillance Systems

Supervisor : Dr Máire O'Neill

Moderator : TBD

Areas : Data Security/Communications

Research Cluster : System-on-Chip

Video surveillance systems are crucial in protecting critical infrastructures. While there are numerous advantages associated with IP-based video surveillance systems, they are exposed to new security threats. Security is a critical factor in making such systems practical and employable. Video streams and control data should be secured and raw data should only be present at sensors and at the computing units with authorised access. Only authorised personnel should be able to access video content and send control data to video capture units. In addition, all security and access control protocols need to be scalable.

The objectives of the project are:

- To become familiar with the basics of data security and IP-based video surveillance techniques.
- To study current state-of-the-art in video surveillance security systems
- To propose a security scheme that provides data integrity and confidentiality to video communications in video surveillance systems.

M.Eng. Extensions

- To propose a scalable security scheme for video surveillance encryption.
- To investigate high-speed encryption architectures to protect real-time video streams.

Learning Outcomes

After completing this final year project, you will:

- Understand security techniques that provide data integrity and confidentiality
- Understand the privacy requirements of IP-based video surveillance systems

School of Electronics, Electrical Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Lightweight Digital Design of SHA-3 Candidate Algorithm
Supervisor : Dr Máire O'Neill

Moderator : TBD

Areas : Data Security/Communications

Research Cluster : System-on-Chip

Security is of paramount importance to the design of modern communication systems. However, it is very difficult to provide security in resource constrained applications such as RFID, due to constraints on power, area and memory. Hash functions are used to ensure the integrity of a message. A hash function transforms a variable-length message into a much shorter fixed length output. This project involves an investigation into the design of a lightweight hardware architecture of Keccak, one of the current SHA-3 contest candidate algorithms.

The objectives of the project are:

- To become familiar with the basics of cryptography and in particular hash functions
- To study the Keccak hash algorithm in detail
- To design a low power, low area Keccak architecture
- To carry out a hardware implementation of Keccak on an FPGA device
- To provide a comparison of your design with similar previous research

M.Eng. Extensions

- To perform power analysis of the Keccak architecture using the Xilinx XPower tool

Learning Outcomes

After completing this final year project, you will be able to:

- Understand the FPGA design flow
- Describe circuit designs in VHDL
- Use digital design tools to implement and analyse hardware architectures

School of Electronics, Electrical Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Cracking the Advanced Encryption Standard Using Power Analysis

Supervisor : Dr Máire O'Neill

Moderator : TBD

Areas : Data Security/Communications

Research Cluster : System-on-Chip

Electronic cryptographic devices are widely used in embedded systems to secure sensitive information. Such devices store the secret key that is used in conjunction with the cryptographic algorithm, as part of the hardware implementation, which prevents access to the key by unauthorized software. However, the information processed by circuits can be leaked via physical characteristics of the device, such as power consumption, electromagnetic emanation, timing, etc. These techniques are known as Side-Channel Attacks (SCA). One of the most effective attacks is Differential Power Analysis (DPA), which involves analysing the instantaneous power consumption of a cryptographic implementation to reveal the key.

The objectives of this project are:

- To become familiar with the Advanced Encryption Standard (AES) algorithm and power analysis attack techniques.
- To understand how to attack AES using a DPA attack
- To extend an existing experimental platform to show how an AES key entered manually can be cracked using a power analysis attack.

M.Eng. Extensions

- To propose a countermeasure to defend against power analysis attacks of AES.

Learning Outcomes

After completing this final year project, you will be able to:

- Understand how to attack an encryption algorithm using power analysis attacks
- Understand techniques that can be used to defend against power analysis attacks.

Electrical & Electronic Engineering Projects 2010/2011

Title: Rapid Synthesis of High Performance FPGA-based Matrix Operations

Supervisor: Dr. John McAllister

Moderator:

Area: SoC

Basic Specification

The latest generation of embedded media processing devices, including Field Programmable Gate Array (FPGA), are capable of implementing exceptionally high performance DSP algorithms, but the VHDL-based development routes for these systems is arduous in the extreme.

A new generation of design tools promise to solve this problem by synthesising high performance FPGA-based circuit architectures directly from MATLAB descriptions. In this project we will apply one such tool, Accelchip, to implementation of high performance matrix operations on FPGA.

The objectives of this project are to:

1. Become familiar with the Accelchip FPGA synthesis systems

2. Develop Matlab expressions of two matrix operations:
    a. A Fast Fourier Transform
    b. A matrix multiplication

3. Synthesis FPGA implementations of these programs using Accelchip.

4. Use Accelchip to optimise the implementations.

5. Evaluate the effectiveness of the results.

MEng Extension:

1. Using the effective route identified above, synthesis a motion estimation operator for a frame of video data.

Electrical & Electronic Engineering Projects 2010/2011

Title: Rapid Synthesis of High Performance FPGA-based Matrix Operations

Supervisor: Dr. John McAllister

Moderator:

Area: SoC

Basic Specification

The latest generation of embedded media processing devices, including Field Programmable Gate Array (FPGA), are capable of implementing exceptionally high performance DSP algorithms, but the VHDL-based development routes for these systems is arduous in the extreme.

A new generation of design tools promise to solve this problem by synthesising high performance FPGA-based circuit architectures directly from C descriptions. In this project we will apply one such tool, CatapultC, to implementation of high performance matrix operations on FPGA.

The objectives of this project are to:

1. Become familiar the CatapultC FPGA synthesis systems

2. Develop C expressions of two matrix operations:
    a. A Fast Fourier Transform
    b. A matrix multiplication

3. Synthesis FPGA implementations of these programs using CatapultC.

4. Use CatapultC to optimise the implementations.

5. Evaluate the effectiveness of the results.

MEng Extension:

1. Using the effective route identified above, synthesis a motion estimation operator for a frame of video data.

Electrical & Electronic Engineering Projects 2010/2011

Title: SystemC-Based Modelling of Network-On-Chip (NoC) Communication Architectures

Supervisor: Dr. John McAllister

Moderator: Prof. Alan Marshall

Area: SoC/DigiComms

Basic Specification

The scale and complexity of single-chip embedded device architectures is such that they are moving beyond the standard single-processor, bus-based architecture style which has pervaded computing systems for the majority of the last forty years. In the new multi-core system arena, it is critical that inter-processor communications structures are scalable to incorporate the ever-growing number of processing units (which is currently doubling every 18 months).

This scenario has motivated the evolution of Network-on-Chip (NoC) technology, where large numbers of computing stations (processors) communicate via a lightweight packet switched communications infrastructure.

There are a number of excellent candidate technologies to enable these NoCs. The purpose of this project is to build a library of components which may be combined into arbitrary network topologies for NoC networks, and test the real-time processing capabilities of a number of such topologies under a variety of operating conditions. This is to be entirely conducted in the SystemC modelling language.

The objectives of this project are to:

1. Survey NOC and embedded multiprocessor communication architectures.

2. Abstract the major components of these architectures and create generic SystemC modules representing these components.

3. Develop at least two sample testbeds representing typical NOC network architectures.

4. Characterise the real-time behaviour of the architectures from 3 as the number of end points and characteristics of their traffic varies.

MEng Extension:

1. Extend the analysis of 4 to include behaviours representative of different network end points.

DSP & Telecommunications (Software)

School of Electronics, Electrical Engineering and Computer Science
BENG FINAL YEAR PROJECT 2010/2011

Title : Development of design examples using the ARM embedded programming system

Supervisor : Prof. R. Woods

Moderator : Dr. R. S. Ferguson

Areas : DSP and Telecommunications (software)

ARM Ltd. Is the most commonly used processor in mobile phones and has been probably been the major UK success in the semiconductor arena. To make the technology more usable, they have developed the NXP Cortex-M0 based LPC1100 microcontroller, a simple, single processor computing platform that can be programmed from the web. Information can be found at the ARM University website (http://www.arm.com/support/university/index.php).

The purpose of the project is to investigate the programming platform and develop some new examples on the platform, mostly web-based which can be used for demonstrating the technology to new students.

The objectives of the project are:

1. Familiarization with the ARM processing platform and programming environment.
2. Set up the system for use via the web or in the first instance via a PC.
3. Derive a simple processing example to demonstrate the technology.
4. Develop and programme the example using the technology.
5. Create a full demonstration
6. Create a full programming environment and notes for future use or develop more advanced examples.

Learning Outcomes

1. In-depth study into a modern, high usable programming technology.
2. Understanding of advanced programming tools.
3. Application of programming techniques to real examples.

School of Electronics, Electrical Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Integration techniques for inclusion of intellectual property cores

Supervisor : Prof. R. Woods

Moderator : Dr. J. McAllister

Areas : DSP and Telecommunications (hardware/software)

The past few years has seen the evolution of intellectual property (IP) cores to help alleviate the design productivity problem created by the continuously evolving silicon technology. Companies will look to develop optimised solutions for systems components either in the forms of silicon layout as in the case of the ARM Ltd. Processor or VHDL descriptions as in the case of technologies developed for the FPGA companies e.g. Xilinx Alliance partners and Altera Mega Partner program.

One of the major issues with IP blocks is the designer's ability to incorporate these cores into a design environment. One approach is to develop a dataflow model for the system description and then generate a "wrapper" to allow these cores to be used in the design environment. The purpose of the project is to investigate this concept using a simple user-developed core, and then applying the procedure to other commercially available cores.

The objectives of the project are:

1. Develop a simple processing core probably an adder core.
2. Investigate the dataflow modelling environment.
3. Create a dataflow wrapper for adder core.
4. Apply to a number of processing IP cores.
5. Create a simple demonstrator to incorporate simple processing cores and more complex IP cores.

Learning Outcomes

1. In-depth study into modern, design procedures for embedded systems.
2. Application of modern programming approaches for hardware.

MEng extension

1. Outline a design methodology for a complete DSP system.

School of Electronics, Electrical Engineering and Computer Science
FINAL YEAR PROJECT 2010/2011

Title : Development of an IP core for Fast Fourier Transform processing

Supervisor : Prof. R. Woods

Moderator : Dr. J. McAllister

Areas : DSP and Telecommunications (hardware/software)

The Fast Fourier Transform is a key processing requirement in DSP systems. The complexity of many systems is such that dedicated hardware implementations of such functions are needed. The aim of the projection is to create a intellectual property core in the form of a soft hardware description language (HDL) for performing the FFT. This will be based on the common Cooley-Tukey form of the FFT; the long term aim is to compare it with an in-house core that has been created.

The objectives of the project are:

1. Familiarisation of the Fast Fourier Transform, particularly the Cooley-Tukey algorithm.
2. Understanding of the processes involved in creating intellectual property cores.
3. Development of a suitable architecture for processing the FFT.
4. VHDL coding of the core including full simulation and synthesis.
5. Compare design with existing IP core.

Learning Outcomes

1. In-depth study into modern, design procedures for digital systems.
2. Application of modern programming approaches for hardware.

MEng extension

1. Undertake a detailed power comparison between the two cores.