University of Malta

Faculty of Engineering

Final Year Engineering Projects Exhibition
4, 5, 6, 7 July 2007

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Final Year Engineering Projects Exhibition 2007

Faculty of Engineering
University of Malta

**FINAL YEAR ENGINEERING DEGREE
PROJECTS EXHIBITION
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Cover Design
This year a group of engineering students is participating in the Formula SAE® competition. The Formula SAE® competition is for students to conceive, design, fabricate, and compete with small formula-style racing cars. Although in past years, engineering students have worked on projects related to the development of the formula-style car, this is the first time that Malta will be represented in this competition. The central focus is the formula-style car designed by this year's team of students and which can be seen in the centre of the cover design. Other elements on the cover design are the laptop and transponder which are used to communicate with the vehicle in order to monitor and log any required telemetry data. The cover design reflects the importance of both electrical and mechanical engineering aspects in the development of such a system. On the laptop screen one can view the logo which will be used by the team of engineering students for this year's Formula SAE® competition.

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Electrical Engineering Stream.

Mechanical Engineering Stream.

FOREWORD

The Exhibition of final-year projects carried out by students in the Faculty of Engineering is now a well-established event in our Faculty's calendar. It brings to a close another academic year and for the students concerned it represents the end of their four-year course at University. Most will soon embark on their professional working life, with a few continuing with their postgraduate studies either in Malta or overseas.

The range of projects undertaken during the year and exhibited demonstrate the wide range of interests of our academic staff who, in most cases, have come up with proposals for projects close to their area of interest. Although in some cases, the projects are proposed by the students themselves.

The Exhibition is living proof of the growth that the Faculty has experienced over the years, not only by the actual numbers of projects and hence students, but also by the quality of the project work being undertaken.

Notwithstanding the growth in numbers, Malta still lags considerably behind the rest of Europe. In fact some reports indicate that the number of graduates in science and engineering is about a fourth of the European average. In other words, for Malta to be in the same position as the rest of Europe, we would need to take in four times as many students in science and engineering as at present. To achieve this we must make engineering attractive to our youngsters, not only to those that are about to join University and therefore considering what course to join, but also to even younger generations so that they choose science at an early age, i.e. before it is too late. We hope that our exhibition will excite the imagination of some youngsters to seriously consider an engineering career.

Engineering, together with the other science based disciplines, requires laboratories where students can see in practice what they learn in theory from lectures and textbooks as well as trying their hands at experiments and at actually building engineering systems, such as what you see in most of the projects being exhibited in this exhibition. This means that maintaining a Faculty of Engineering as it should is an expensive affair. Money never seems to be enough.

Finally I would like to thank the Faculty committee that organised the Exhibition for their hard work in putting it all together, to both the academic and non-academic staff for the dedication and commitment that they show to our students, to the students for their project work and their parents for the support that I am sure they all give their children.

Professor Robert Ghirlando
Dean, Faculty of Engineering

WE WILL DESIGN AND BUILD THE FUTURE TOGETHER…

The annual exhibition of final-year engineering projects is always a happy occasion.

It is an opportunity for our University to celebrate the rich pool of talent of its graduates, and demonstrates, without shadow of doubt, that the engineering product of the University of Malta is world-class and the backbone of our industry.

The world we live in will continue to change rapidly and indeed an engineer will have to face technologies, in the course of his or her career, which haven't yet been imagined, less-still conceived. Today, perhaps more so than ever before, an engineer must be creative, must think outside the box, and must create or apply technologies to provide solutions for modern-day challenges.

We are proud that our engineering students get the theoretical, scientific and mathematical underpinning that is required to give them longevity and versatility in a world of rapid technological innovation. This said, our graduands, through their projects, have the opportunity to translate theoretical know-how into practical and innovative solutions to real-world problems. They are not merely ready to support our existing industries but they will undoubtedly become the pillars of tomorrow's industries.

The socio-economic development of our country requires our mechanical and electrical engineers to work in tandem with other professionals in other disciplines to create innovative and cleaner ways of generating and conserving energy, to devise efficient ways of managing and recycling waste, to create materials that enhance durability and longevity, to create automation to enhance production efficiency and accuracy. We see the advent of nanotechnology, we see the creation of complex instrumentation to control aircrafts, ships, and heavy machinery, and we see a brave new world unfold around us, heralded by the rapid developments in information and communication technologies that have been taking place in the past decade.

In short, it is a good time to be an engineer.

I believe that there is an engineer hidden in every one of us - let's design and build the future of our country together.

Professor Juanito Camilleri
Rector

Introduction

Modern society is greatly influenced by developments in engineering. Our life has become ever more dependent on technological products and services. These include the provision of electrical energy, information technology, transportation systems, medical equipment and much more. The modern engineer must therefore fulfil the leading and responsible role of meeting and supporting the ever-growing technological demands of society and also ensure that this development meets the challenging constraints imposed by safety, economic and environmental concerns.

In order to meet this challenge, universities must respond by providing a modern, flexible and thorough engineering education. The Faculty of Engineering at the University of Malta is continuously working to ensure that this objective is maintained, by developing and updating its degree programmes in order to generate graduates endowed with the necessary engineering skills for today's highly-competitive, industrial environment. By means of the various teaching and research programmes conducted within the Faculty, students are not only exposed to current engineering developments, but also to the technological requirements of the future. The various areas of engineering expertise found within the Faculty are reflected in the six departments that constitute it, namely

1. Department of Communications and Computer Engineering
2. Department of Electrical Power and Control Engineering
3. Department of Electronic Systems Engineering
4. Department of Manufacturing Engineering
5. Department of Mechanical Engineering
6. Department of Metallurgy and Materials Engineering

The engineering degree programmes provided by the Faculty range from undergraduate to postgraduate level. These include undergraduate courses leading to the B.Eng. (Hons) degree, and postgraduate courses or research programmes leading to M.Sc., M. Phil. and Ph.D. degrees.

This exhibition focuses on the engineering projects of the final year students following the B.Eng. (Hons) course. These projects reflect the efforts of several months of work and dedication by the students. This exhibition booklet contains information on all the projects being exhibited. Further information about the exhibition and the Faculty can be obtained from the Faculty Officer and from the web site http://www.eng.um.edu.mt/exhibition2007

Faculty Facilities

Communication Systems
System Design and Analysis Software.
Digital and Analogue Satellite Receivers.
Video Encoding Systems.
HF, VHF and UHF Transceivers.
Communications Test Equipment.
Microwave Equipment.

Computer Systems
In-Circuit Emulators.
Microcontroller systems.
Computer Network Modelling Software.

Signal Processing Systems
Speech and Vision Software and Hardware.
Motion Control DSPs.
Other DSP Hardware.
Acoustic Measurement Software and Hardware.

Image Processing
Solid-State Cameras.
Frame Grabber.
Digital Image and Video Capture and Recording Equipment.
Machine Vision Lighting Equipment.
Thermal Imager.

Instrumentation and Calibration
Electronic Calibration Systems.
High precision electronics measurement equipment.
Metrological Equipment Including CMMs and Surface Texture Measurement.
Calibration of Metrology Equipment in Roundness, Linear and Angular Measurements.

Electronic Circuit Development
Digital and Analogue IC Design.
IC Probing Station and Testing Equipment.
PCB Design, Manufacturing and Testing.
FPGA Development.
Electronics Bench Equipment for Electronic System Design and Analysis.

Control Systems
Control Systems Design Software.
Analogue and Digital Control System Development Tools.
Programmable Logic Control (PLC) Systems.
Robotic Manipulators.
Pneumatic/Hydraulic Control Rigs.

Power Electronics
Harmonic Voltage and Current Measurement Set-up.
Grid Connected PV and Wind Systems.
High voltage and current DC supplies.
Passive/Active Filters for Power Factor Improvement.
Switching Frequency Current Sensing for Power Electronics and Control.

Electrical Drives
High Performance Machine Control.
Vector controlled Induction Motor, Permanent Magnet Synchronous Motor and Switched Reluctance rigs.
Medium Power DC Machine Loading Units.
Electrical Drives and Control Simulation Software.
200V AC 28KVA 3-phase and 200V DC 20KW Supply for Testing Purposes.

Product Design and Development
CAD Systems (2D, 3D, Animation).
CAD/CAM Systems.
Concurrent Engineering Research Facilities.
Thermoplastic Design Guidelines.
3D Studio, AutoCAD, ProEngineer, Inventor.
3D Scanner.

Industrial Automation
PUMA 260 Industrial Robot.
DVT SmartImage Sensor and Accessories.
Various Actuators and Sensors.
PLCs.
Automation Training and Prototyping Facilities for Pneumatic and Hydraulic Systems.
Interfacing Hardware.

Mechanical Testing and Design
Tensile Testing Equipment.
Impact Testing Equipment.
Fatigue Testing Equipment.
Sub-sonic Wind Tunnel.
Sound Level Measurement Equipment.
Finite Element Methods Software ANSYS.

Metallurgy and Materials Engineering
High Pressure Quench Vacuum Furnace.
Plasma Nitriding and Gas Nitriding Furnace.
Ion Beam Assisted Deposition Equipment.
Physical Vapour Deposition (PVD) Plant for Deposition of Hard Ceramic Coatings.
9kW CO2 Laser with 4-axis CNC System and Wire and Powder Delivery Systems.
Pin on Disc Wear Testing Equipment, Coating Adhesion - Scratch Tester.
Macro and Micro Hardness, Coating Thickness Measuring Equipment.
Tensile and Compression Testing Equipment.
Fatigue Testing Equipment.
Creep Testing Equipment.
Microscopes, Specimen Preparation – Grinding, Polishing & Specimen Mounting Equipment.
Scanning Tunnelling Microscope.
Salt Spray Cabinet for Corrosion Testing.
X-ray Diffraction.
Salt Bath Equipment for Treatments such as Martempering.
Gas Fired Furnace for Aluminium Castings.
Electric Furnaces.
Automatic Degreaser for Component Cleaning.
CNC Machine Tool Centre for Die Manufacturing.
Sand Blasting Machine.
High Magnification Optical Microscope.
Stereo Microscope.

Manufacturing Facilities
Conventional Machine Tools.
Non-conventional Machine Tools, including Electric Discharge Machining, Water Jet Cutting.
Ultrasonic Machining, and Abrasive Flow Machining.
CNC Vertical Milling Machine.
CNC Vertical Machining Centre.

General
Networked Computer Laboratories.
Mail and Web Servers.
100Mbits Switched Network in all offices and laboratories.
MATLAB and Simulink Simulation Software.
C, C++ and Fortran Programming Language Development.

Areas of Research

Communications and Computer Engineering
Speech, Acoustics and Image Processing; Coding; Multimedia transmission over Wireless and High Speed Networks; Antennas, RF and Microwave Systems; Source and Channel Coding; Embedded Systems; Real-Time Operating Systems; Network Modelling; Navigational Aids; Voice over IP; VPN Technologies; Information Hiding; Multimedia Security; Power Line Communications; Secure Wireless Access; WiMAX; RFID.

Electrical Power and Control Engineering
Quality of Electrical Supply; Electric Vehicle Technology; Wind and P.V. Grid connected systems; Renewable Energy Systems; Electrical Energy Savings and Natural Daylighting; Electrical Machine Drives; Automatic Control Applications; Intelligent and Adaptive Control; Robotics; Biomedical Systems Modelling and Control; Direct AC-AC Converters; Switching Frequency Current Sensing.

Electronic Systems Engineering
ASIC Design; Quantum Well Structures; Signal and Image Processing; Biomedical Engineering; Neural Networks; Machine Vision; Electronic System Design; Aviation Safety; Avionics; Traffic Collision Avoidance; Cockpit Instrumentation; Computational Intelligence.

Manufacturing Engineering
Concurrent Engineering; Intelligent Systems in Design and Manufacturing; Computer Aided Engineering Design; Product Development and Methodology; Rapid Prototyping; Industrial Sustainable Development; Industrial Robotics and Mechatronics; Robotic Grasping and Handling; Industrial Automation; Quality Engineering.

Mechanical Engineering
Thermodynamics/Fluids; Energy; Sound and Vibrations; Refrigeration; Structural Integrity; Pressure Vessel Design; Solar Cooling; Wind Turbine Design; Aerodynamics.

Metallurgy and Materials Engineering
Ion-beam Assisted Deposition; Laser Surface Engineering and Material Deposition; Plasma Assisted Physical Vapour Deposition.

COLLABORATING ORGANISATIONS

The following firms worked conjointly with the Faculty on some of this year's engineering projects by providing essential expertise or financial and technical resources:
Attard Services Ltd; Enemalta Corporation; ESI Malta Ltd; Honeywell; Lifan; Meli Group of Companies; Methode Electronics (Malta) Ltd; National Instruments; Michael Attard Ltd; Ricardo; Tekconsult Ltd; Toly Products Ltd; Universal Spares Ltd; Wurth.

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ELECTRICAL ENGINEERING STREAM

Department of Communications & Computer Engineering
Department of Electrical Power & Control Engineering
Department of Electronic Systems Engineering

B.ENG.(HONS) STUDENTS

DIAGNOSIS OF APPENDICITIS USING NEURAL NETWORKS

Student: Amanda Abela   **Supervisor: Dr Ing. Kenneth P. Camilleri**

Introduction
Appendicitis is an inflammation of the appendix. Once it starts, there is no effective medical therapy, so appendicitis is considered a medical emergency. It is important that this condition is diagnosed in its early stages. However diagnosing appendicitis is not a trivial task since appendicitis symptoms are frequently vague or similar to other ailments.

Project Objectives
The aim of this project is to investigate the performance of various neural network (NN) architectures based on the Alvarado score (AS) or on the symptoms making up the AS. This score and these symptoms are used as input features to the expert system. The expert system is trained to recognise the feature pattern of a subject and provide an output as a diagnosis of appendicitis or non-specific abdominal pain.

System Design and Implementation
The expert systems have been trained and tested using data obtained from 63 cases of which 32 had been diagnosed by a physician to have acute appendicitis and 31 to have non-specific abdominal pain. Three different classifiers were implemented and investigated namely the Bayesian classifier (BC), the Multi Layer Perceptron neural network (MLPNN) and, the Radial Basis Function neural network (RBFNN). Various architectures for the two types of neural networks were trained and tested and the optimal architectures were identified. The performance of each of these classifiers was then evaluated using the Receiver Operating Characteristic (ROC), sensitivity and specificity rates and overall classification rates.

Results
The BC implemented and tested uses only the AS to classify the cases, whereas the MLPNN and the RBFNN use the features making up the AS. The optimal MLPNN was found to be a three layer sigmoidal 5-4-2 neural network, trained using the back-propagation algorithm with a learning rate $\square$=0.028. The optimal RBFNN was found to be an 8-1 feed-forward supervised NN whose activation function $= e^{-n^2}$. The optimal performance of these classifiers was determined by the cross-validation method.

These results are shown in table 1 below:

	Bayesian Classifier	MLPNN	RBFNN
Sensitivity (%)	87.5	82.0	78.0
Specificity (%)	77.4	60.0	94.0
Classification Rate (%)	82.5	73.4	86.0
Area under ROC	0.5726	0.3061	0.6396

It can be observed that the RBFNN has the best overall performance but the least sensitivity whereas the BC performs better on all measures with respect to the MLPNN.
Additional data is being processed and updated results will be reported in the project dissertation.

THE DESIGN OF A DRIVE SYSTEM FOR A MICRO-WIND TURBINE

Student: Mark Axiaq   **Supervisor: Dr Joseph Cilia**

Background
Wind turbines are machines for converting the wind kinetic energy into mechanical energy which will rotate a generator to transfer it to electrical energy. This type of renewable energy is presently widely used to reduce CO_2 emissions and achieve a cheaper alternative for energy generation.

The generator in mind for the drive of a micro wind turbine was a Brushless DC motor (BLDC), since it can offer a higher ratio of torque delivered to the size of motor when compared to DC and induction motors. This is useful in applications where space and weight are critical factors. BLDC motors are rapidly gaining popularity since it can offer High dynamic response, High efficiency, long operating life, Noiseless operation, High speed ranges and a better speed versus torque characteristics when compared to other motor drives.

BLDC motors are a type of synchronous motors. This means that the magnetic field generated by the stator and the magnetic field generated by the rotor rotate at the same frequency. BLDC motors do not experience the slip that is normally seen in induction motors

Project Objectives
This dissertation describes the design, implementation and testing of a drive system for a micro-wind turbine. The motor under test was a brushless DC motor, chosen for its high efficiency, ease of control and silent operation.

System Design and Implementation
A test rig for two 3kW Brushless DC motors was designed and implemented in practice. The speed for the motor under test was governed by the use of a remote control unit. A simulation model of the DC brushless motor was also setup using Matlab and Simulink. The model can then be used to predict the system behavior and to facilitate control system design. The results obtained were compared to the practical results of the drive performance. Battery charging during the testing period was monitored by the use of a Battery monitoring unit (BMU), interfaced to a pc for data logging.

GENERATED OUTPUT CURRENT AND
VOLTAGE WAVE FORMS
AT 1.5ohms STAR CONNECTED LOAD

GENERATED OUTPUT VOLTAGE
SPECTRUM AT 1.5ohms STAR
CONNECTED LOAD
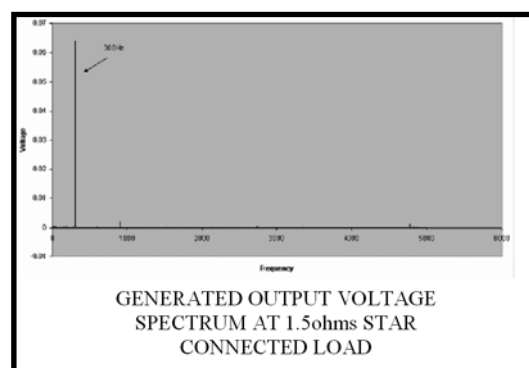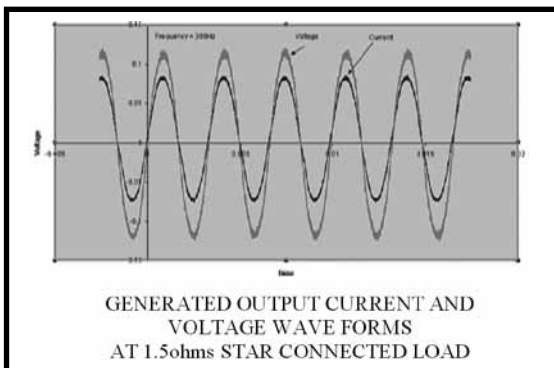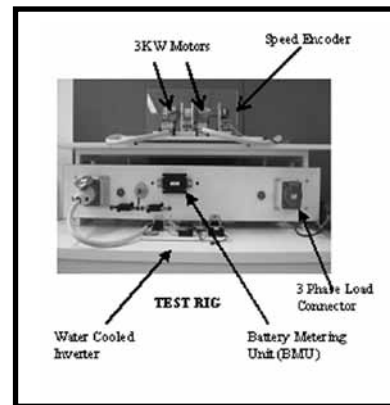
ELECTRONIC MONITORING AND FEEDBACK SYSTEM FOR CYCLING SPORTS AND TOURISM

Student: Andrea Azzopardi   **Supervisor: Dr Ing. Adrian Muscat**

Introduction

When cycling for sports or leisure, it is important for the cyclist to keep track of their activities. In general bicycles do not come equipped with a system that gives information regarding the performance of the cyclist.

The user of the bicycle would want to know basic information such as speed, acceleration, distance travelled and other measurements that would enable him to judge his performance.

Project Objectives

The main objective was to design an electronic monitoring system for a bicycle which includes an LCD interface. This would enable a cyclist to view his performance in real-time. Also a study on how to implement wireless features within the project where explored. A case study regarding future implementations was also conducted as to come up with feasible ideas that would improve the project.

System Design and Implementation

The first part of the project was to design the system at a high-level and research all the different parts that were required. Research for wireless communication between neighbouring bicycles was also done. After that the general design was done, sensors were constructed together with some interface circuitry so that these sensors could be integrated with a microcontroller board. Each of the sensors where tested inside a lab to ensure accuracy and reliability. The next phase of the project was to program the microcontroller as to incorporate the sensors, an LCD user interface complete with a keypad. The final part of the project involved the integration of all the components into one complete system. The entire system was then tested on track to make sure everything worked as required.
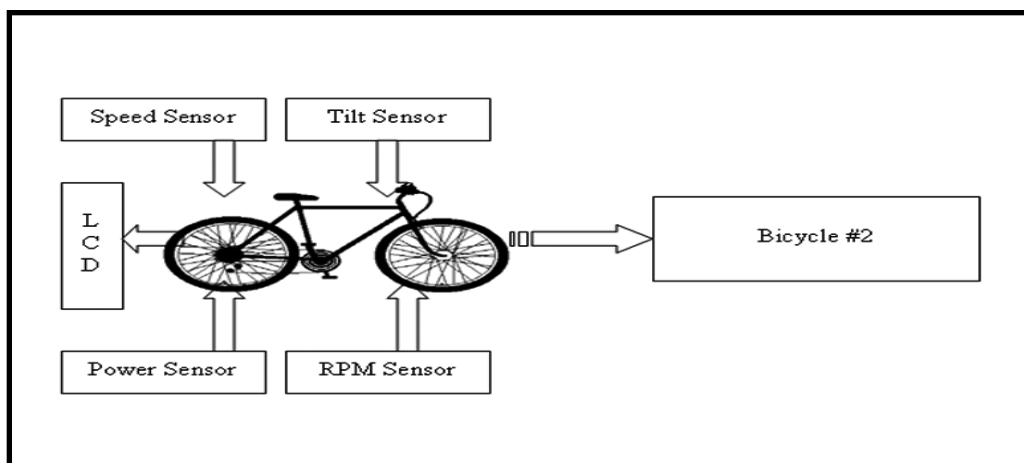
A 3KW BRUSHLESS DC MOTOR DRIVE FOR AN ELECTRIC BOAT APPLICATION

Student: Steve Azzopardi   **Supervisor: Dr Ing. Maurice Apap**

Introduction

The ever growing concern about pollution and the increase in the fuel costs, have given engineers and researchers challenges to come up with a clean and efficient electrical system to replace the combustion engines.

Project Objectives

The aim of this project is to investigate the performance of the brushless direct current motor (BLDC) in order to built a suitable converter drive. BLDC motors consist of a stator and a rotor, where the stator can have a number of phase windings and the rotor has surface mounted permanent magnets. BLDC motors do not have commutators and brushes and therefore electronic control techniques for operation are required.

System Design and Implementation

BLDC motors can be constructed mainly in two different physical configurations called the inrunner and the outrunner. In both configurations the electromagnets are stationary while the permanent magnets rotate. The outrunner in a star electrical configuration was chosen for this project because outrunners typically have more poles and wye configurations are more efficient than delta because only two phases conduct at any instant. The converter that drives a BLDC has two main functions- current control and commutation. For the current control, a digital proportional Integral (PI) controller was implemented which regulates the output of the buck converter by calculating the error between the reference input and the actual current flowing in the motor. The circuit which performs the commutation is made up of power transistors switched in synchronization with the rotor position determined from an incremental encoder.

The converter: Current regulation and commutation
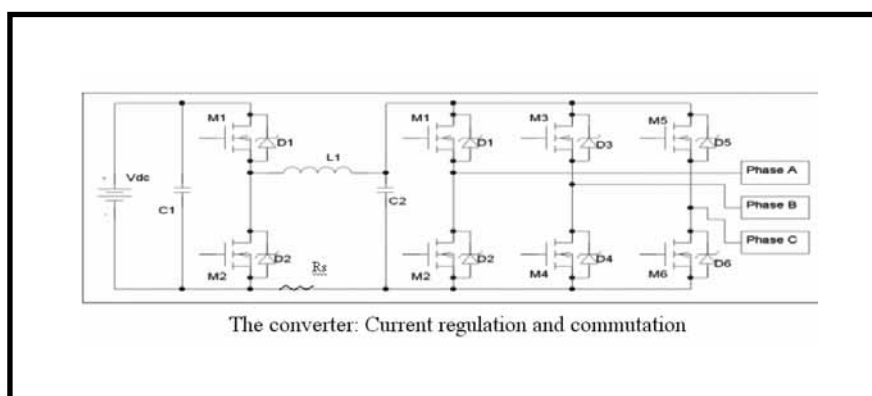
Additional data is being processed and results will be reported in the project dissertation.

A REVERBERATION CHAMBER FOR TESTING MOBILE TERMINAL ANTENNAS

Student: James Baldacchino   **Supervisor: Dr Ing. Adrian Muscat**

Introduction
The traditional method of testing antennas was (up till a few years ago) by means of an anechoic chamber. However such set ups are very large and expensive, and require high power transmissions. In 1968, H.A. Mendes introduced the concept of a reverberation chamber, which is a chamber of a particular size with electromagnetically conductive walls. This traps most of the radiated power within the chamber, and creates a number of resonant modes. A number of stirrers are used within this chamber to excite the modes, thus creating a statistically uniform field which enables engineers to test antennas in a multipath propagation environment.

Project Objectives
The main goal of this project was to build a fully functional reverberation chamber, with mechanical, platform and polarisation stirring capabilities. This chamber was to be accompanied by adequate software to remotely control it and take readings. A 'head-phantom' to replicate the electro-magnetic properties of the human brain was also to be designed, so as to be used within the chamber to analyse the effects of the human head on an antenna's radiation efficiency.

System Design and Implementation
The project was carried out in the following manner:
• Research and literature review on anechoic chambers.
• Research and literature review on reverberation chambers.
• Conceptual design of the reverberation chamber.
• Construction of the chamber.
• Design of control & instrumentation software using LabView.
• Design of Motor Circuitry.
• Research and design of human head phantom.
• Connection of all separate components and testing.
• Experimental measurements.

Results:
This chamber will be used to test the radiation efficiency of mobile phone antennas. Results will be compared to those obtained when the mobile is held close to one's head.
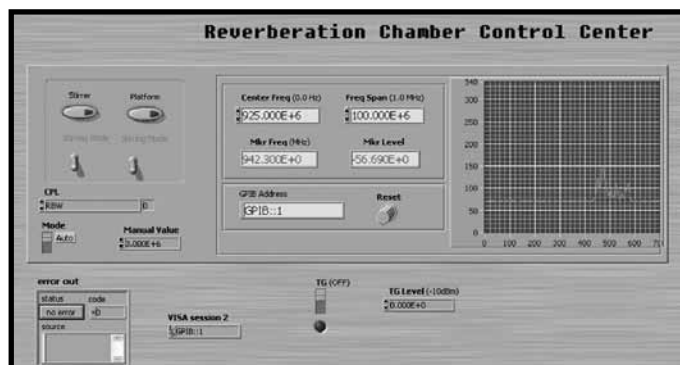
OFF-LINE HAND-WRITTEN GRAPHICAL SYMBOL RECOGNITION

Student: Pauline Bartolo   **Supervisor: Dr Ing. Kenneth P. Camilleri**

Introduction
This project constitutes part of an ongoing research effort which aims to interpret paper based sketched drawings and automatically generate a 3D model of the sketched object using a CAD package.

Project Objectives
In this project image features from 13 different sketched symbols belonging to the Prescribed Sketching Language (PSL) are extracted and processed to assign a unique label to them, thus automating the labeling stage. Since the symbols to be recognized are sketched, they will not be accurate but will have disturbances. This implies that the implemented system should be robust to distortions.

System Design and Implementation
Sketched (graphical) symbol data from the PSL symbol set was collected from left and right handed people. Seven invariant moments were extracted from the centered symbol sketch and used as features for the subsequent Multi Layer Perceptron (MLP) Neural Network (NN) classifier. Two types of MLP NN were implemented. The first NN consists of a monolithic feed forward MLP. The second type is a two level Hierarchical feed forward Neural Network (HNN) which was used such that the first level MLP NN classified symbols according to the labels of predefined groups and the second level MLP NNs each represented the different groups, providing the final symbol label. The symbol groupings were determined on the basis of confusion matrices obtained for different groupings.

Results
The performance of the monolithic feed forward NN was tested for the 13 symbols. The overall average recognition rate for an architecture of [250-200-150-13] was equal to 74.5%. The resulting confusion matrix (percentage values are quoted) is shown in Table 1.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	61.8	11.8	0	5.9	0	2.9	8.8	5.9	0	0	2.9	0	0
2	11.8	79.4	2.9	5.9	0	0	0	0	0	0	0	0	0
3	2.9	0	61.8	0	5.9	2.9	0	0	2.9	2.9	2.9	14.7	2.9
4	8.8	11.8	0	64.7	0	0	2.9	5.9	0	5.9	0	0	0
5	0	0	2.9	0	94.1	0	0	0	2.9	0	0	0	0
6	0	0	0	0	0	58.8	0	8.8	8.8	23.5	0	0	0
7	5.9	0	0	0	0	0	94.1	0	0	0	0	0	0
8	8.8	0	8.8	0	0	11.8	0	58.8	0	0	8.8	0	2.90
9	0	0	0	0	0	8.8	0	5.9	73.5	11.8	0	0	0
10	5.9	0	2.9	0	0	35.3	0	2.9	0	50	0	2.9	0
11	2.9	2.9	5.8	11.8	0	0	0	0	0	14.7	50	11.8	0
12	0	0	23.5	0	0	0	0	0	2.9	0	14.7	52.9	5.9
13	0	0	0	0	2.9	0	0	0	0	0	2.9	0	94.1

Table 1 Confusion Matrix. The symbols in the table are respectively represented by: [1]cube; [2] pyramid; [3]sweep; [4]wedge; [5]extrude; [6]revolve; [7]sphere; [8]torus; [9]circle; [10]cylinder; [11]cone; [12]curve loft; [13] straight loft

BLUETOOTH TO SCART CONVERTER

Student: Matthew Bianco   **Supervisor: Dr Ing. Carl J. Debono**

Introduction
The interconnectivity of devices and amalgamation of multimedia equipment has in recent years become fundamental in the development of technology. With advancements in wireless technology, the ability for a standalone device to be interconnected with other devices has become easier and more straightforward without the need for expensive and cumbersome cabling.

Project Objectives
This work explores the interconnection of PCs, PDAs and mobile phones to a standard television, which is the core of a home entertainment centre, by means of wireless technology, namely Bluetooth. The Bluetooth to SCART (Syndicat des Constructeurs d'Appareils Radiorecepteurs et Televiseurs) converter is used for the decoding of Baseline JPEG images and the outputting of the decoded data in an analogue form via SCART for a preset period of time.

System Design and Implementation
The main components used to achieve this result were a Bluetooth transceiver module, an FPGA and a VGA to SCART converter. The core of this system is the FPGA in which a JPEG image received via the Bluetooth interface is decoded to a bitmap. It is then converted from digital to analogue and outputted using the VGA standard. Finally, the VGA to SCART converter modifies the horizontal and vertical synchronisation of the video signal in order to achieve the desired SCART standard output.
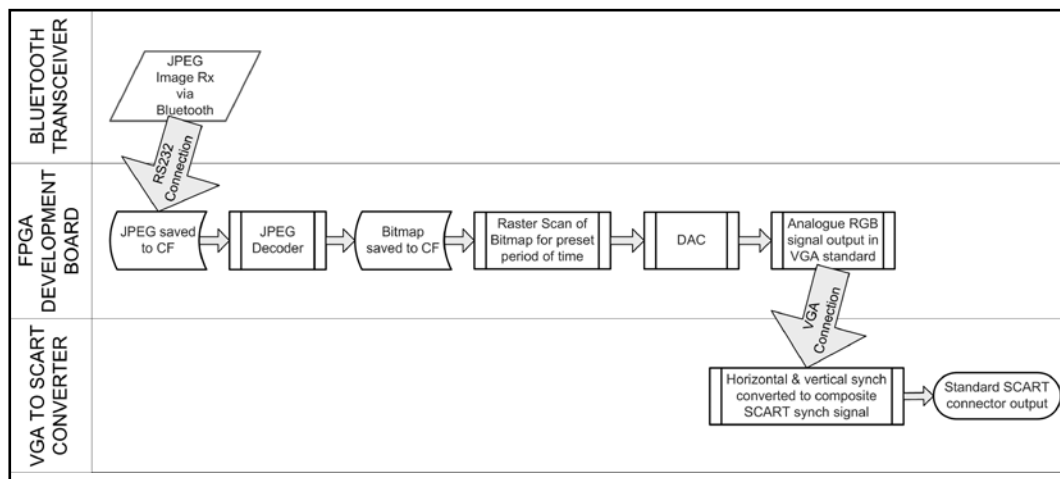
Bluetooth to SCART Converter Flow Diagram

8051 FLASH USB LOGGER

Student: Allen Carl Bonnici   **Supervisor: Ing. Paul P. Debono**

Introduction
Sensors are widely employed especially in today's industry. They are used to monitor variables which at times also need to be logged, thus requiring an external logging system, capable of autonomous operation, large memory space and secure data transfer to a remote PC.

This project utilises a Silicon Labs 48 MIPS 8051 μC core board to perform the logging tasks, flash memory (SD & CF) for data storage, and Serial/USB for communication and data transfer to host PC.
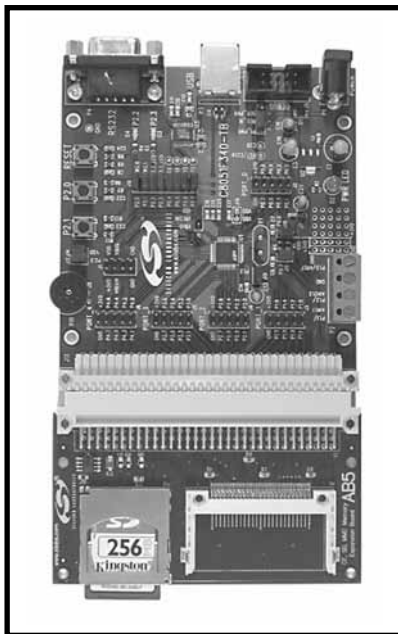
Project Objectives
• System capable of logging analogue /digital data streams.
• Ability of unsupervised operation.
• Ability of remote setup and data transfer.
• Data stored on system board.
• Ability to log several pri-connected sensors.
• Data manipulation.

System Design and Implementation
The system was implemented using the Silicon Labs C8051F340 board. Utilising the board's 10-bit ADC, analogue signals were digitised, whereas the USB-MSD AB5 expansion board was used to save the samples on compact flash (CF) or secure digital (SD) cards as text (*.txt) files. The cards could be accessed remotely via USB as mass storage devices (MSD). The serial interface is on the other hand used to setup the logging scheme, duration, rate, data dump, input type, number of input signals and permit MSD access.
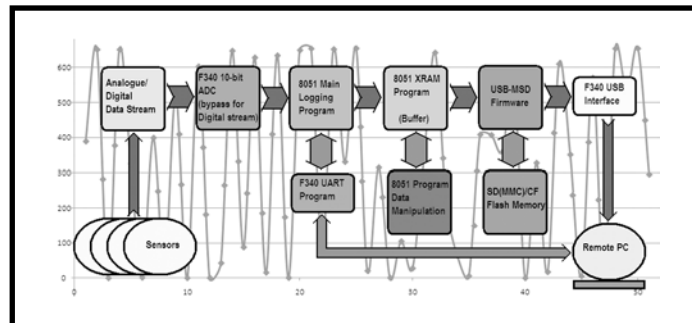
LOW POWER GRID CONNECTED INVERTER

Student: Joanne Bonnici   **Supervisor: Dr Ing. C. Spiteri Staines**

Introduction
Renewable energy such as photo-voltaic and wind energy are clean, highly efficient and sustainable sources of energy. Different inverter topologies for both systems exist. Dual stage topologies with grid isolation are currently in use on the market, however, the isolation transformer tends to reduce the system's efficiency. Single-stage topologies, without isolation are becoming more attractive, since they tend to have a higher efficiency. An LCL output filter utilised at the inverter output, provides better attenuation of the switching harmonics and a more compact design when compared to similar size L and LC filters.

Project Objectives
The aims of this project are to, simulate a single phase, single stage, grid connected inverter, without isolation, design an LCL output filter, control the grid current using Hysteresis Control, to construct an inverter model including a Watchdog circuit and to program a Digital Signal Controller for generation of complementary Pulse Width Modulation (PWM).

System Design and Implementation
The simulation of the open loop system consists of sine-weighted pulse width modulation, dead time logic, gate drive circuitry, the IGBTs power topology and an LCL power filter. The inverter output is filtered using a designed LCL filter, which is connected to the grid. Power is transferred from the inverter to the grid. In the closed loop system, Hysteresis control provides pulse width modulation, to control the magnitude and phase of the grid current, to obtain unity power factor. The digital signal controller was programmed to output a 50Hz, sine-sampled PWM waveform at a frequency of 3kHz. This waveform is required to drive the inverter circuit, built for demonstration purposes. The function of the Watchdog circuit is to protect the inverter, that is, to switch off the inverter in case of loss in the PWM generation signals.

Results
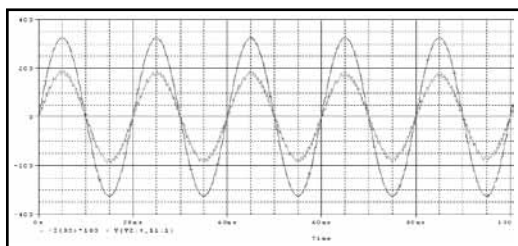
Figure 1: Grid current and LCL output voltage with Hysteresis Control
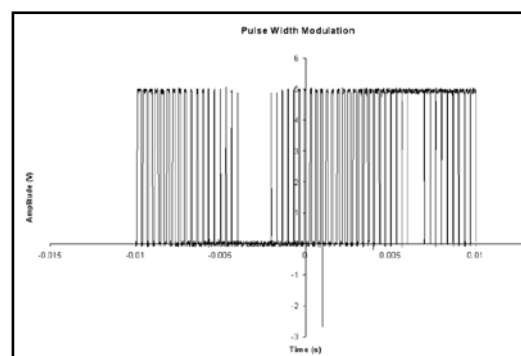
Figure 2: PWM from digital signal controller

WIRELESS HOME ENTERTAINMENT SYSTEM

Student: Efrem Borg   **Supervisor: Dr Ing. Saviour Zammit**

Introduction
The emergence of Media Center PC's is fuelled by the availability of various Media-Center applications and operating systems, and the availability of interface boards to receive all types of broadcast media including, Terrestrial TV – both analogue and digital, Satellite TV, radio, DAB etc. At the same time, wireless networks based on IEEE 802.11 have become commodity items and the possibility exists of combining Media Centers with wireless networks to develop Wireless Home Entertainment Systems.

Project Objectives
The projects main objectives are:
- To implement a Linux based Media Center back-end capable of receiving, digitizing, storing, replaying and streaming broadcast TV, together with other media such as playing MP3's and viewing Pictures.
- To implement a low cost media appliance capable of receiving signals from the Media Center back-end and playing back/displaying the streamed media remotely.
- To implement a domestic 802.11g network and study its suitability to deliver the streamed media between the back-end and front-end devices.

System Design and Implementation
The Media Center backend has been implemented on an Ubuntu Linux PC equipped with PC-TV card capable of receiving analogue Radio and TV stations, digitizing them, storing on hard-disk in PVR mode, and streaming the media, also from the hard-disk and DVDROM, to the low-cost front-end. The low cost front-end has been prototyped using a miniITX Via board equipped with Intel compatible low-power EDEN processor capable of running the Ubuntu Linux OS. The minimal mini PC is equipped with a FLASH RAM hard-disk and a PCI-802.11 b/g DLINK card. The backend is connected to a Linksys WRT54G 802.11g Access Point through a 100 Mbps Ethernet connection. Software tools such as iperf, bmon and Wireshark are to be used to measure the throughput and monitor the performance of the system over the wireless network.

Results
The back-end PC and the low-cost front-end client have been implemented successfully and digital audio visual programs can be streamed over the Ethernet and wireless 802.11g network. A remote control and LCD have been also interfaced to the front-end. Currently the 802.11g network measurements are being collected and analysed.
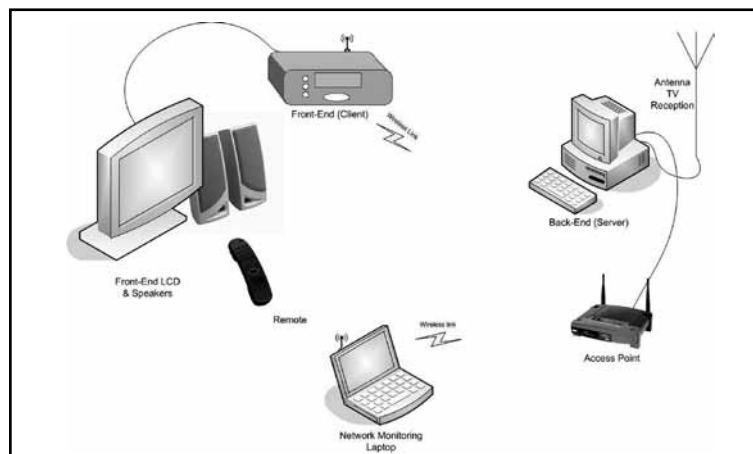
AUTOMATIC FAULT DETECTION AND CONTROL RECONFIGURATION

Student: Graziella Borg   **Supervisor: Dr Ing. Simon G. Fabri**

Introduction

A control system is an arrangement of physical components related in such a way as to regulate some physical variables or another system. It is a fundamental concept of controller design that a set of input variables acts through a given plant to create a desired output, by means of feedback.

In order to be able to program a closed loop by means of software applications, a control law has to be developed to map the control signal u from the plant output signal y and a reference signal y_d, where y_d is the desire value of y. When a fault in the plant equipment occurs, the nominal controller designed for the fault-free system might be unable to maintain the control objective.

Thus, Fault Detection and Isolation (FDI) is an online process which is in charge of detecting and isolating faulty components, using the model of the plant. The controller might also reconfigure itself according to the new situation. The kind of reconfiguration strongly depends on the severity of the fault; it may consist of shutting down the control system in case of severe faults, or adopting small reconfigurations in the control structure.

Project Objectives

The main aim of this project is to provide a laboratory-scale test rig for studying automatic fault detection and reconfiguration. The setup consists of an air heating process flowing through a tube, shown in Figure 1. The main challenge is to detect faults making use of a single air temperature sensor. The control input is the power fed to the heating element while the controlled output is the temperature at the end of the tube. The response of the plant will be examined under different modes of operation, namely: (1) a fault free mode and (2) introducing changes to emulate faulty modes. Observers are used to continuously monitor the physical plant and provide feedback to a Bayesian algorithm that identifies the mode of operation. Furthermore this control scheme will be implemented to an industrial Programmable Logic Controller (PLC), to provide insight on its practical application in industry.

System Design and Implementation

Kalman filter algorithms are considered in order to develop a bank of three observers for continuous monitoring of the plant. Each observer is able to follow the plant during operation under one of three different operating modes respectively. A Bayesian approach is used for calculation of the probability of being in a particular mode. Pole placement control with added integral action is used in order to pre-compute a control law for each mode and effect control reconfiguration. Simulations are initially carried out using MATLAB® while physical implementation is interfaced on the test rig using a Siemens S7 PLC, provided by ESI - Engineering for Science and Industry (Malta).

The developed laboratory-scale plant for studying FDI

AUTOMATIC RECOGNITION OF SPEECH USING WAVELET BASED PARAMETERS FOR A NEURAL NETWORK APPLICATION

Student: Glyton Carl Camilleri   **Supervisor: Prof. Ing. Paul Micallef**

Introduction
The advent of multi-resolution analysis and wavelets has brought new ways of analysing non-stationary signals for suitable parameterisation. This project employs the use of Wavelet Decomposition to dynamically locate areas in a speech signal's frequency spectrum that contain useable energy content. Phoneme frames of 512 sample duration are extracted from the TIMIT database using a Hamming window, their features extracted and passed to a Self-Organising Map for classification.

Project Objectives
The main aim of this project is to train a Self-Organising neural network using parameters extracted by a wavelet-based decomposition system such that a probabilistic approach towards classification is favoured. Any relevant maxima in the network's output are converted into a probability density function, thus producing a confusion matrix.

System Design and Implementation
The system was implemented entirely using software: MATLAB® was used for the data and feature extraction, while C was used for the neural network implementation. The first three levels of decomposition of a typical /s/ are shown in Figure 1, where decisions are taken according to the energy difference between adjacent sub-bands (represented by branches in the decomposition tree). Both the sign and magnitude of the energy difference give information that is closely related to the energy contour of the frequency spectrum.

Results
Results obtained for interclass discrimination show similarities with values obtained using other methods such as LPC and MFCC.
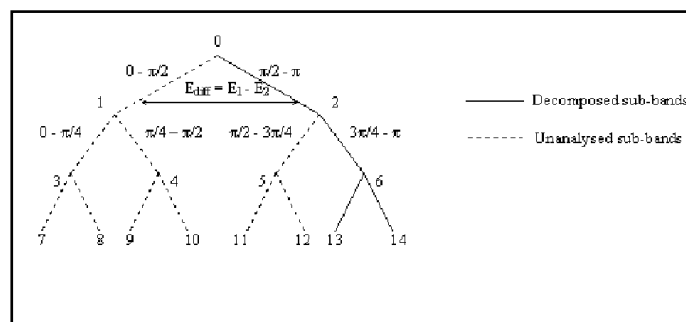
A typical three level decomposition of the unvoiced fricative /s/

CONTROL STRATEGIES FOR A VARIABLE SPEED SMALL-SCALE WIND TURBINE

Student: Justine Coppini　　　　　**Supervisor: Dr Ing. Cedric Caruana**

Introduction
The efficient operation of the small-scale wind energy conversion system (WECS) depends on the overall control strategy, despite the recent advances in the blade design. The power conversion efficiency can be improved by forcing the turbine rotational speed to track the instantaneous wind conditions. The relatively high inertia of the wind turbine rotor coupled with rapid variations in both wind speed and direction, make this goal difficult to achieve.

Project Objectives
The main objective of this thesis is to compare different control strategies designed for a variable speed small-scale wind turbine. This project also aims to derive the generator parameters of the current test rig, which are then used in simulations to obtain the generator output characteristic. In order to control the d.c. link voltage of the WECS, a constant voltage load circuit is required, this circuit is to be designed, constructed and tested.

System Design and Implementation
• A review of the theoretical issues regarding control strategies used in Small-Scale Wind Turbines.
• Simulations of the WECS using MATLAB SIMULINK® at steady state conditions.
• Simulations of the WECS using an average model.
• Simulations of the control strategies at transient conditions using results obtained from steady state conditions.
• Comparisons of different models used in simulations.
• Measurements for test rig generator parameters.
• Implementation of a constant voltage load circuit using a PIC16F876 microcontroller.

Results
The Sun Profi SP 2000 inverter currently being used for the wind turbine found at the University of Malta, has fixed d.c. link voltages at 200V, 275V and 300V. The simulations carried out, test whether it is feasible to have varying voltage settings to obtain maximum power output or not. These comparisons were done using simulations generated in MATLAB® using SIMULINK®. It has been shown through these simulations that for a small-scale wind turbine, a varying d.c. link voltage at the inverter results in optimum power output.
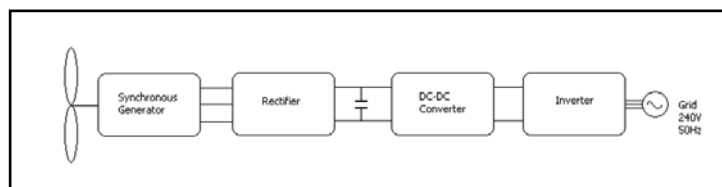
Wind Energy Conversion System

DIGITAL FORENSICS: SOFTWARE FOR THE OFFLINE ANALYSIS OF MEMORY DUMPS

Student: Stephanie Cordina   **Supervisor: Dr Johann A. Briffa**

Introduction
Living in an age where computers and software are being developed at a very high rate, developers must keep rising to the challenge in order to prevent malicious use of the available technology. Digital forensics are techniques developed and implemented in order to minimize the impact of computer crimes. Several tools exist in this area, however the analysis of memory dumps is in its infancy.

The aim of forensic memory analysis is to find malicious processes or files that were residing in memory at the time of the incident. This can range from root kits and malicious software that hide themselves from the user or do not even write themselves on secondary storage devices, to incriminating files and data that a user might have running in his or her computer, that may serve as evidence in a criminal case.

Project Objectives
The objectives of this project are to have a desktop program that takes a Linux memory dump, analysis it and presents the user with a list of processes that were being used at the time of the dump. A further function of the program is the reconstruction of some image files still in memory.

System Design and Implementation
The Linux kernel memory is made up of a number of structures programmed in C. Traversing these structures, in a memory dump by means of pointers, allows collection of relevant data from the structure elements. From this data a process list can be built and pages that comprised of a file can be found, in order to rebuild the file.

Figure 1: Part of a memory dump, containing the process called 'swapper'

Figure 2: Part of a memory dump, containing data representing an image file called 'bluestar.jpg' open in a program called "The GIMP" at the time that the memory dump was taken

WIRELESS MONITORING AND CONTROL OF A CAR ENGINE

Name: David Cristina   **Supervisor: Dr Ing. Carl J. Debono**

Introduction
The increasingly severe emissions-control legislations for internal combustion engines have led to the development of electronic gasoline engine management systems. The control unit (ECU) is the central point which operates and controls the actuators according to the operating parameters measured by sensors and set point generators and the driver's specified settings.

'On-Board-Diagnostics II' regulations specify that the electronic engine-management systems must monitor the system operation, perform integral diagnosis functions, and report all parameters via specific OBD-II CAN bus protocols (depending on the manufacturer).

Project Objectives
• To simulate the data registered by the engine's sensors using specifically designed electronic circuits controlled by an FPGA according to the driver's settings via the set point generators;
• To convert the OBD-II protocol output from the ECU into serial data using a Scan Tool interface;
• To interface the serial port into an embedded serial to wireless Ethernet bridge;
• To access and query the OBD-II report over the TCP/IP network.

System Design and Implementation
• Research on the specific data registered by the different sensors and set point generators;
• Design of analogue electronic filters, DAC's, ADC's and interfacing circuitry required to interface the ECU with the FPGA;
• Implementation of VHDL code on the FPGA;
• Familiarisation with the serial to 802.11 b/g wireless network embedded server;
• Implementation of serial transmissions over TCP/IP and virtual COM port settings.
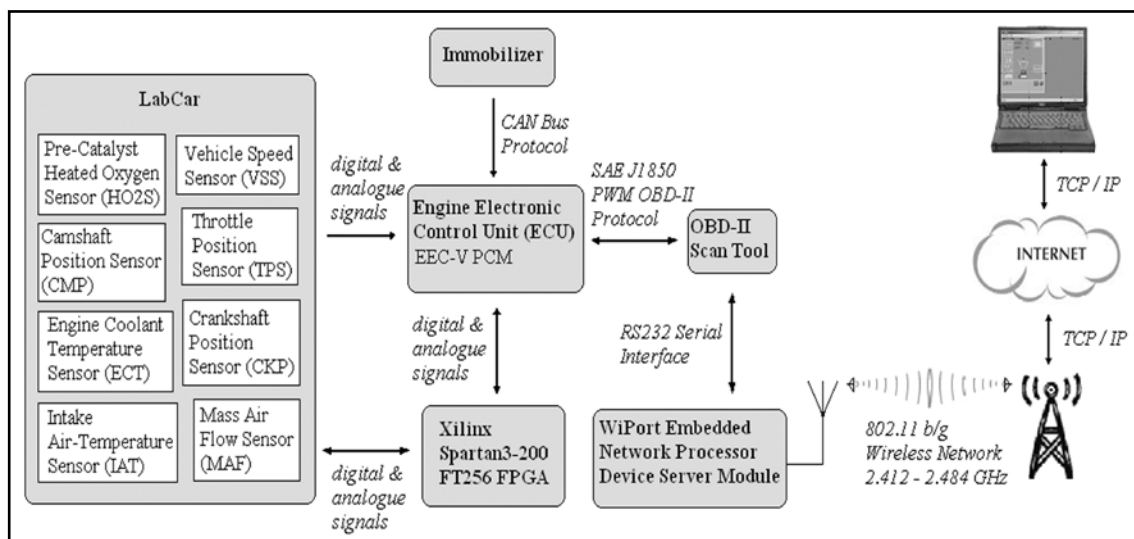
System Architecture

THE DESIGN AND IMPLEMENTATION OF AN ELECTRIC BOAT

Student: Charles Darmanin   **Supervisor: Dr Joseph Cilia**

Introduction

With the on-going rise in oil prices together with the pollution produced by combustion engines, an environmental friendly solution had to be designed and implemented on a boat to be used for short trips at Blue Grotto caves. These caves are part of the Maltese heritage and a very important tourist attraction, making their conservation of utmost importance. Past projects dealt with the development of different blocks required for a suitable drive. The complete system was designed, built and tested in my thesis.

Project Objectives

The first objective was to make necessary alterations to the boat so as to accommodate all the electric drive components and circuitry. A second objective was to implement the circuit on the boat, and a third objective was to simulate the whole system and compare actual results obtained from trial runs at sea with simulation results.

Figure 1: shows the electric boat.

System Design and Implementation

The circuit implemented on the boat consists of two 48V relays, four 12V 70Ah gel type batteries, a Curtis motor controller, Permanent Magnet dc motor, charger connection, protection circuitry for boat lights, and a Battery management unit. The latter makes it possible to monitor the state of charge of the batteries through an RS232 connection or via Bluetooth. This circuit provides means of safety, control, and monitoring of the whole drive system. Figure 2 shows a block diagram of how the system was simulated taking into consideration the effects of thrust and drag. Simulation results are within 6% accuracy. Figure 3 shows the circuit as it was designed for the boat.
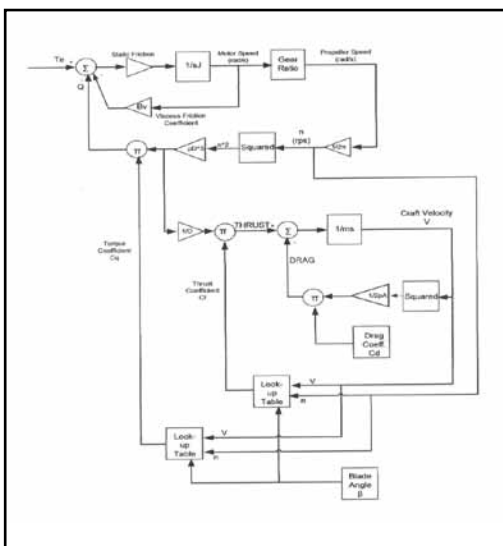
Figure 2
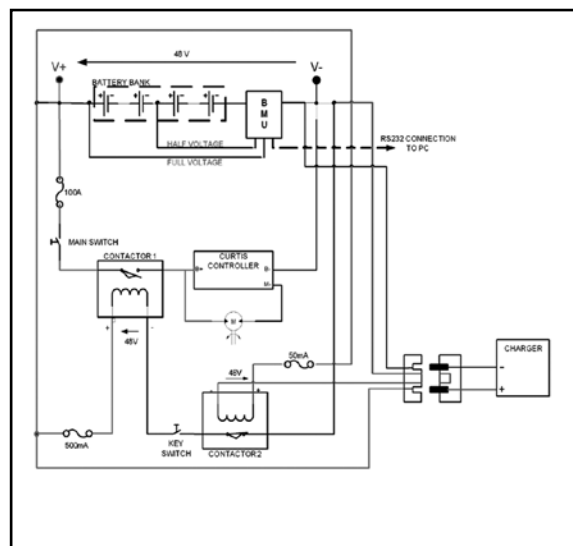
Figure 3

ACOUSTIC MODELING OF ENCLOSED SPACES

Student: Aaron Debattista   **Supervisor: Prof. Ing. Paul Micallef**

Introduction
Acoustics is simply stated as the study of sound and is the science concerned with the production, control, transmission, reception, and effects of sound inside an enclosure or in free-field conditions. The study of acoustics is of paramount importance especially in architectural design. The aim of acoustic modeling is that given an enclosed space with specific conditions on the boundary surfaces and the objects placed inside the enclosure one can simulate its response to a given source also located anywhere inside the enclosure. By modeling the enclosed space one is able to derive various acoustical parameters which may be used in the design of the enclosure.

Project Objectives
The primary goal of this project is that using a wave-based algorithm the room impulse response of an enclosed space is simulated. Also an estimate of the reverberation time is calculated for the simulated enclosure.

System Design and Implementation
An analytical solution of the wave equation is only possible for simple enclosures with well defined boundary conditions. Wave-based methods do not solve the wave equation, but they try to numerically approximate its solution. The digital waveguide mesh is a well known wave-based algorithm and is a variant of the finite difference time domain methods. Digital waveguide mesh models have provided an effective way of modeling the properties of many resonant structures, including acoustic spaces.
The implemented algorithms are able to:
- Simulate acoustic wave propagation inside an enclosure at different frequencies and positions for both the receiver and the source. (Figure 1).
- Simulate a rectangular enclosure having any size and boundary conditions.
- Obtain the reverberation time and impulse response in different octave frequencies (Figure 2)
- Simulate the effect of objects placed inside the rectangular space at any required position having any size and boundary conditions.

Simulated results were compared with field measurements taken inside a rectangular enclosure where both the reverberation time and impulse response of the enclosure were measured. Also experiments were set up to measure the absorption coefficients of materials used inside the enclosure in order to achieve reliable references.
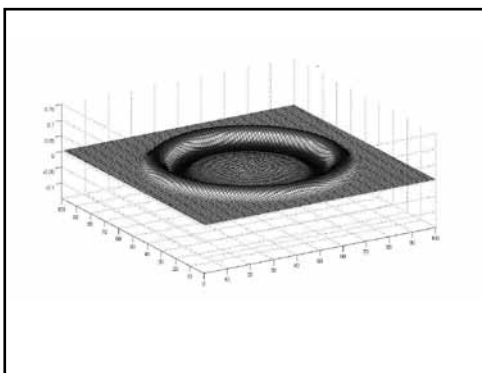
Figure 1
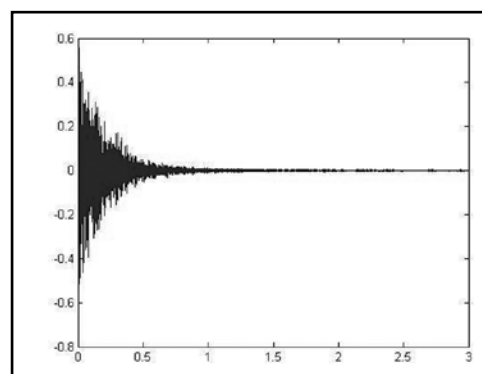
Figure 2

NEURAL NETWORK CONTROL OF A ROBOTIC MANIPULATOR

Student: Lisa Farrugia   **Supervisor: Dr Ing. Simon G. Fabri**

Introduction

The modelling and control of non-linear systems, such as a robotic manipulator, can be highly complex and computationally expensive for traditional controllers due to their complicated dynamic behaviour. Neural Network based controllers are ideal for the modelling of such systems due to their learning capability and ability to derive meaning from complicated or imprecise data. Neural Networks have been shown to be able to approximate practically any dynamic function, provided the network is large enough. They are implemented by storing model experiences in memory and using these experiences to make predictions for new situations, in 'human-like' learning behaviour.

Project Objectives

The main objective of this project was to implement a Neural Network based Controller to regulate the motion of the robotic arm in an accurate and efficient manner. The controller had to be robust enough to cater for the inherent non-linearities of the plant itself coupled with external disturbances caused by practical limitations, such as gearbox backlash, static friction and measurement noise and any other random environmental disturbances.

System Design and Implementation

The fore mentioned objectives were tackled by:
• Modelling the plant using MATLAB® and Simulink®.
• Training various Neural Networks to learn the forward and inverse dynamics of the robotic manipulator using Radial Basis Functions and Back propagation Algorithms. This was done in both the vertical and horizontal planes, and using both simulated data and that obtained from the plant itself. In particular, the use of training algorithms that utilize regularization was found to be vital when training with noisy experimental data.
• Using the trained Neural Networks to create robust controllers for the simulated and actual plant. The principles of Feedforward Inverse Control and Internal Model Control were used to design the controller.
• Implementing the Internal Model Controller in the dSPACE® environment to control the actual plant.
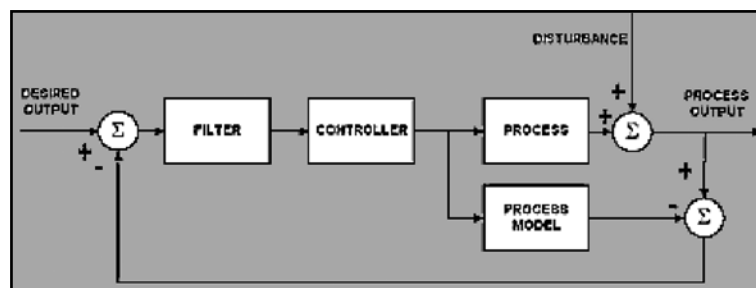
Structure of an Internal Model Controller

THE PROPAGATION OF HARMONICS IN ELECTRIC POWER NETWORKS

Student: Carl Fenech   **Supervisor: Dr Cedric Caruana**

Introduction

The problem of power systems harmonic has been recognized when the significant amounts of distorted voltage and current waveforms were detected in the transmission line. The increasing use of highly non linear power electronic devices has caused an increase in the generation of harmonic currents which are being injected into the power system. Impact from this phenomenon causes equipment heating, fuse and breaker mis-operation, conductor heating etc. As a result, harmonic studies are becoming a growing concern.

Project Objectives

In order to accomplish the project's main goals, the approach outlined in this section was followed:
• Gain familiarity with harmonic distortion measurements and international harmonic limits standards.
• Simulation of sample systems.
• Record harmonic content of various equipment.
• Build a system and record harmonics at various points.
• Examine the problem of resonance due to presence of power factor correction capacitors.

Results

The results were obtained by building a sample system consisting of electronic equipment as the harmonic source in parallel to an ideal load, that is, a resistive load, and confirm that even though the latter produced no harmonics, harmonics were observed at its input due to neighbouring equipment.
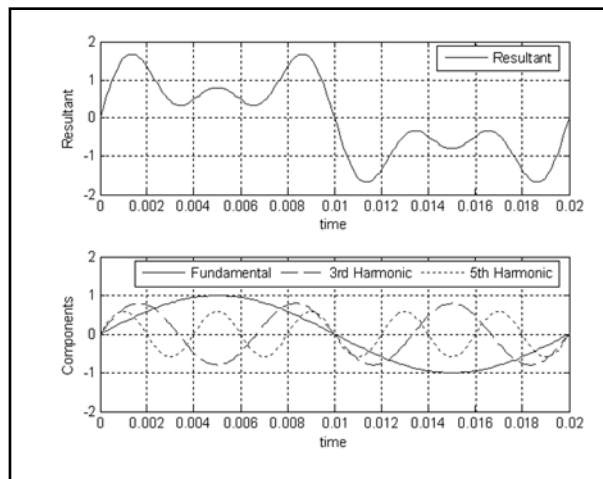
The resultant distorted waveform is caused by the addition of the
3rd and 5th harmonic to the fundamental.

THE EFFECTS OF HARMONICS ON ENERGY METERS

Student : Michael Galea   **Supervisor: Dr Joseph Cilia**

Background

This project is sponsored by Enemalta Corporation. With the increase in the use of Power Electronics, today there is a large presence of Harmonics on the Electrical Supply Networks. This project investigates the effects harmonics have on the kWh Energy Meters used by Enemalta to record power consumption. There are basically four types of meters used by Enemalta, namely

• Single Phase Analogue and Single Phase Digital.
• Three Phase Analogue and Three Phase Digital.

Project Objectives

• Determination of the effects each individual lower order Harmonic has on each Meter.
• Determination of whether the Meters behave differently (i.e. give incorrect readings) when operating in a harmonic environment.
• Filter Design and Implementation for the elimination of high frequency components that can damage and affect the Energy Meters.

Project Methodologies

• Suggest and implement setups, so as to test how lower order harmonics effect each Meter and also to test how each Meter functions, first in an environment without harmonics and then with harmonics.
• Design, simulate and implement a low pass LC Filter to minimize the effects of harmonics on the Energy Meters.
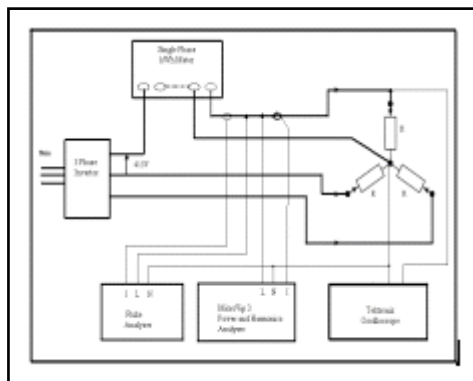
Figure 1: Setup for Single Phase Meter Tests

Figure 2: Motor Switchboard used for Tests

PHONEME RECOGNITION USING NEURAL NETWORKS

Student: Tara-Elese Galea   **Supervisor: Dr Ing. Edward Gatt**

Introduction
The information that is communicated through speech is intrinsically of a discrete nature i.e. it can be represented by a concatenation of elements from a finite set of symbols. The symbols from which every sound can be classified are called phonemes.

Project Objectives
The main motivation for this project was to study the performance of speech analysis methods, mainly the Discrete Wavelet and Fourier transforms, together with neural networks in automatic speech recognition. The plan was to perform a decomposition of the speech phonemes into energies per frequency band and then input these into an artificial neural network. Further more, comparative analysis between the standard Fast Fourier Transform and a wavelet based set of features is carried out to evaluate the speech recognition rates of two aforementioned parameterization methods.

System Design and Implementation
In this project, MATLAB® was used to create a method for identifying different phonemes from speech signals. Below one can find a flowchart of speech coding and classification algorithm.

MATLAB®
(1) Access .wav file
(2) Segment each phoneme into 15 ms time slices
(3) Input each time slice into the DWT to extract coefficients
(4) Use coefficients to compose sub band energies, which are written to a text file.

NEURAL NETWORK
(1) Construct back progagation network
(2) Train network using processing data for all phonemes
(3) Test network using processing data for all phonemes
(4) Phonetically classify results to obtain recognition rates.

DESIGN AND ANALYSIS OF ELECTRICAL MACHINES

Student: David Gerada   **Supervisor: Dr Cedric Caruana**

Introduction
This thesis deals with the design and analysis of induction machines. Traditionally, induction machine parameters have been evaluated using formulae based on approximations to the actual flux distribution in the machine. In new machine design applications, requiring high levels of accuracy, numerical methods such as the Finite Element Method (FEM) are used to simulate the magnetic circuit of the machine, going into details of specific machine geometry, skin effect and saturation.

Project Objectives
• Perform the finite element analysis of an existing 11kW deep bar, closed rotor slot induction machine (figure 1), of which all geometrical and constructional details are known, in order to determine equivalent circuit parameters and how they are effected by saturation and skin effect at all slip frequencies.
• Design an induction motor for an aircraft actuation system.

Implementation
In the analysis of an existing 11kW machine, two approaches were adopted. In the first approach the indirect motor tests are reproduced. From the field solutions, the motor parameters are determined and a variable parameter equivalent circuit is built. In the second approach the motor operation under load is simulated directly using a transient solver.

In the second part of the thesis, given operational requirements and design constraints, a 5.5kW induction machine was designed (figure 2) and its performance evaluated using analytical techniques. The FE method was included in the machine design cycle to verify design assumptions and performance evaluation, and also to aid in the optimisation of the design.

Results

11kW machine	Starting Torque (Nm)	Rated Torque (Nm)
Experimental	237.6	74
FE indirect tests	231.4	80
Direct Simulations	202.2	80.4

FIGURE 1
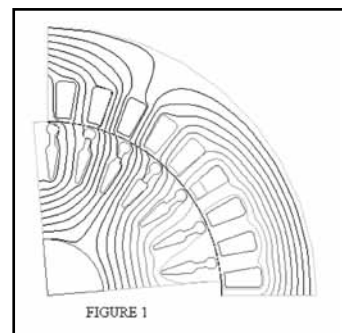
5.5kW machine	Analytical	FE
Rated Torque	45.63 Nm	48.19 Nm
Maximum Output	11.16 kW	10.99 kW
Core Losses	303 W	290 W
Starting Torque	44.36 Nm	52.22 Nm
Torque Density	20.5 kN/m3	21.6 kN/m3

FIGURE 2
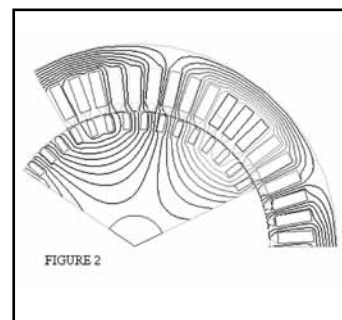
DESIGN OF A 2.4 GHZ RF RECEIVER

Student: Lawrence Grech   **Supervisor: Dr Ivan Grech**

Introduction

With the introduction of IEEE 802.15.4 Zigbee, the demands for low cost, low power and small size wireless transceivers has been increased significantly. A typical Zigbee RF transceiver consumes 19.7 mA in receiver mode and 17.4 mA in transmit mode, making use of low supply voltage ranging from 2.1 V to 3.6 V. At these low powers, parameters such as gain, noise figure and linearity will be degraded significantly. Thus research and innovative ideas are essential to achieve such requirements.
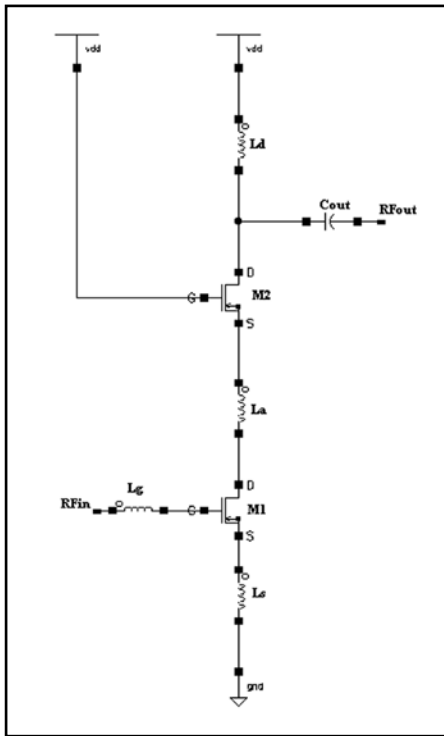
Figure 1: LNA

Project Objectives

This thesis presents the design of a Low Noise Amplifier (LNA) and a Down-Conversion Mixer for a 2.4 GHz RF Receiver. The aim is too obtain satisfactory gain, noise figure and linearity with low power so to meet IEEE 802.15.4 standard requirements.

System Design and Implementation

- Literature review and research on different LNA and Mixer topologies.
- Select the most suitable LNA and Mixer topologies that work under low power.
- A model that simulates non ideal inductors was also designed.
- Simulation and optimisation of the circuits using CADENCE software.
- Evaluation of results and comparison with published results.

Results

Satisfactory results were obtained from the LNA topology shown in Figure 1. Then the Double-balance Gilbert-cell mixer topology shown in Figure 2 was designed. Current work focuses on improving the mixer performance at the least possible power consumption.
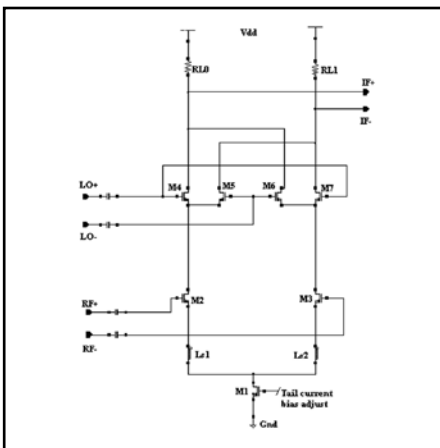
Figure 2: Gilbert-Cell Mixer

DIGITAL IMPLEMENTATION OF CELLULAR NEURAL NETWORKS

Student: Ryan Grech   **Supervisor: Dr Ing. Edward Gatt**

Introduction

Much research has been conducted on the field of cellular neural networks. Their ever increasing processing power due to their high degree of parallelism is continuously changing the ways in which problems can be solved. The discriminating factor in cellular neural networks CNN is the locality of the interconnections, which is a very attractive feature for VLSI implementation. These types of networks are quickly gaining popularity in the area of real time signal and image processing, and also particularly in the solution of partial differential equations, which require very demanding mathematical computations.
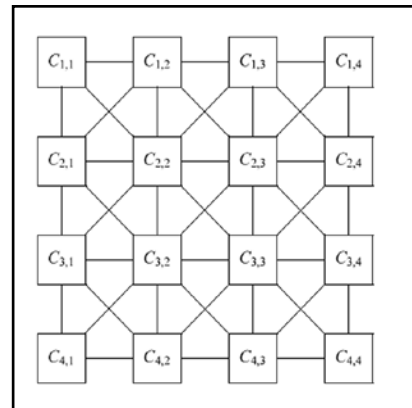
Project Objectives

The aim of this project is to build a library of building blocks using a hardware description language (VHDL) which would make up a fully functional digital Cellular Neural Network. The architecture was implemented thereafter on a Spartan 3 FPGA board, which allows for rapid system prototyping, reducing time and implementation costs. The main design objectives were to maximise system speed while consuming minimal area on the FPGA for practical applications. Also, other minor objectives were to generate optimal CNN templates to ensure operational correctness and ultimately, a stable output.

System Design and Implementation

The adopted design procedure is an iterative process, which consisted on the following steps given in chronological order:
- Literature review on VHDL coding techniques for more efficient system design.
- Literature review on synthesising techniques for efficient system prototyping.
- Constructing different code configurations to extract the one giving the best speed to area ratio.
- Implementation on the Spartan 3 FPGA board.
- Debugging building blocks as necessary for better and more stable FPGA implementation.

Logical Not Operation
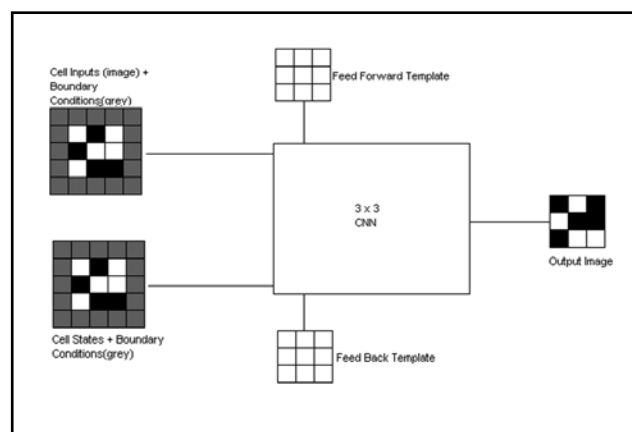
MULTILEVEL CONVERTER TECHNOLOGY IN AC DRIVE APPLICATIONS

Student: Benjamin Pavia   **Supervisor: Dr Ing. Maurice Apap**

Introduction
The utilization of high-speed switching semiconductor devices allows the use of higher switching frequencies allowing higher control bandwidths and the reduction of passive filter component sizing while maintaining high converter efficiency. However as a consequence of this fast switching speed is that the high dV/dt at the converter outputs leads to increased common-mode conducted noise through the motor and cables, which tends to lead to increased peak voltages across the motor windings. This reduces the motor lifetime. Common mode line currents also lead to motor bearing currents leading to increased motor maintenance requirements.

The use of multi-level technology allows smaller output voltage transitions which should therefore lead to the reduction of EMI associated phenomena and the possibility of increased cable lengths without the use of common-mode output filters.

Project Objectives
• Modelling of a 2-level DC/AC converter and the evaluation of the common-mode voltages at the PWM outputs.
• Modelling of a 3-level DC/AC converter including an appropriate multilevel PWM schemes and the evaluation of output common-mode voltages.
• A comparison of the common-mode voltage levels of these topologies.

Project Approach
• Evaluation of Multi-Level inverters described in recent literature.
• Evaluation of which are the most commonly used nowadays and why.
• Gain knowledge of what modulation methods are used for switching IGBTs.
• Construct a mathematical model, then develop a design and implement the inverters after getting familiarization with Simulink®.

Results
It can be clearly seen in Fig.2 that the EMI of VL-L is improved with respect to Fig.1. The FFT of the 2-Level and 3-Level Inverters are shown in Fig.1 and Fig.2 respectively. Both results are obtained from the Simulink® models using PWM having a Modulation Index set to 0.93.
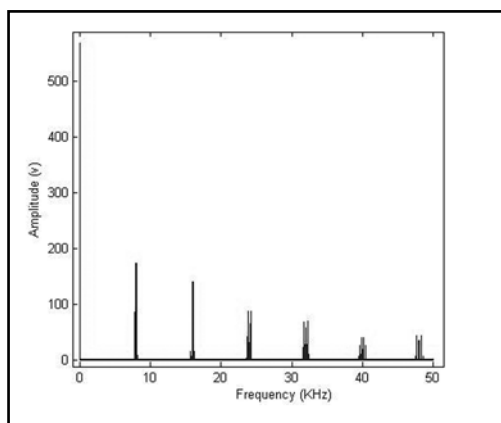
Figure 1: FFT of a 2-Level Inverter   Figure 2: FFT of a 3-Level Inverter
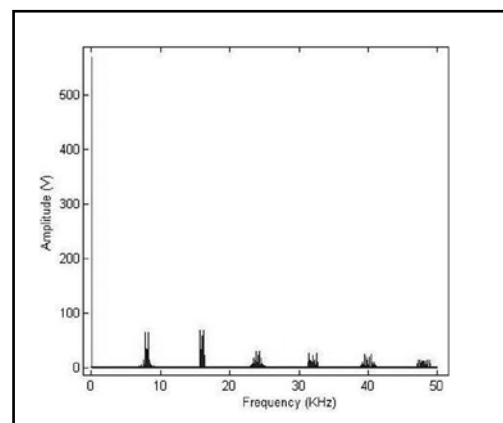
AN AIRBORNE PLATFORM DATA HANDLING SYSTEM

Student: Nathanael Portelli   **Supervisor: Dr Ing. David Zammit Mangion**

Introduction
Unmanned aircraft are becoming popular today for performing tasks which would be too expensive to perform using traditional piloted aircraft, both in military and civilian roles. Examples are surveillance, search and rescue, land surveying and prospecting for natural resources. Every unmanned aircraft must have a suitable control system, generally based on radio communications and microprocessors to control essential functions and do any data processing that has to be done in real time.

Project Objectives
The objective of this thesis is to design and implement a microcontroller development platform that can be used on a small airborne platform and do control and data handling functions. The platform must fit several design requirements such as compactness, flexibility, consideration for future development, performance, efficiency and ease of use.

System Design and Implementation
The development of this platform followed several pre-defined steps as follows.
- Choice of the best bus architectures for on-board communication.
- Choice of a microcontroller and support hardware to satisfy the requirements.
- Design and implementation of a circuit board for the platform.
- Acquisition of suitable tools for development, both software and hardware.
- Setting up the system and creating test programs to confirm that the platform is usable and testing of peripherals.
- Documentation of the development platform so that future users will find it easy to start developing their code next year.

Results
A microcontroller system was built using an LPC2194[ARM7TDMI-S] microcontroller by Philips Semiconductors and it functions correctly. The board can be programmed via RS232 using a bootloader. JTAG interface hardware was also built and used with an open source IDE/compiler/debugger toolchain to permit in circuit debugging of code. Finally several on-chip peripherals were tested and example code for them written.
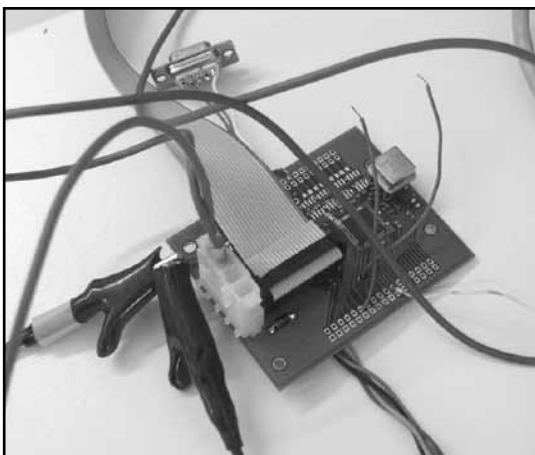
Figure 1: The development board in use
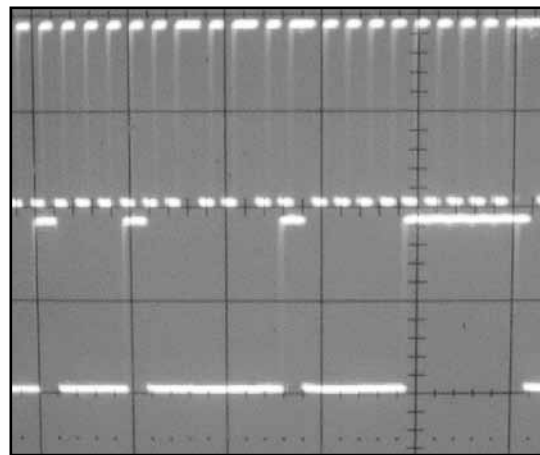
Figure 2: I2C bus waveforms during testing

REAL TIME WATERMARKING IN MPEG-2 DVB TRANSPORT

Student: Vincent Rapa   **Supervisor: Dr Johann A. Briffa**

Introduction
With the evolution of digital multimedia technologies, content owners require new forms of copyright protection for digital images, audio and video particularly since, multimedia duplication does not result in the degradation of quality suffered by analogue media. Based on the traditional process of watermarking and exploiting the properties of digital multimedia, watermarked multimedia protects copyright, discourages counterfeiting and attests ownership. To this end, an invisible, robust and secure watermark is embedded into the multimedia whilst maintaining the quality of source data. While the mere presence of a watermark is a deterrent, it should still be impossible to destroy the embedded watermark without corrupting the source data, rendering the multimedia unusable.

Project Objectives
The aim of this project is to present a classification of the current watermarking technologies and implement a robust video watermarking scheme as a copyright protection system for Melita Cable plc to be employed on re-transmission of ITU-R BT.656-4 digital component video signals, typically encoded to MPEG-2 DVB-C. The Microsoft DirectShow API was used to design a Transform Filter for embedding and retrieving the watermark scheme which in turn interfaces with Decklink video capture and render Filters.

System Implementations
The following Video Watermarking Schemes were implemented:
• Least Significant Bit modification.
• Direct Sequence Spread Spectrum.
• Modifying the Discrete Cosine Transform (DCT) coefficients.
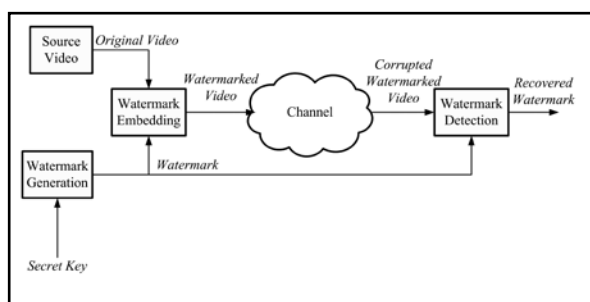
Figure 1: Block Diagram of a Basic Watermarking System
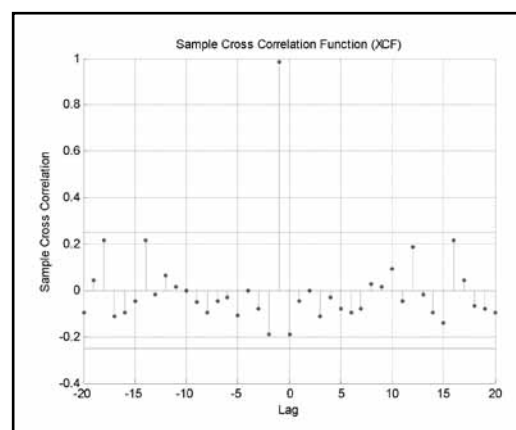
Figure 2: Correlation between the watermark and retrieved watermark before video compression.

AN OFFLINE FLEET MANAGMENT SYSTEM

Name: Edward Scerri   **Supervisor: Dr Ing. Adrian Muscat**

Background
The success and growth in every business activity – from manufacturing to customer service – depends upon how an organization utilizes its critical data. Performance monitoring is a tool that will keep the business on track. Drivers in the past had little control exercised over them once they left the company premises. Mobile telephony and messaging systems facilitated job despatching, but still relied on the witty driver.

Project Objectives
The idea behind this project is based on a low cost infrastructure-less system for logging and interpreting of data related to the automotive world in the ambience of a vehicle fleet owned by the typical Maltese Enterprise; an Enterprise classified as "small" in common EU terms.

The ultimate goal behind such idea is to ensure that company assets are used in the most efficient and effective manner, minimizing vehicle wear and tear and fuel cost. These measures also help in tackling global warming and thus enhancing environmental friendliness.

System Design and Implementation
The main assignment in this project was the process of bringing together a system of many components. This step was crucial in understanding the value of design methodologies and abstractions.
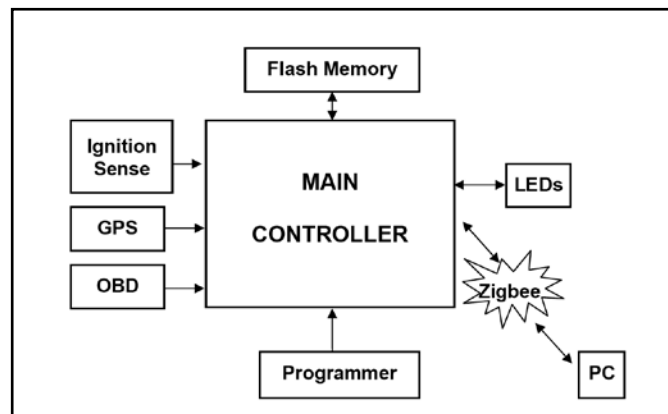
System Architecture

AIRBORNE PLATFORM COMPUTER ARCHITECTURE

Student: Stephen Schembri   **Supervisor: Dr Ing. David Zammit Mangion**

Introduction
My project consists of a microcontroller, which has a SPI and a UART peripheral on-chip, connected to a JPEG Compression Camera Module and a flash memory card. The microcontroller is able to download a snapshot, of what the camera module is "seeing" through its lens, verify its integrity and uploads it onto the SD card.

Project Objectives
The project objectives are to build a mobile system which can be mounted onto an aircraft for reconnaissance purposes. Therefore the system has to be small, lightweight and consumes as less power as possible without trading off performance.

System Design and Implementation
The system was designed using a PIC18F452 microcontroller, a C328-7640 JPEG Compression VGA Camera Module and a Secure Digital (SD) flash memory card and the related signal conditioning circuits. The PIC controller first makes a connection with the SD card, which must be preformatted in FAT16, and then it waits for a trigger from the user. The system is capable of working into either of the two modes of operation. It can either be triggered to take a single shot, or else it can take a burst of shots, starting shortly after the trigger. In either case the PIC connects with the camera module and configures it to take JPEG images at a resolution of 640x480 pixels.
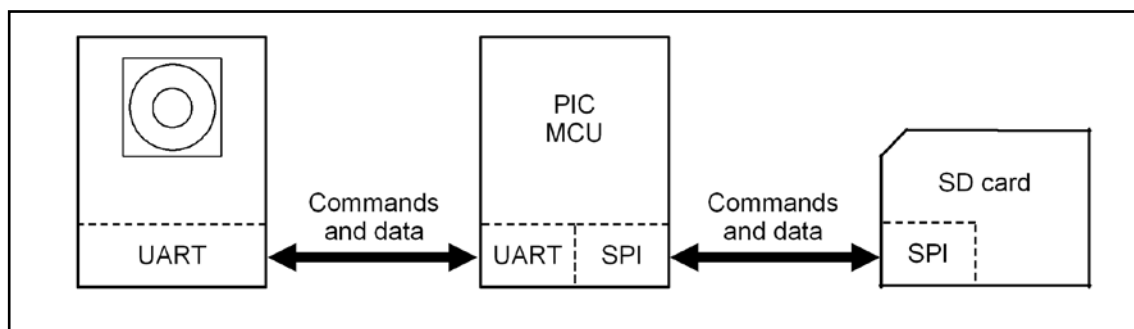
A schematic diagram showing the flow of commands and data between the three main devices used in the project.

BI-DIRECTIONAL POWER SEMICONDUCTOR CONVERTOR
TOPOLOGY: THREE PHASE TO THREE PHASE MATRIX CONVERTER

Student: Kenneth Spiteri   **Supervisor: Dr Ing. Cyril Spiteri Staines**

Introduction

The matrix converter offers an all silicon solution for AC-AC conversion. The circuit consist of nine bi-directional switches arranged in such a way that any of the input lines can be connected to any of the output line. This arrangement takes the form of a matrix, hence its name. The output waveform is then created using a suitable PWM modulation similar to that of a normal inverter, but instead of having a DC link at the input we have got a three-phase supply. The advantage of removing the DC link is that of removing the need for large reactive energy storage components which normally take up 30% to 50% in large converters above 20kW. However, an input line filter is still required to circulate the high-frequency switching harmonics, which are typically in the range of 2kHz to 10kHz. Depending on the switching frequency used.

Project Objectives

The project consist in the design and construction of bi-directional power semiconductor switches for the soft starting and speed control of a 1kVA three phase AC machine. It should also eliminate the need for large reactive components and instead it should make direct use of the input supply. A suitable topology will be studied to allow for this control
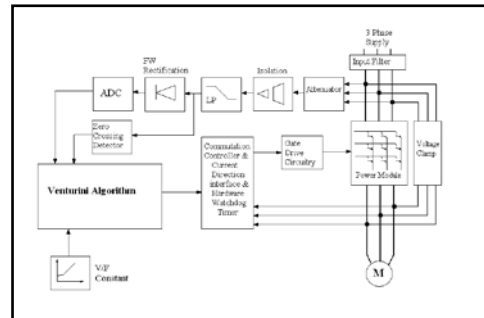
System Implemented

A three phase matrix converter has been built. This is rated at 2.25kVA with an output voltage of $93V$ and a line current of $14A$. This consists of nine bi-directional power semiconductors connected in common emitter i.e. two IGBTs are connected in series opposition, each with a high speed anti-parallel diode. The power module, gate drivers and the commutation controller are connected in cascade style forming one output leg of the converter. Since this is a 3*3 converter, three such legs where constructed. It is also possible to build a 3*N converter using the built hardware by reproducing the output leg for N–times. Each power module has its own heat sink and its where all the power devices have been mounted. These include the six-IGBTs with the antiparallel diodes and two schottky diodes connected in back-to-back. These are needed for the current direction circuitry, where the voltage drop across them is a direct indication of the current direction through them. This is required because the forced commutation implemented is output current direction dependent.
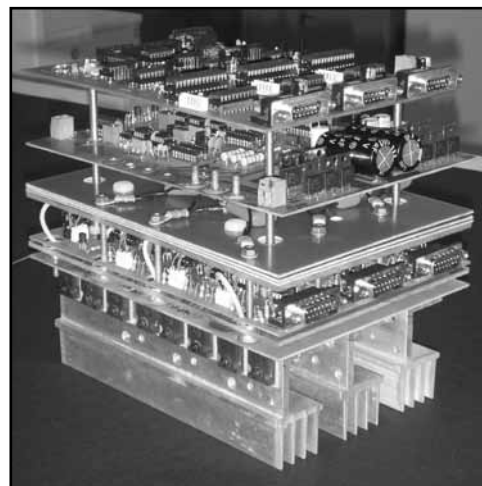
The Built Converter

IMAGE STEGANALYSIS

Student: David Vassallo   **Supervisor: Dr Johann A. Briffa**

Introduction
Steganography is a form of covert communication in which the goal is to hide information imperceptibly within some other media, in such a way that the existence of the hidden information is unknown.

Steganalysis is the art and science of detecting instances of steganography. It has generated significant interest in the technical community as a way to better improve information security, since the illicit use of steganography may be a threat to the security of worldwide information infrastructure.

Project Objectives
• To implement various steganography (information hiding) algorithms on a varied collection of images.
• To implement various steganalysis algorithms in an effort to detect the presence of information embedded by the aforementioned steganographic algorithms.
• To successfully train a classifier to be able to distinguish between images with no hidden information and those with embedded hidden information.

System Design and Implementation
MATLAB® was used to write both the steganography and the steganalysis algorithms in a modular fashion and the final program was run on a cluster of PCs running MATLAB® to tackle the task of gathering statistics on both normal and steganographic images. This data was later used to train and test the image classifier.
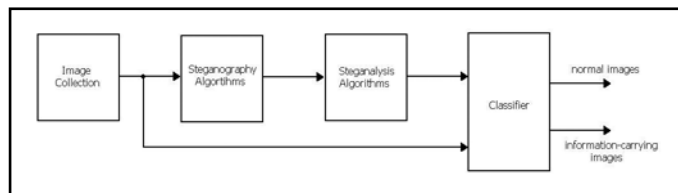
Results
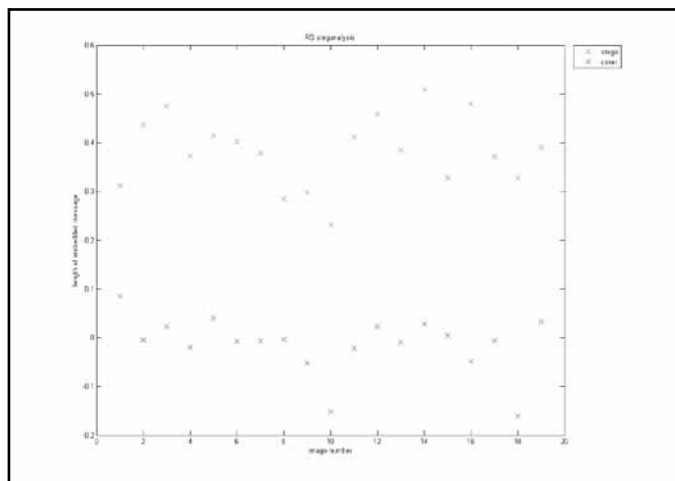
*Statistical Steganalysis, showing the difference between cover
and stego image features*

8051 MULTI-CONTROLLER CAN BUS NETWORK

Student: Roderick Vella   **Supervisor: Ing. Paul P. Debono**

Introduction
Multi-controller systems have become widely used in the last twenty years and networking using the CAN (Controller Area Network) bus is used especially in the automotive industry. CAN is a message based protocol and data transmission between a Master Controller and Slave Controllers or devices can be established at speeds of 1Mbit/s for short distances and at 5kbits/s for large distances.

Project Objectives
The main objective of this project was to test the safety and reliability issues using linked 8051 boards using a CAN bus network. A secondary objective was to improve and upgrade the PAULOS cooperative RTOS and build a new operating system which supports the CAN protocol, enabling slave controllers running their own RTOS to be synchronised to the master RTOS. Finally a number of programs were developed to test the capabilities of the new developed CAN_OS using two 8051 micro-controllers.

System Design and Implementation
Using the Keil IDE a number of programs were first written in order to setup the CAN bus network individually. These were tested using two Silicon Labs C8051F040 boards. Functions from these programs were then used to develop the CAN_OS operating system which is an improvement over the PAULOS real time operating system. Programs using the CAN_OS operating system were than used to test the CAN capabilities of this operating system.
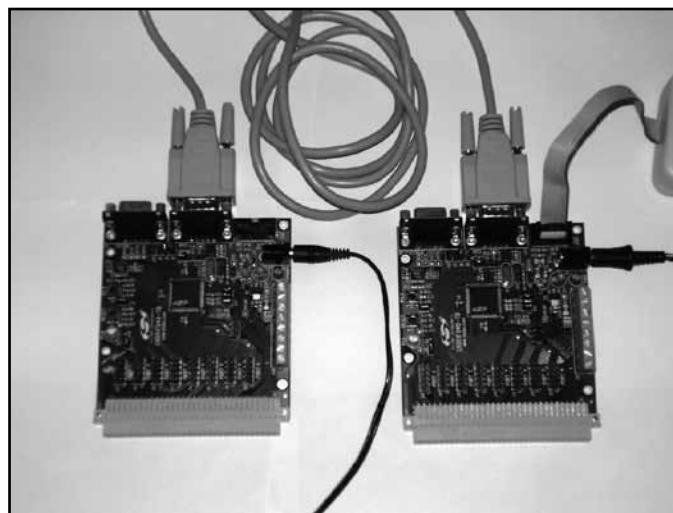
Photo of Microcontrollers connected through a CAN BUS

A STUDY ON THE IMPROVED TAIL CURRENT SOURCE IN LOW VOLTAGE APPLICATION

Student: Di Wu   **Supervisor: Prof. Ing. Joseph Micallef**

Introduction
Nowadays the Op-Amp is running at a very low voltage supply, to perform a good Input/Output characteristics, an improved tail current source is introduced to achieve this goal.

Project Objectives
This project deals with the analysis and simulation of the Improved Tail Current Source compared with the Traditional single transistor current source. To understand the advantages of optimal tail current source that provides large output resistance; low compliance voltage; a better CMRR.

System Design and Implementation
Mainly the analysis is based on a two stage single-ended amplifier, a measurement of the DC operating point, transient response and frequency response gives the satisfied results correspond to theories.
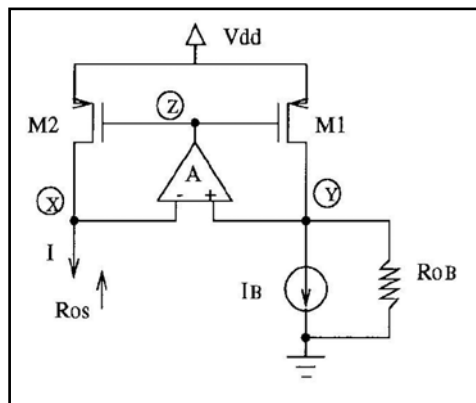
Figure1 : shows the architecture of the improved tail current source which the analysis based on.
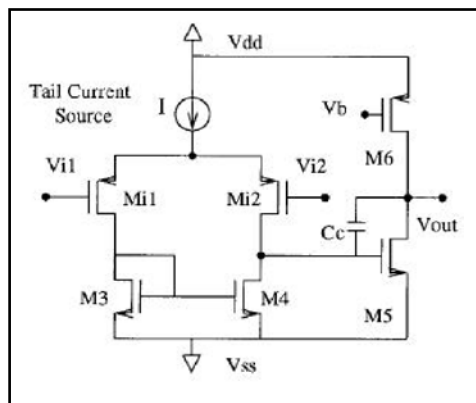
Figure2 : presents the use of the proposed current source in a simple two stage amplifier.

HIGH BANDWIDTH CURRENT AND CURRENT DERIVATIVE SENSORS

Student: Karl Xerri   **Supervisor: Dr Ing. Cyril Spiteri Staines**

Introduction
The thesis focuses on current derivative sensors mainly the Rogowski coil. The Rogowski coil is used for the measurement of alternating current; it is in theory an air-cored coil, which is toroidally wound around the conductor. The resulting magnetic field produced due to the current induces a voltage in the Rogowski coil. This resulting voltage is directly proportional to the rate of change of the current. Rogowski coils can be of two types those wound on a rigid former and those wound on a flexible former. The Rogowski coil possesses a number of advantages over other sensors which include excellent linearity properties due to the absence of magnetic materials, simple circuitry which is non expensive and the added benefit of the coil not being intrusive on the conductor carrying the current. The other sensors used for comparison included the current transformer and the shunt sensor. The shunt resistor works on the principle where the current passes through a small resistance. The C.T. is another popular current sensor that is highly regarded in industry.

Project Objectives
The main project objectives were to design and construct a Rogowski coil sensor, which would be compared with commonly used sensors such as the current transformer and the shunt sensor and also with other current derivative sensors. For the testing purposes a current ramp generator was designed and constructed. A high frequency sine wave generator was also constructed using two TDA2030 power amplifier driver ICs.

System Design and Implementation
For the thesis two Rogowski coils where constructed by hand which consisted of two rigid coils. A flexible Coil was also designed. The current ramp generator circuit was designed to produce a current ramp of approximately 2 Amperes. A power amplifier circuit was also constructed. This was used to produce a sine wave output with a maximum power output of 30W. The coils and other sensors where then placed under the same conditions to analyse their performance at different frequency values. The integrator design and also the self-integrating schemes where also researched and implemented.

Results
A number of results with various sensors including the Rogowski coil have been obtained. Mainly the current derivative wave forms where analysed and in the end comparison was made between the Rogowski coil and the other coils. The performance of the rigid coil was compared with that of flexible coil as well.
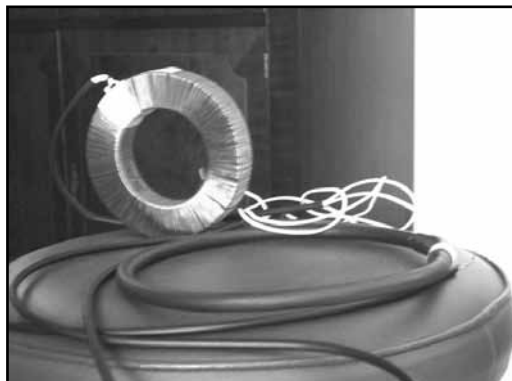
AC/DC/AC CONVERTER CONTROL FOR A REDUCED DC LINK CAPACITOR SIZE

Student: Daniel Zammit   **Supervisor: Dr Ing. Maurice Apap**

Introduction
The aim of the project is to model an AC/DC/AC converter which drives a vector-controlled induction motor drive, and apply a closed-loop scheme for the minimization of the dc link capacitor size.

Commercial back-to-back inverter drives normally consist of two inverter drives connected together at the dc link. This leads to a dc link capacitor of twice the size of that used in standard inverter drives with six-pulse input stages. In the case of an AC/DC/AC converter where both converter stages are PWM controlled, the dc link size can be reduced by the integration of the control algorithms of the two converter stages.

Project Objectives
• Modelling of an AC/DC/AC converter driving a vector-controlled induction motor drive.
• Apply a closed-loop scheme to minimize the dc link capacitor size.

System Design and Implementation
The AC/DC/AC converter and the vector-controlled induction motor were modelled in Simulink® which is part of the Matlab® software package. Each part of the converter, including the switching function, was dealt with separately and then connected together to form the complete converter and the vector-controlled induction motor drive. Finally, the control algorithms of the rectifier and the inverter were integrated together to achieve a smaller dc link capacitor size.
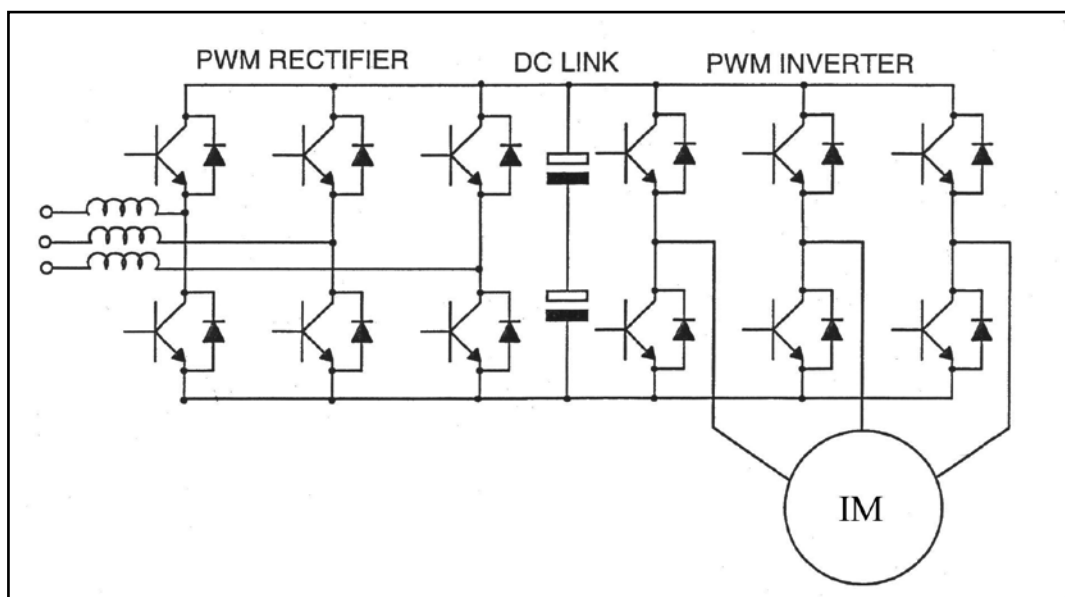
AC/DC/AC Converter

LOW-VOLTAGE MULTIMODE LNA DESIGN IN SIGE TECHNOLOGY

Student: Mark Zammit   **Supervisor: Prof. Ing. Joseph Micallef**

Introduction
In the present world of communications, changing technologies, resulting in changing communication standards, have become a norm. As mobile communications move progressively from GSM towards third-generation systems such as UMTS, the need for multimode receivers becomes evident, as more than a single standard will need to coexist on the same application. A compact multimode receiver allows for greater integration by sharing use of circuitry that is common to multiple standards, leading to an effective reduction of chip area.

Project Objectives
This project investigates part of the front end design for a dual-band WCDMA/GSM receiver, specifically the Low Noise Amplifier (LNA). Design is done using SiGe 0.25mm technology, mostly focusing on the use of Heterojunction Bipolar Transistor (HBT), for operating frequencies centred at 900 MHz and 2.1 GHz. The designs are investigated for operation at low supply voltages down to 1.8 V Simulation results obtained are compared with published results.

System Design and Implementation
- Extensive research on multimode design principles.
- Further research regarding LNA design.
- Design and simulation of individual LNAs for WCDMA and GSM.
- Integration of both LNAs as a dual-band LNA.
- Simulation and optimization using CADENCE® software.
- Analysis of results in relation with existing published results.
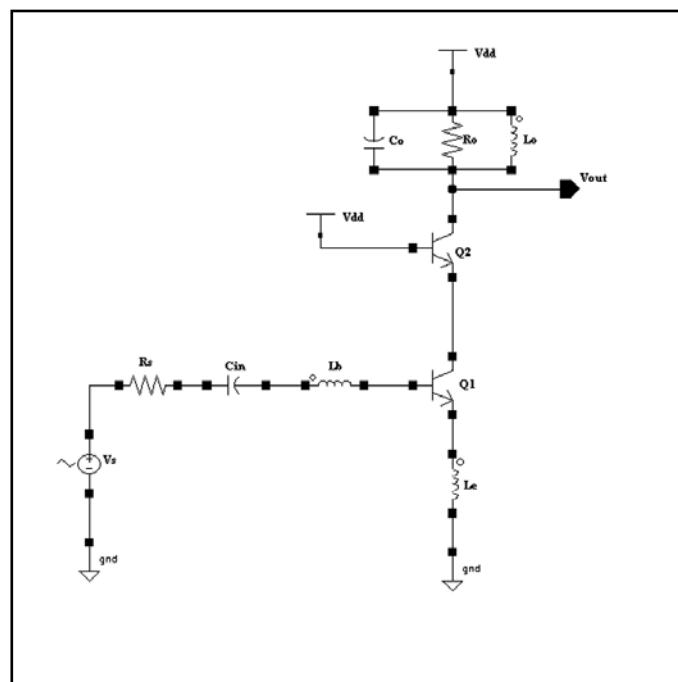
Simple schematic of a cascode LNA

DESIGN OF A BICMOS SIGE HIGH SPEED A/D CONVERTER

Student: Paul Zammit   **Supervisor: Dr Ivan Grech**

Introduction
In modern wireless communication systems operating at high frequencies, a number of down-conversions are necessary in order to bring the signal within the digital circuitry bandwidth. This requires expensive down converters, which increase the system cost and hence reduce its versatility. In order to avoid these intermediate stages, high sampling rate and high analog input bandwidth, analog-to-digital converters (ADCs) are required. Furthermore, modern receivers require an intermodulation performance in excess of 70 dB at the intermediate frequency, thus a large spurious-free-dynamic-range (SFDR) is also necessary.

Project Objectives
The objective of this project is the design of an 8-bit resolution, 3 GSample/s Nyquist ADC using a 0.25 µm SiGe BiCMOS process. A cascaded folding and interpolating architecture (Figure 1) was chosen because of its speed and power efficiency.

System Design and Implementation
• Extensive literature review on the most modern design techniques and ADC architectures that permit a power efficient, single step conversion.
• Literature review and design of a high speed front-end track and hold amplifier (THA).
• Literature review and design of a low settling time differential reference ladder.
• Literature review and design of folding amplifiers and other gain stages.
• Literature review and design of a high speed, ECL comparator.

Results
The THA was designed and it shows a minimum of 8 bit linearity at a sampling rate of 3 GHz over an input signal bandwidth of 1.5 GHz. The differential reference ladder was designed and shows a worst case settling time of less than 19% of a sampling period when loaded with preamplifiers and driven by the THA. Folding amplifiers and other gain stages were designed and simulated to meet specifications. The comparator was designed and simulated to operate correctly at a clock frequency of 3 GHz with a differential input sinusoidal signal of 5 mV amplitude and a frequency of 4 GHz.

ADC Block

70
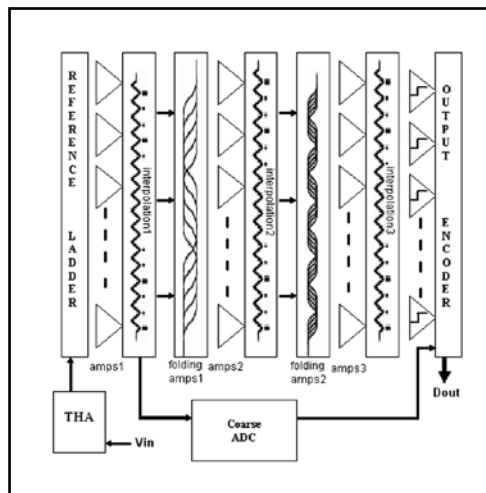
HOT WIRE ANEMOMETER

Student: Robert Zammit   **Supervisor: Dr Ivan Grech**

Introduction
Hot wire anemometry is a method used to measure instantaneous fluid velocity. A hot wire sensor placed normal to a flow will be cooled by the flowing fluid due to the heat transferred from the wire to the fluid. The magnitude of heat transfer is related to the velocity of the fluid.

Project Objectives
Designing and building a three channel input anemometer instrument which is capable to measure average velocities and turbulences of flowing fluids. The instrument includes an LCD and a keypad for user interface, and also connects to a computer for data acquisition and control.

System Design and Implementation
The hot wire is connected to one side of a Wheatstone bridge and heated by an electric current. A servo amplifier balances the bridge by controlling the current in the hot wire so that the resistance and hence temperature - is kept constant, independent of the cooling imposed by the fluid. The bridge voltage squared represents the heat transfer and is thus a direct measure of the velocity. A slave micro controller is used for user interface, while a master micro controller is used for instrument control. Both controllers are programmed to perform their algorithms. A 12-bit 133k sample/second A-D converter is used. Data is transferred to the computer over RS232. A LabView® software program is used for data acquisition, representation and external control.

HAPTIC FORCE FEEDBACK FOR A HUMAN CONTROLLED COMMAND DEVICE

Student: Andrew Zammit Mangion   Supervisor: Dr Ing. Simon G. Fabri

Introduction
The sensory systems in the human hand and arm are a fundamental component in a person's capability of controlling mechanical devices. However in modern control systems, due to the use of servos, there are no physical mechanical links between the object being controlled and the device through which the human enters its command (e.g. a joystick). This has resulted in loss of mechanical "feel" to the human at the command device. In such circumstances, artificial feel in the form of forces or movements at the command device would provide the necessary feedback that enables the human being to optimally perform the task. This technology of providing a realistic sense of touch at the interface between the human and the command device is called haptic feedback.

Project Objectives
The project is intended to investigate the use of electric actuators to provide force feedback to an input command device for providing haptics to the human operator.

System Design and Implementation
The project involves the i) design and construction of 2 prototypes: a joystick operating in one axis and a two degrees of freedom robotic arm, both shown in Figure 1 and ii) the development and implementation of the relevant control algorithms. Controller implementation is effected on the dSPACE 1104 controller board through use of the real-time interface blockset in SIMULINK®. The controllers developed effect force feedback with and without the use of force sensing.

Results
Figure 2 shows the ideal (solid line) and displayed (marked line) forced response of the haptic device for a specific desired impedance mimicking an under-damped spring.

Figure 1: Test Rigs
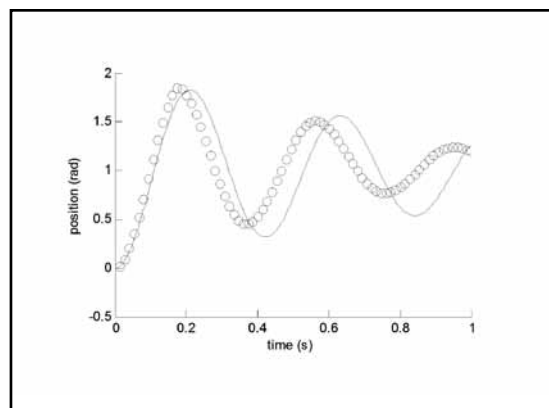
Figure 2: shows the ideal (solid line) and displayed (marked line) forced response of the haptic device for a specific desired impedance mimicking an under-damped spring.
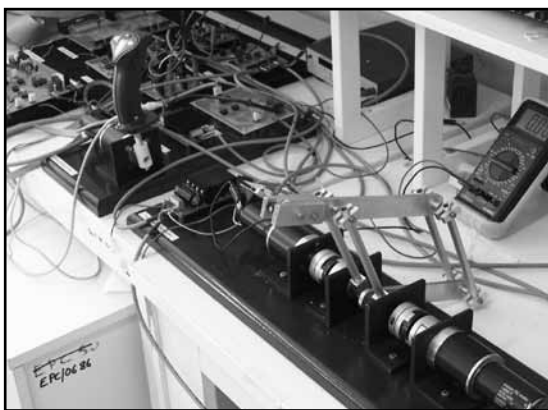
MECHANICAL ENGINEERING STREAM

Department of Manufacturing Engineering
Department of Mechanical Engineering
Department of Metallurgy and Materials Engineering

B.ENG.(HONS) STUDENTS

AUTOMATED IN-LINE COSMETIC CASE INSPECTION

Student: Karl David Agius

Supervisors: Dr Ing. Conrad Pace
Mr Philip Farrugia

Abstract

This project is sponsored by Toly Products Malta Ltd and is directly related to the inspection process of make-up cases produced by Toly. This process is currently performed manually and is quite labour intensive, therefore the objective was to develop an automatic inspection system that reduces the labour costs and improves the inspection outcome for these cosmetic compact cases.

The compact case considered is one of the most popular make-up cases produced for Chanel, a leading brand in the sector of cosmetic products. The automation to be developed regards the inspection of some of the most frequent production defects that make this cosmetic compact case unacceptable. These defects which are classified as functional defects arise during the injection moulding and the assembly process of this compact. The following are the functional requirements that the automated process needs to test:

• The gapping of the compact between the lid and base must not exceed a stipulated amount.
• The torque to open the lid must lie within a given range in order to ensure that the lid is not too easy or too difficult to open.
• The push-button is in position and properly assembled.

This thesis is therefore concerned with the research, design, development and testing of an automated system satisfying the above purposes and targets. An analysis of the failures was first carried out using failure mode and effects analysis. The conceptualisation and evaluation of the design concepts were then performed, following a design methodology, and the promising concepts were developed further for experimental analysis. A testing jig to prove these selected concepts was built. This consisted of two separate automated rigs that simulate the inspection process of these make-up cases. This project concludes with comments and additional suggestions on the implementation of the proven concepts within the current production process.

Cooper compact case Toly Products

CONTINUOUS DEVELOPMENT OF AN AUTONOMOUS GUIDED VEHICLE PLATFORM

Student: Sandro Azzopardi   **Supervisor: Dr Ing. Conrad Pace**

Introduction
This project is part of an ongoing project by the Department of Manufacturing Engineering to develop an autonomous guided vehicle that can ultimately be integrated within a smart flexible manufacturing environment. The vehicle used in this project was constructed in a previous project.

Project Objectives
The primary development objectives of this thesis were:
- To develop the control programme for the differential drive configuration.
- To develop a path sensing setup using vision sensing.

System Design and Methodology
The kinematic equations of the differentially driven vehicle were modelled by the so-called chain form equations. Applying an input scaling controller to these equations derives the controller that will drive the lateral and orientation errors from the desired vehicle path to zero. A velocity scaling controller was next implemented on the control wheel velocity outputs. This would scale the wheel velocities down to achievable values by the vehicle. A simulation application programmed in Visual C++ was developed to test and optimize the behaviour of the vehicle. This simulation could also model the acceleration behaviour of the vehicle based on the vehicle's dynamics.

Furthermore, a vision system was developed for path detection. A digital camera was mounted on the vehicle to sense the path in front of the vehicle. Making use of the Open Computer Vision (OpenCV) library provided by Intel, several image processing steps were performed in real-time on the initial RGB image so as to localize the path. In order to eliminate the perspective effect due to the camera orientation with respect to the path, the image coordinates were remapped to the real world coordinates by applying the Inverse Perspective Mapping (IPM) technique. Having localized the path in the real world coordinates, the lateral error and orientation error could be geometrically calculated and input to the control system for path following.
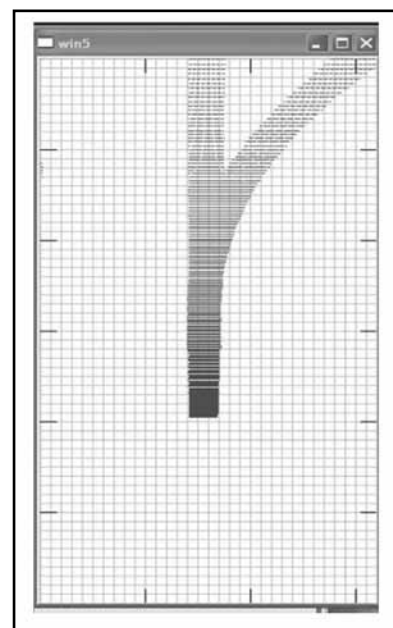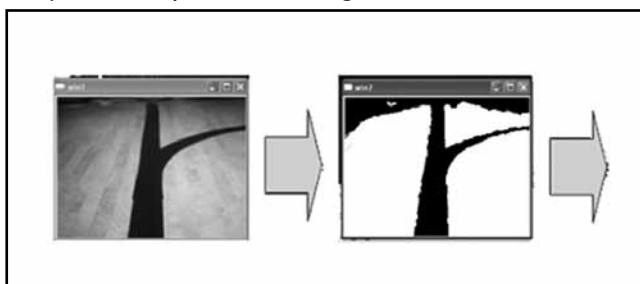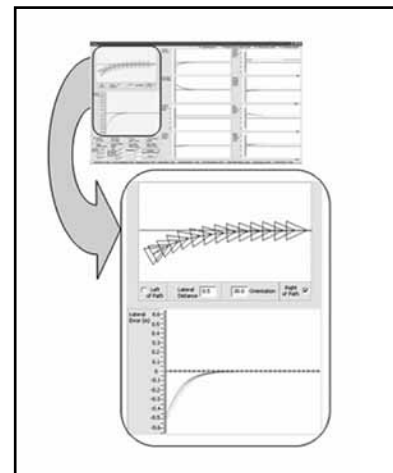
PARAMETRIC 3D MODELLING THROUGH FREEHAND SKETCHING
A Geometric Constraint-Based Approach

Student: Franklin Balzan   **Supervisor: Ing. Philip J. Farrugia**

Introduction

Despite the availability of Computer-Aided Design (CAD) technology, paper-based sketching is still widely used by designers as means to externalize their form design concepts. This is due to the rigid user-interface (UI) of current CAD systems, which lack the fluidity of paper sketching. Consequently designers are constrained to manually transfer freehand sketches into CAD systems, which is time consuming. As a step towards addressing these issues, a prototype computer-based design tool is continuously being developed at the Concurrent Engineering Research Unit (CERU), Department of Manufacturing Engineering (DME), which allows the designers to automatically obtain 3D CAD models directly from paper-based sketches. However, with the current tool, nicknamed mX-SKetch, it is not possible to generate parametric CAD models. Given that a freehand sketch is usually imprecise, it would be beneficial that the generated CAD model is parametric, as it can be used later in the design process.

Project Objective

The overall objective of this project is therefore to improve the current mX-SKetch tool enabling the generation of a 3D parametric model from a freehand paper-based sketch. In order to generate useful 3D parametric models, appropriate geometric constraints must be specified in the sketch and be comprehended by the mX-SKetch tool, as shown in the figure. Furthermore, a remote support tool which aids the designer in the semiformal sketching stage is to be devised. This online library of symbols provides the designer the symbol he requests on his mobile device.

Methodology

- Literature review on design theory, sketching activity and parametric modelling.
- Understand the technical requirements necessary to obtain a parametric and feature-based 3D model.
- Understand the current operation of the mX-SKetch tool.
- Implement these technical requirements in mX-SKetch.
- Evaluate the improved tool's underlying concepts with potential users.
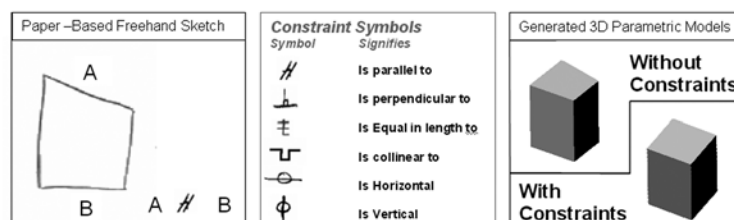
Geometric constraints that can be specified in the improved mX-SKetch tool

AN INVESTIGATION OF GEOTHERMAL HEAT PUMP SYSTEMS

Student: Albert-Paul Borg   Supervisor: Prof. Ing. Peter Paul Farrugia

Introduction
Geothermal heat pump systems are reputed to be the 'greenest' of heat pumps. Instead of rejecting/absorbing heat from ambient air, such systems utilise more favourable heat sinks/ sources, available in the form of constant temperature reservoirs present naturally as either groundwater or the earth itself. Easier heat transfer results in energy savings.

Project Objectives
• Design and implement a geothermal system to replace a conventional air conditioner.
• Determine the COP and measure the energy consumption of both systems.
• Analyse the feasibility and possible locations/configurations of such systems in Malta.

System Design and Implementation
Adequate testing facilities (an appropriate room) were built to be able to compare the performance of the conventional heat pump with that of the geothermal heat pump accurately and as is common practice according to standards. A heat exchanger for use with underground or well water was designed and built. Both the conventional and geothermal systems were installed and tested (compared) by loading the indoor unit and determining the COP and energy consumption for both the heating and cooling cycles.

Results
The conventional heat pump was tested at different outdoor temperatures and it was noted that during cooling mode its efficiency decreased at high temperatures and vice versa during heating mode. The geothermal system remained at a more favourable temperature during testing. Thus energy consumption was less and did not vary.
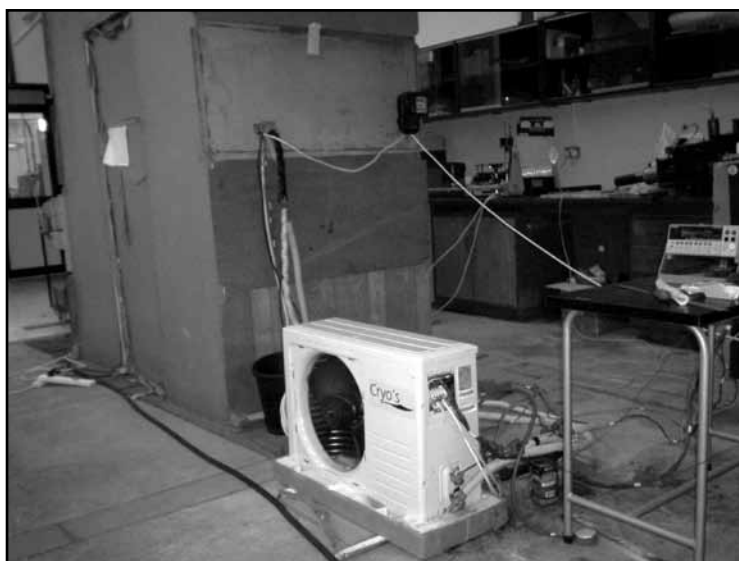
Figure showing the apparatus set up

ANALYSIS OF A SPINAL SEGMENT

Student: Neal Borg   **Supervisor: Ing. Zdenka Sant**

Introduction
The understanding of the behaviour of a spinal segment under load would be a useful tool to researchers in the biomedical industry so as to improve current designs of implants such as artificial discs, stabilizers and posterior synthetic spacers.

Project Objectives
- Create a solid model of a spine segment.
- Create a material model.
- Analyse stress and strain distributions within the segment.

System Design and Implementation
The study included a detailed background investigation of the biological and biomechanical properties of a lumbar spinal segment, focussing mainly on the articulations between the lumbar vertebrae. A finite element model of an intervertebral disc (as shown in the figure), with the aim of being joined to previously modelled lumbar vertebrae, was created using ANSYS Multiphysics 10.0. The model's geometry was based on data provided by a CT scan of an L4-L5 segment of a 28 year old male. The model was built based on three main materials: a central nucleus pulposus, twelve annulus rings, and collagen fibres alternately oriented at approximately 110 degrees between each ring. The intervertebral disc model was subjected to compressive loading, obtaining a distribution of the stress and strain throughout the various parts of the model.
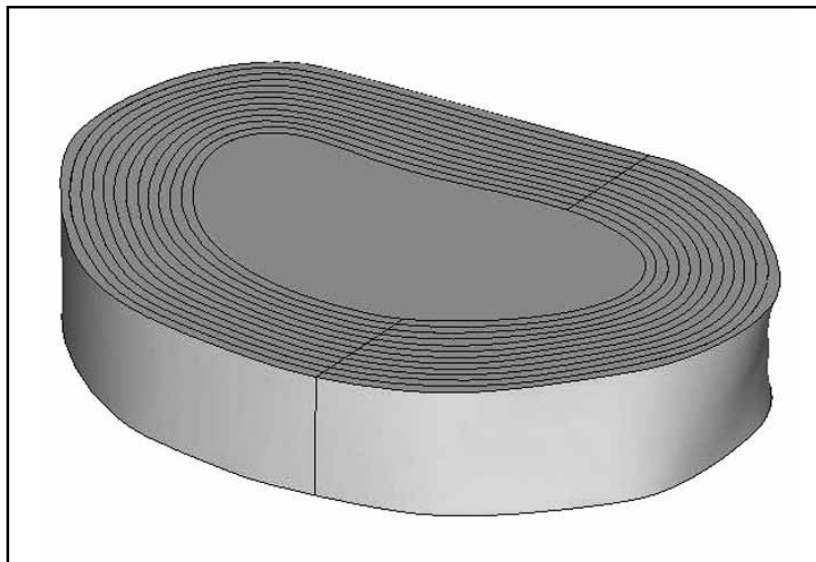
Volume plot of the intervertebral disc modelled.

FATIGUE STRENGTH OF PRESSURE VESSELS

Student: Omar Bugeja   **Supervisor: Dr Ing. Martin Muscat**

Introduction
The design of pressure vessels and pressure vessel components is carried out using a stress analysis approach. The European pressure vessel code EN 13445-3 is divided into two main sections – Design by Formula (DBF) and Design by Analysis (DBA). In both sections the code ensures to prevent failure due to a number of possible failure modes. One of these failure modes is failure due to high cycle fatigue. Good knowledge of how to perform the design check against high cycle fatigue failure is of paramount importance to safe design of pressure vessels.

Project Objectives
• To investigate fatigue strength of welded structures by conducting a preliminary study.
• To study and explain the fatigue assessment procedures available in the European pressure vessel code EN13445-3.
• To perform a fatigue assessment using the finite element analysis software ANSYS.

System Design and Implementation/Methodology
To understand better the effects of welding on the fatigue strength of pressure vessels, the first step in the project was to carry out a preliminary study on fatigue strength of welded structures. The stress concentrations produced by different types of welds were shown by finite element models. The next step of the project was to study the fatigue assessment procedures available in the pressure vessel code. Finally, a fatigue assessment was carried out on unwelded and welded pressure vessel components by the DBA route through the use of ANSYS.

Results and Achievements
The preliminary study revealed that welded components are less tolerant to fatigue loading than non-welded components. Additionally a better understanding of how to perform a fatigue assessment was achieved through the examples conducted.
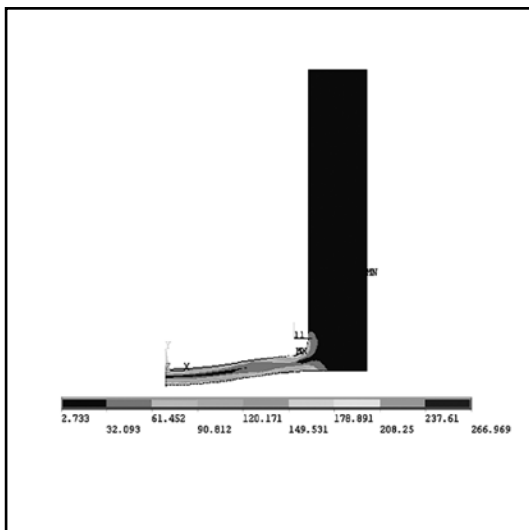
FE model of a thin flat end
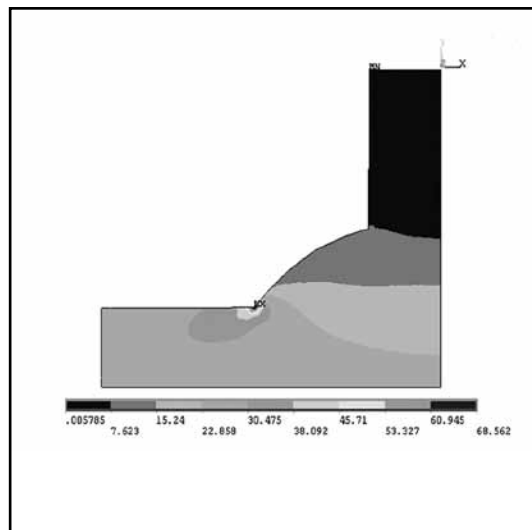
FE model of transverse fillet weld showing stress concentration at weld toe

ENGINE SIMULATION "AN INVESTIGATION OF AN HCCI ENGINE CONCEPT"

Student: William Camilleri   **Supervisor: Dr Ing. Mario Farrugia**

Introduction
Homogeneous Charge Compression Ignition (HCCI) is a combustion process in which a uniform charge of fuel and air are compressed. This compression is sufficient to cause instantaneous auto-ignition of the fuel throughout the combustion chamber. HCCI has the potential to significantly reduce NOx and particulate emissions. The overall efficiency exceeds that of SI engines and is comparable or better than that of CI engines.

Project Objectives
The primary aims of this thesis were to:
• Build a computer model to simulate HCCI in a conventional reciprocating engine.
• Compare the results with those from other researchers.
• Investigate the characteristics of the engine.

The secondary aims of this thesis were to:
• Build a computer model to simulate HCCI in a Non-reciprocating Internal Combustion Engine (NICE).
• Investigate the characteristics of the NICE engine.

System Design and Implementation
Two computer models were built to test the two engine concepts. The models were implemented in Ricardo Wave® and the results compared with experimental values reported in technical literature.

Results
The main results of simulations on the conventional reciprocating engine were in line with those reported by other researchers, namely, high peak pressures and temperatures. Controlling the point of auto-ignition also proved difficult. However, through the use of Internal - Exhaust Gas Recirculation (I-EGR) and intake air preheating successful control over a range of speeds was achieved.

The simulations on the NICE engine proved that no external control was needed to control the point of auto-ignition which is a major advantage of this engine over the conventional reciprocating engine. However, it was found that intake air preheating was still required to achieve spontaneous combustion of the fuel. In fact the higher the speed the more air preheating was required.

EMOTION-DRIVEN DESIGN FOR A USER 'FLEXIBLE' MOUSE

Student: Fleur Caruana

Supervisor: Dr Ing. Jonathan C. Borg
Co-Supervisor: Ing. Oliver Fenech

Introduction and Problem Background
Competing products are becoming technically equivalent, and recent design trends show an inclination towards products that provide the most pleasure, inspiration or excitement to stakeholders. For this purpose, the area of Emotion-driven Design, though novel, has gained considerable importance over recent years.

In this respect, the functional equivalence of most computer mice available on the market provides a suitable scenario for the adoption of such an Emotion-driven Design strategy. Due to the fact that the evaluation of products is typically subjective, product customisation has come to be acknowledged as a valuable means of meeting the customer's individual needs. In this case, customisation can therefore be provided through the design of a flexible computer mouse.

Project Methodology
The project was implemented as outlined below:
• Literature search in the field of Emotion-driven Design.
• Acquiring a better and common understating of the stakeholder through Survey research.
• Generation of a number of conceptual flexible computer mice designs.
• Evaluation of the final flexible computer mouse designs with potential users.
• Generation of a number of generic Design For emotions (DFe) guidelines.

Results
The conducted Survey research resulted in the identification of three user groups, termed Nostalgics, Fun-seekers and Usability-minders. Subsequently, via the use of creativity techniques such as Personas and Image boards, three conceptual flexible computer mice were designed, one for each user-group (see figure).

CAD models of three conceptual computer mice

DETERMINATION OF THERMAL CONDUCTIVITY OF BUILDING MATERIALS USING THE CALIBRATED HOT BOX METHOD

Student: Jeanelle Cassar

Supervisor: Prof. Ing. Robert Ghirlando
Co-supervisor: Mr Mario Fsadni

Background

The 2006 draft building regulations were introduced to improve the approach of the construction industry towards energy performance of buildings. However, these regulations are proving to be inadequate for the local Maltese climate conditions. These building regulations need to be amended to be in line with Maltese climate conditions as well as to available building materials. Through experimentation one can revise the stated U-values, so once these values are determined the draft regulations can be corrected accordingly.

Aim

• To determine the thermal properties of local building materials using a calibrated hot box.

Objectives

• Understand and collect information and data from previous projects.
• Set up the hot box and all other equipment.
• Calibrate the hot box and carry out tests with specimens of known thermal conductivity.
• Obtain detailed scientific data on the thermal properties of in-service local building materials.

Design of Experiment

The experimental set was designed to measure air and surface temperatures on each side of the test wall. The hot box was constructed of two halves made of 0.06m of plywood with 0.225m expanded polystyrene insulation. The two halves (hot chamber and cold chamber) can be rolled away from each other from a base on which a test wall can be built. Eighty-three thermocouples were positioned on the inside and outside of the hot box. A DAQ system in conjugation with a customized data collection and handling software was used to record and monitor the temperatures over a specified period of time.

Conclusion

Three tests were carried out; the first test was a calibration test using an expanded polystyrene wall. In the second test a polyurethane foam panel coated on both sides with 80-micron thick aluminium foil was used. Finally a brick wall was built and finished in order to simulate real building conditions.

OPTIMISATION OF ROBOT HAND DESIGN
THROUGH HUMAN MANUAL DEXTERITY TESTING

Student: Alistaire Chetcuti   **Supervisor: Dr Ing. Michael A. Saliba**

Introduction

The human hand is the most dexterous entity that one can find in nature. It is made up of 21 degrees of freedom in the fingers only (i.e. excluding the palm and the wrist). To build a commercially feasible anthropomorphic end-effector one must keep the design as simple as possible. Since dexterity is a measure of manipulation capability, reducing the degrees of freedom will reduce dexterity which is the contrary of what is expected from this project. This might not be the case though if one can identify any attributes in the human hand which are redundant or contribute too little to be included in a robotic hand.

Project Objectives

The aim of this project was to design a set of dexterity tests to be carried out on human subjects in which specific attributes such as joint flexion, joint abduction and touch sensing were separately restrained. The results obtained would then be used to formulate a set of guidelines for robot hand design.

System Design and Implementation

Three standard tests were constructed to satisfy this aim: the Grooved Pegboard Test, the Box and Block Test and the Nine-Hole Peg Test. Thirty human subjects were asked to repetitively carry out these tests, each time restraining a different attribute of the human hand. The figure shows a human subject inserting the pegs in the Grooved Pegboard with his middle finger immobilised.

Results

From the results obtained it was concluded that from the four fingers opposing the thumb the middle finger is the most important one for these tests. It was also observed that the pinky finger's contribution to the hand's dexterity is negligible since the results for the free hand and for the hand with the little finger immobilised were approximately identical. The effect of abduction and sense of touch were also determined.

The Grooved Peg-Board Test

UPGRADING THE HOUNSFIELD TENSOMETER

Student: Ryan Curmi   **Supervisor: Dr Ing. Martin Muscat**

Introduction

Around 1963, the Department of Mechanical Engineering acquired a small yet versatile materials testing machine known as the Hounsfield Tensometer. This machine is capable of performing tensile tests and various other tests for mechanical properties of engineering materials. The data acquisition system of the original machine was completely manual, thus leading to loss of accuracy in the measured data. It has been decided to revive the Hounsfield Tensometer by computerising the machine, allowing it to be used for demonstrations and materials testing alike.

Project Objectives

The main project objectives included:

- Making a preliminary study and report on how the Hounsfield Tensometer operates.
- Listing and studying the tests which could be performed using the Hounsfield Tensometer.
- Improving the way data is captured on the Hounsfield Tensometer - basically to design and implement a strain gauge transducer/s that can be used to carry out all the mechanical property tests available, via computer.

System Design and Implementation

Initially the Hounsfield Tensometer was fully refurbished as it was unused for several years. Some simple tests were carried out using the machine to familiarize with the manual data recording systems available before dismantling the hazardous mercury column load transducer, along with other obsolete recording devices. Finite element analysis (FEA) using ANSYS® was carried out on the spring beams of the machine, which serve the purpose to deflect upon application of load. It was then decided to transform one beam into a load cell, by the use of strain gauges. Also, an electronic motion sensor system was set up to detect the elongation of specimens, to

Figure 1: Spring Beam FEA model

serve as an extensometer. Everything was coupled to a computer via National Instruments® (NI®) data acquisition (DAQ) hardware. The final stages of the project involved the design and building of a custom load cell to fit the tensometer, with the possibility to calibrate the machine and also to serve as a transducer itself. Graphical programming using LabVIEW® (by NI®) allows the machine to be used like any other modern materials testing machine.
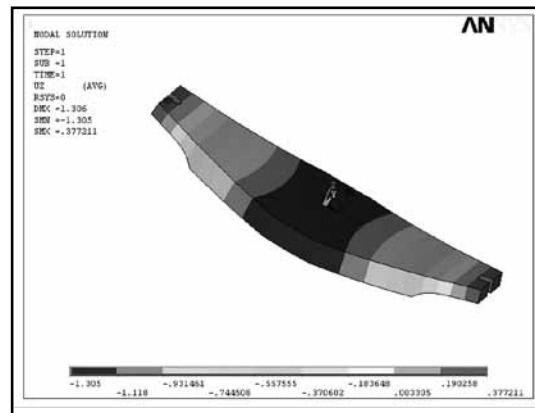

Figure 2: The restored Hounsfield Tensometer

INVESTIGATING THE AERODYNAMIC PERFORMANCE OF A MICRO WIND TURBINE OPERATING IN THE BUILT ENVIRONMENT

Student: John De Carlo   **Supervisor: Dr Ing. Tonio Sant**

Introduction
Environmental concerns coupled with economical concerns are slowly shifting electrical power generation from conventional means to more environmentally friendly renewable sources of energy such as wind energy. In countries like Malta, where land space is quite limited, large scale systems on land are not viable and the implementation of small scale systems operating within the built environment may have to be considered. This thesis investigates the velocity variations in the flow around a building so as to determine the flow characteristics reaching a wind turbine installed above a building. Velocity augmentation can be beneficial to power generation because of the cubic relation of wind speed with available power in the wind as shown in the equation below.

$$P = \frac{1}{2} r \, AU^3 C_P$$

A small increase in wind speed U will result in a much greater increase in available power P. However, this may also be a disadvantage in power performance assessment. Special attention should be given when deriving the power coefficient directly from wind speeds and power measurements. This is because a small error in U results in a significantly larger error in C_P.

Project Objectives
- To design and build a rig in order to investigate the flow around a model building inside a wind tunnel and assess the velocity variation at different heights above the building for different wind directions.
- To determine velocity differences between anemometer and rotor hub location.
- To model the building using CFD and validate the results obtained from the simulation with those obtained from experiment.
- To analyse recorded data from a wind turbine at the University of Malta and plot performance curves, compensating for wind flow velocity corrections determined experimentally or by computational means.
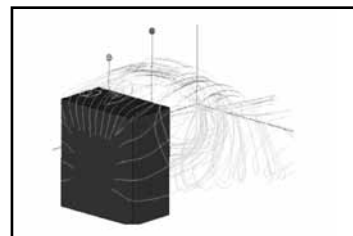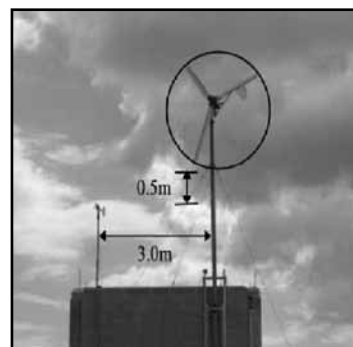

Figure 1

Results and Achievements
Velocity variation plots for various wind directions were obtained both experimentally, as shown in Figure 2, and from CFD simulations. Figure 3 shows a streamline plot obtained from the CFD simulation.
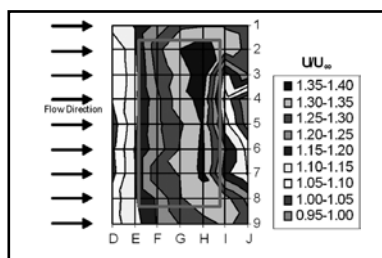

Figure 2

Figure 3

MEASUREMENT OF THE UNSTEADY AERODYNAMIC LOADS ON A PITCHING AEROFOIL USING STRAIN GAUGE TECHNIQUES

Student: Kristian M. Farrugia   **Supervisor: Dr Ing. Tonio Sant**

Introduction
Wind energy is one of the most effective power technologies that are available today. Yet, if engineers are to make wind energy more economically viable, a better understanding of the flow physics over a wind turbine and its aerodynamic behaviour is essential. This thesis is a study on how we can measure the aerodynamic loads on a wind turbine blade operating in an unsteady environment.

Project Objectives
The aims of this dissertation are:
- to construct a wind tunnel test rig consisting of a symmetrical NACA 0012 aerofoil fitted with a servo motor and strain gauges to measure indirectly the normal force induced by the aerofoil.
- to interface the strain gauges and servo motor with a computer using the Labview software, in order to give different motion inputs to the wing.
- to conduct various tests using the setup and obtain dynamic stall hysterisis loops on the $C_L - \alpha$ curves at low Reynolds' Numbers.

### System Design and Implementation
In unsteady aerodynamics, measurement techniques unlike conventional wind-tunnel techniques have to be used. Unsteady aerodynamic loads do not allow for typical measurement techniques such as spring, pulleys and counterweights. In this project a NACA 0012 aerofoil was set up in the wind tunnel at the University of Malta. The aerofoil was given different kinds of pitching motion inputs using a servo motor and controller. The aerodynamic loads were then measured using strain gauges and accurate data logging using Labview©.
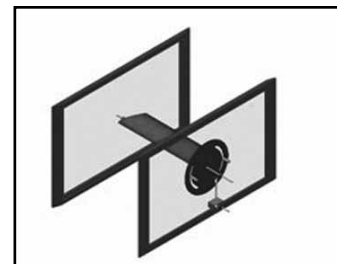
The apparatus used

Results
Having obtained different values of normal forces acting on the aerofoil at different angles of attack, we could plot hysterisis loops on static lift-curve plots and analyse the response of the aerofoil. In general, elliptical loops as those predicted by theory were observed for attached flow. Also, a delay was observed in flow separation and flow reattachment.
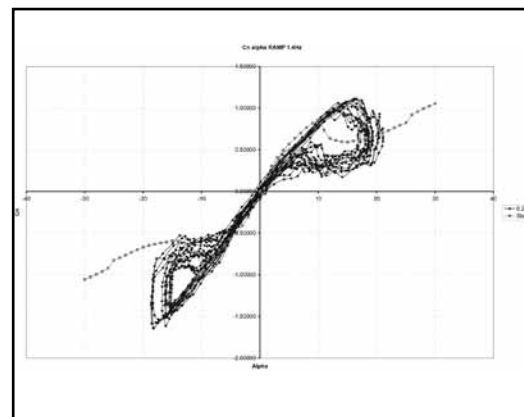
A typical dynamic stall loop

THE CREATION OF A RIG FOR VALVE JUMP AND VALVE BOUNCE TESTING

Student: Michael Farrugia   **Supervisor: Dr Ing. Mario Farrugia**

Introduction
Valve jump and bounce are problems affecting force-controlled automotive valvetrain systems operating at high speeds. In valve jump, the inertia of the valve as it opens is greater than the force exerted by the spring pushing it back up against the rocker arm. For a short time the valve floats freely not under control of the camshaft. At valve bounce the closing speed of the valve is higher than designed and so instead of seating properly the valve hits the valve seat violently and rebounds, causing an undesired second opening of the valve.

Valve jump and bounce are studied by engineers designing engines for sports applications where high RPMs are generally reached, since they cause loss of engine power and even the risk of severe engine damage. Of particular interest are the engine speed at which these phenomena occur and the effect of valve weight and spring stiffness on this speed.

Project Objectives
The objective of the project was to design and create a test rig that would be able to test a cylinder head for valve jump and valve bounce. The rig was to be built and used to test a number of methods for detecting jump and bounce.

System Design and Implementation
The system was designed to provide versatility and plenty of opportunity for further upgrades. A SOHC cylinder head was used for testing, but the rig is designed to work with a variety of cylinder head types. Variable speed for the camshaft is provided through a 3-phase induction motor controlled by an Inverter. The motor is fixed inside a purposely-built frame that allows the torque output to be measured if required. A load cell was designed and modelled in ANSYS® to be used for this purpose. The cylinder head is fixed to another frame and torque to the camshaft is applied through a belt drive. A lubrication system was put in place. Detection methods tested are aural, visual (using a stroboscope) and measuring the bending forces on the rocker arm.
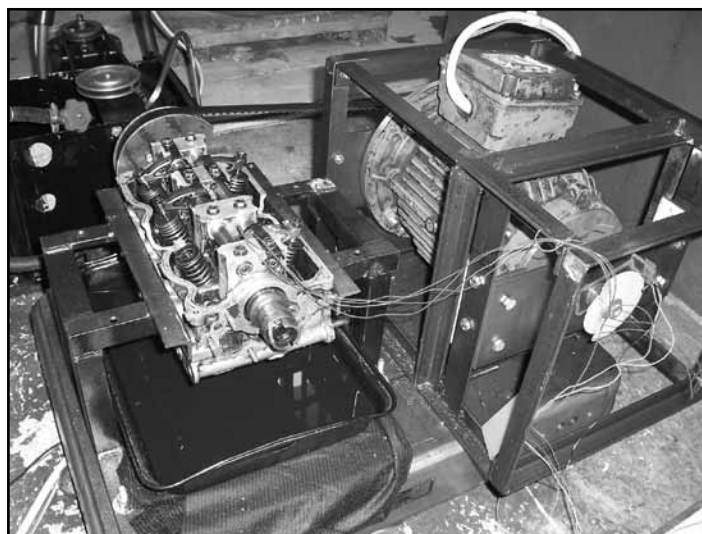
The Test Rig

THE ASSESSMENT OF CORROSION RESISTANCE OF MAGNESIUM ALLOY ASSEMBLIES

Name: Owen Farrugia **Supervisor: Dr Ing. Stephen Abela**

Introduction
The limited supply of mineral resources, ecological aspects and technological limitations, have led engineers to search for materials which are abundant in the earth's crust and having better properties. An experimental setup has been designed in order to generate several thousands of volts which are to be applied to magnesium components. This will serve to produce a conversion coating for magnesium alloys surfaces. The surface modification technique has been selected such as to make up for the poor tribological properties of magnesium and its alloys, with particular reference to their high susceptibility to electrolytic and galvanic corrosion.

Figure 1: Plasma Source in Chamber

Figure 2 : Scaled Down AM50 Mg Alloys Hubs

Project Objectives
The goal of this project is to assess the improvement imparted on the corrosion resistance by the novice conversion coatings to the surface of a magnesium alloy component, making part of a complex assembly.

System Design and Implementation
The Extra High Voltage (EHT) is used to ionize the gas injected into the chamber producing plasma in which the components are immersed. These are accelerated towards the substrate under the effect of the high electric fields set up by the EHT resulting in plasma immersion ion implantation. The plasma density was further increased by the use of a secondary electrode provided with magnetic confinement. The conversion process is conducted under vacuum and room temperature, thereby resulting in the minimal use of gases and energy. Surface-treatment experiments have been conducted on scaled down components machined out of AM50 magnesium/aluminium alloy on the IBAD (1mbar, 150Hz, 40kV), at the Surface Engineering Limited, University of Malta.

Figure 3: Experimental Setup in our Labs

Results
Coatings have been demonstrated to be perfectly transparent. Further examination of the coating includes the assessment of corrosion resistance and immunity to galvanic coupling compared to the untreated version. Improvement of the apparatus and refinement of the process parameters – which include the injection of miscellaneous gases (such as the addition of BF3-ether as a source of fluorine) in the plasma reactor are ongoing to further reduce the processing time and enhance the coating properties. Subsequent coatings are planned to be deposited on top of the conversion coating to provide a better overall protection.

AIR FLOW RATE MEASUREMENTS FOR ENGINE SIMULATION

Student: Keith Fenech   **Supervisor: Dr Ing. Mario Farrugia**

Introduction
The study of air flow in engines has always been of great interest to manufacturers within the automotive industry. The flow bench provided an easy, yet accurate way to investigate the flow of air entering the components under test, facilitating the design process and allowing for modifications in tuning operations. Flow benches are used extensively to test and modify various engine components. The combination of the results obtained from such tests with engine simulation software (such as Ricardo WAVE®) provides the grounds for a detailed inspection of the events taking place within a running engine.

Project Objectives
The objectives of the project were: to build a flow bench, to carry out flow tests on a Peugeot 205 cylinder head and an FSAE® Throttle Body using the flow bench, and to grow familiar with the Ricardo WAVE® engine simulation software package to better understand the importance of flow bench data.
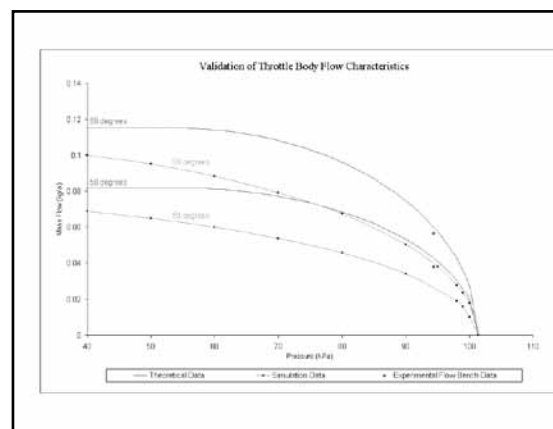
System Design and Implementation
Prior to the physical construction of the flow bench, the project required the theoretical verification of whether the fan used in the setup would deliver the pressure head of 6.97kPa required for the tests. This was done using the Similarity Rules and scaling the performance characteristics of the fan. The new characteristics were analysed and compared to the manufacturer's data. The Hyundai Karman Vortex type Mass Air Flow (MAF) sensor used to measure the air flow rates was also calibrated. Thus the flow bench tests could be performed.

Results
The tests conducted on the cylinder head yielded values for the Coefficients of Flow (C_F) and Coefficients of Discharge (C_d) at various valve lifts for the intake and exhaust runners with and without bell-mouth entries. The tests on the Throttle Body allowed for the comparison of data obtained through simulations with the experimental data from the flow bench.
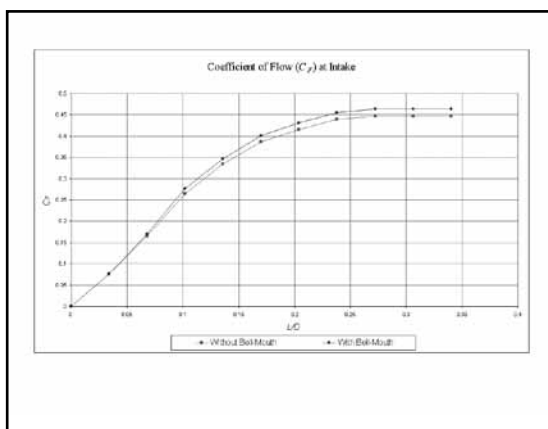
CF against L/D for the Intake Side   Validation of Throttle Body Flow Characteristics

DISASSEMBLY OF ELECTRONIC SYSTEMS WASTE

Student: Matthew Galea   **Supervisor: Prof. Ing. Robert Ghirlando**

Introduction
Through ever improving technology and reduced prices, Plasma and liquid crystal display (LCD) monitors are taking over Cathode Ray Tube (CRT) monitors. With the increased amounts of CRT disposal, comes an increased environmental problem that needs to be dealt with. Presently Malta simply collects such monitors and exports them for recycling. This process is not cost efficient.

Project Objectives
This project studies ways and means how monitors can be dismantled locally, with the goal of retrieving materials from them, which need little processing, eventually selling them commercially.

System Design and Implementation
The legislative framework that Malta has to abide to by 2008 was first studied to understand fully what is needed and what needs to be done. Next the process by which CRT screens and small computer towers are dismantled was studied and subsequently timed to analyze cost efficiency of the process

Results
Through continual efforts, a work station was designed to ease the way of dismantling not only monitors but also computer towers, which have very high amounts of aluminium that can be easily sold.

Tests have also been carried out how to clean CRT glass which has high levels of lead. Research was carried out to understand how this glass can be handled, treated and used.
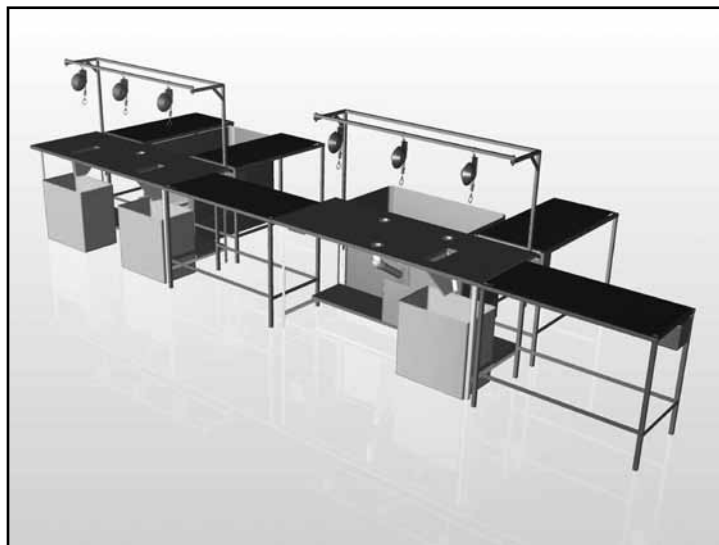
Rendered image showing Work Station

DESIGN FOR MAINTAINABILITY (DFM)

Student: Christopher Gatt   **Supervisor: Ing. Pierre Vella**

Introduction
In today's lean manufacturing environment, companies strive to achieve their optimum efficiency. This can be done by reducing their overall running costs. Maintenance costs are a major element in product life cycle costs and hence it is important that these costs are reduced. By considering the products' maintenance features during the early stages of the design process, maintenance costs can be reduced. Design for maintainability aims at reducing maintenance efforts and costs by considering factors that affect maintainability early during the design phase where flexibility is high and hence the cost due to change are low.

Project Objectives
The goal of this project is to capture the main design features that affect product maintainability and to create a set of rules/guidelines that will assist designers in designing products that are easy and cost effective to maintain. This set of guidelines will be developed both as a paper based and html format.

Project Methodology
The set of guidelines were created by collecting the necessary data through literature review and also through experience gathered from industrial visits at different local companies, as well as through observations carried out on various types of equipment. The guidelines created are specific to the machinery found at the above companies, however they may be applied to any type of machinery since the same rules and concepts apply.

Results
The result is the development of a set of, prototype maintainability design guidelines, whose development process may be applied to develop guidelines for any type of mechanical system. In addition to this, a method for organising the resultant guidelines in relation to the taxonomy of mechanical system was devolved, such that it becomes easier for the designer to use and apply these guidelines. The figure shows a screenshot from the html format.

One of the factors effecting maintainability

FINITE-DIFFERENCE MODEL OF A HEAT FLUX SENSOR

Student: Alan Grech   **Supervisor: Dr Ing. Mario Farrugia**
Co-supervisor: Dr Ing. Tonio Sant

Introduction
Heat flux is the rate of energy transfer through a given surface. This quantity can be measured using a heat flux sensor. The measurement of heat flux is of importance to many engineering fields, one example, heat flux measurements in the exhaust port of a spark ignition engine. A typical heat flux sensor used in this area consists of a surface thermocouple and a recessed thermocouple. Under a temperature gradient, the two thermocouple junctions will be at different temperatures and so will register a voltage. The heat flux is proportional to this differential voltage. To measure transient temperatures the surface thermocouple needs to have a fast response. A particular heat flux sensor, a product of Nanmac Corporation, is investigated for two dimensional effects because users made remarks that the gauge does not follow a 1-dimensional model due to the mica sheets which act as electrical insulation between thermocouple and body material.

Project Objectives
• Building of a transient finite-difference model of the surface thermocouple simulating surface pulsed laser heating at 10kHz.
• Compare results with measured surface temperature data of heat flux sensor heated with a laser at the same frequency.

Building of Model
The finite-difference model was built using C since a lot of iterations are needed and C performs faster than most of the other programming languages. The finite-difference equations were derived for this particular model. Results were exported to a file and compared to measured data. Surface temperature profiles were plotted to analyze the resultant surface temperatures on the surface thermocouple.
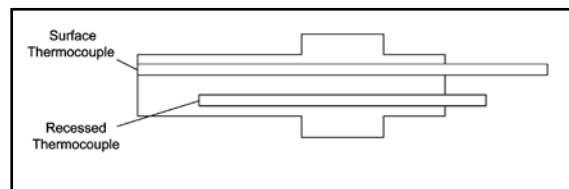

Figure 1: Typical heat flux sensor

Results
Results showed that two-dimensional effects are present but properties of the body material still dominate the surface temperature. However the temperature decay between pulses was matched better using thermal properties of mica sheets.
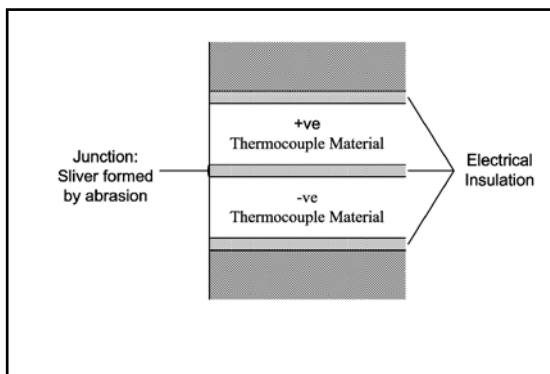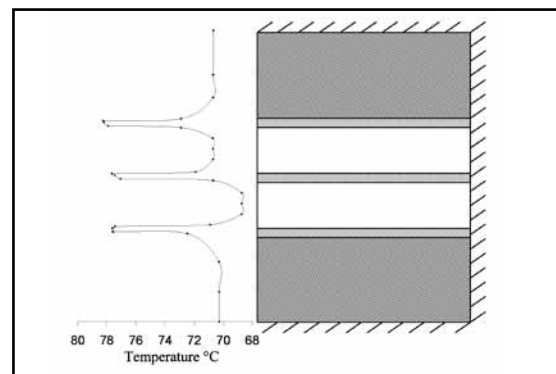

Figure 2: Surface Thermocouple

Figure 3: Resultant Surface Temperature profile

I.C. TURBOCHARGING SIMULATION AND FUEL INJECTION IMPLEMENTATION

Student: Nicholas Grech   **Supervisor: Dr Ing. Mario Farrugia**

Introduction
Formula SAE® regulations dictate a 20mm diameter restrictor must be present in the intake system whose purpose is to limit engine power, pushing students to come up with ways to compensate for the lost power. This dissertation focuses on two such methods; turbocharging and fuel injection systems.

Project Objectives
Learn the theory behind turbocharging and ECU engine tuning and using Ricardo WAVE® engine simulation software, come up with the best turbocharged setup for a Kawasaki 600cc engine to be used for the FSAE. This meant establishing the ideal boost pressures and most importantly, the compression ratio of the engine required to prevent knock. The turbocharger used was a Garrett GT15V donated by Honeywell®.

System Design and Implementation
The engine and turbocharger were modelled in WAVE® and various simulations were run. Variables included: engine compression ratio, boost pressure, valve timing, intercooling efficiency and exhaust manifold geometries. Engine tuning via ECU was implemented on a Hyundai 1400cc engine with LabVIEW™ DAQ software and the Kawasaki engine was converted from carburetted to a multi-port fuel injection system.

Results
For a constant pressure turbocharging setup, the ideal boost pressure was found to be 1.3bar with a compression ratio of 8 required to eliminate knock. These values for a pulse system turbocharging were 1.5bar and compression ratio of 7.
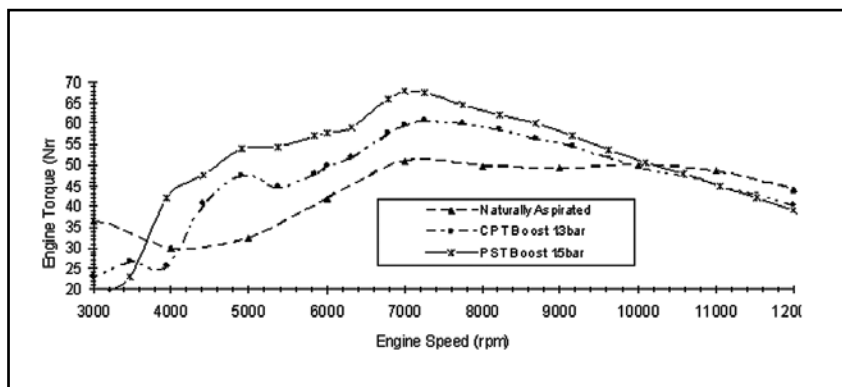
Engine torque results from WAVE® simulation

AUSTENITE TRANSFORMATION IN ADI

Student: Lynne Hopkins　　　　　　　**Supervisor: Prof. Ing. Maurice Grech**

Introduction

When Morrough and Mills altered the morphology of graphite from flake to nodular, all the heat treatments developed earlier for steel could be applied to iron improving its mechanical properties. One such thermal treatment is austempering and the resultant iron is called austempered ductile iron (ADI).

The microstructure of ADI consists mainly of ferrite needles and high carbon austenite which is stable at room temperature. The stability of the austenite is determined by the amount of retained carbon content, which in turn influences the martensitic start temperature, M_s. Some researchers have claimed that the austenite can be stable down to temperatures of -120°C, implying that it transforms to martensite when cooled.

Objective

This work is intended to carry out a preliminary investigation of ways how to transform the austenite to martensite. It is thought that this may be developed as a means of improving the surface properties of components. In this regard it is to be noted that the formation of martensite not only improves the hardness and presumably therefore the wear characteristics but also induces in the surface compressive stresses which may be beneficial to fatigue strength. This may be attractive to components such as gears.

System Design and Implementation

In the first part of this work a number thermal and mechanical operations were applied to an ADI austenitized at 900°C for 2 hours and austempered at 360°C for 1 hour. This condition was chosen because previous work carried out within the department showed that this iron exhibits a structure containing large amounts of austenite, maximum ductility and impact energy. However all attempts to transform the austenite to martensite failed indicating that the austenite was too stable to transform, even when placed in liquid nitrogen (-196°C).

X500 Austenitized at 900°C, austempered at 360°C for 60min, etched in 3% nital

The second part of the thesis concentrated therefore in producing starting structures that contain less stable austenite. For this reason the following heat treatment conditions were investigated. Austenitizing at 950°C and 900°C for 2 hours, followed by austempering for

10, 20, 30, 40, 50 and 60 minutes at 360°C, 375°C and 400°C. These structures were studied at the as treated condition and compared to their counterparts after quenching in liquid nitrogen. The ideal conditions are those that result in minimal martensite in the bulk structure but maximum martensite content after quenching.

VERTEBRA SOLID MODEL VIA CT

Student: Julian Mamo   **Supervisors: Ing. Zdenka Sant**
                                                              Ing. Zdenek Florian
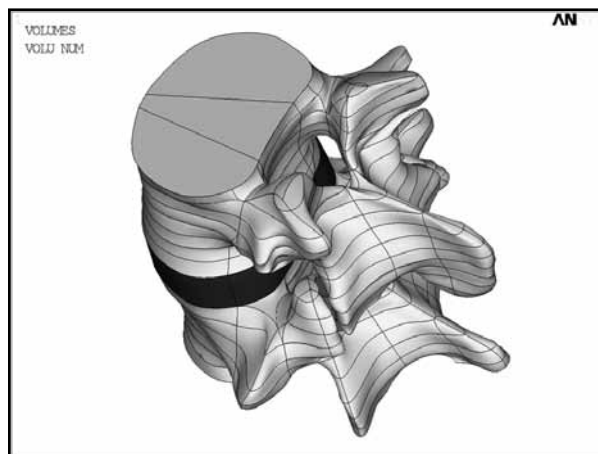
Introduction

A large percentage of people experience some form of back pain in their life. The creation of a spinal motion segment subjected to loading would be valuable for the analysis of the stress distribution and could be used in future work in conjunction with medical implants or fixation devices.

Project Objectives

The aim of the project was to create a patient specific model of a motion segment of the lumbar spine and then to load the model in compression. The model was to be built using Computed Tomography (CT) scans as it is common practice to scan the lumbar region using CT technology.

System Design and Implementation

The model shown in the figure below includes two adjacent vertebrae composed of the two types of bone, a single phase intervertebral disk and zygapophyseal joints as well as endplates. This was achieved by converting the CT images (DICOM format) into JPEG format to be imported into Rhinoceros computer aided design software. This software was used to create the outline of the vertebrae by tracing the image of each slice using segmented splines. This procedure generated splines on parallel planes with the distance between them equal to the slice thickness giving a 3D outline of the vertebrae. This set of splines was then exported to a finite element package (ANSYS®) using the IGES format. In this package new splines were added to create areas, and then areas used to create volumes. These volumes were then meshed and material properties commonly found in literature were assigned to each separate component of the motion segment. The model was then constrained for all degrees of freedom at the bottom face of the lower vertebra and a series of pressure loads were applied to the top face of the upper vertebra simulating compressive loads. The simplified single phase zygapophyseal joints limited loading to compression only; any other loads would have given unrealistic results. The stress and strain contours were then computed and analyzed. The simulation gives data on the compressive stress distribution inside the vertebrae as well as the amount of resulting deformation that takes place.

Model of a spinal motion segment

ENVIRONMENTAL PRODUCT DECLARATIONS

Student: Matthew Mangion   **Supervisor: Ing. Francis E. Farrugia**

Introduction

All manufacturing companies and service industries play a vital role in the change towards sustainable product development. This is so since products affect the environment at several instances during their whole life cycle.

In a bid to preserve the ecological heritage around us, an increasing number of companies are nowadays using environmental product declarations (EPDs) as a tool to promote the acquisition and use of greener products by disseminating environmental performance information to end-consumers.

In July 2006, ISO 14025 was issued as an international standard giving guidance to the development and use of environmental product declarations. It defines EPDs "as quantified environmental data for a product with pre-set categories of parameters based on the ISO 14040 series of standards, but not excluding additional environmental information."

Project Objectives

The main objective of this project is to carry out extensive research work on the need, purpose and use of environmental product declarations. To substantiate this work, an attempt is made to develop an EPD for a plastic bottle preform manufactured at MCL Components Ltd.

PET bottle preforms before being transformed into a finished plastic bottle by injection blow moulding processes.

LASER DEPOSITION OF STELLITE 6 FOR COMPONENT REPAIR AND MODIFICATION

Student: Mark Meilak

Supervisor: Ing. John Betts
Co-supervisor: Ing. Maurizio Fenech

Introduction

Engineering components usually degrade when their surface is unable to withstand the external forces or the working environment to which they are subjected. This situation governs components` service life and their utilisation. This research focuses on component repair using laser beam cladding to rebuild AISI D2 steel shear blades. Shear blades are extensively used in the sheet metal industry, and like any other engineering component are prone to different modes of degradation. Laser beam cladding of Stellite 6 was performed on D2 substrate in order to obtain a suitable set of parameters which can be applied to component recovery.

Project Objectives

The aims of this research are:
- To develop a laser parameter envelope for the laser deposition of single and multiple Stellite 6 tracks on D2 substrate.
- To investigate clad properties such as dilution, aspect ratio, hardness profile and metallography.
- To perform wear tests on the Stellite 6 clad layers and compare their performance to the wear characteristics of D2.

System Design and Implementation

A Rofin-Sinar CO_2 laser equipped with a coaxial powder feed nozzle was used for cladding single clad tracks. The development of the process parameters envelope was guided by optical microscopy and microhardness measurements of clads and substrate.

The achieved parameters were applied to the production of multiple track surfaces, their tribological behaviour being subsequently investigated by wear testing.
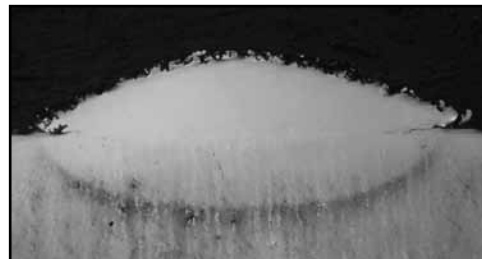
Stellite 6 Clad on A.I.S.I D2 Substrate

Results

Selection of a set of optimal parameters for single track cladding was based on clad hardness, clad geometry and dilution. Once a suitable overlap ratio and time intervals between consecutive clads were identified, these parameters were applied to successfully deposit multiple track clads.

STUDY ON COILED HEAT EXCHANGERS

Student: Luke Micallef　　　　　　**Supervisor: Prof. Ing. Peter P. Farrugia**

Introduction
Many industrial applications involve the heating or cooling of a fluid in recuperator type heat exchanger. Coiled Heat Exchanges are becoming widely used due to their higher heat transfer coefficient and smaller space requirement compared to straight tubes.

Project Objectives
The objective of this dissertation was to design and built a coiled heat exchanger which accommodated steam on the outside of coiled helical pipes. The effect of interrupting the fluid flow pattern on the inner heat transfer coefficient for a single phase turbulent flow, under sensible heating conditions was studied.

System Design and Implementation
A 6kW steam generator was built together with a test section that consisted mainly of a cylindrical tube with a helical contour welded to its outer surface. The coiled coppers pipes with or without inserts were screwed inside the test section and twenty thermocouples were soldered to their periphery to read their wall temperature. The steam condensate was collected from five tappings and its volume measured. Also the inlet, outlet water temperatures and change in pressure inside the coils were recorded. Each coil was tested at a flow rate of 0.8 to 2 litres/minute. Values of the inner heat transfer coefficient were calculated and compared to other correlations.

The testing equipment

TOWARDS A PORTABLE KNOWLEDGE BASED SYSTEM

Student: Giovanni Piscopo

Supervisors: Mr Philip Farrugia
Ing. Christopher Spiteri

Introduction

This thesis takes one step towards creating a tool powerful and natural enough to be used in the preliminary stages of mechanical engineering design. The proposed system supports designers when away from the office. This is done by providing them with engineering product and process knowledge related to paper-based freehand sketches which have been drawn and captured using a hand-held mobile device.

Project Objectives

This is an ongoing project whose primary goal is to significantly expand the knowledge base and supported feature types of the system. Moreover, the generated knowledge is then combined with a CAD model picture of the sketched component and the two are then exported as a single file to the designer's hand-held mobile device.

System Implementation

The aforementioned objectives were realised through the construction of an expert system named 'KiS'. KiS is a feature-recognition system in which features are extracted from the sketch and relationships between these features are then sought. Design for manufacturing (DFM) recommendations are generated depending on the relationship and geometry of the sketch's features. Amongst the various technologies involved in this project are Matlab®, Visual Studio. Net, html and Wxclips.
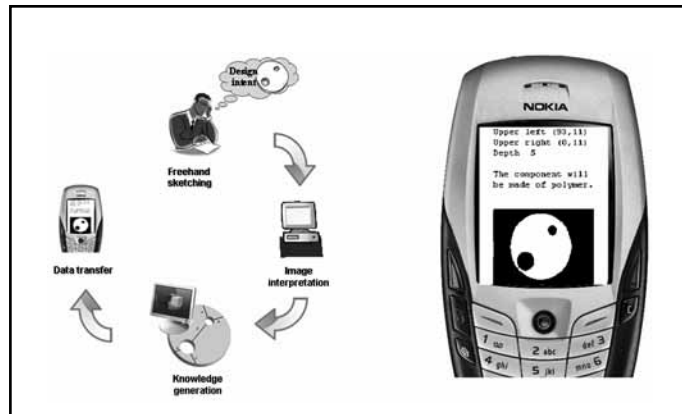
ANALYSIS OF SOLAR THERMAL DESALINATION

Student: Paul Refalo   **Supervisor: Prof. Ing. Peter P. Farrugia**

Introduction

It is estimated that by 2025, two thirds of the world population will face water scarcity. The cost of desalination is increasing due to the fossil fuel crisis the world is facing. The idea of coupling Renewable Energy Sources (RES) with desalination is becoming very popular, especially in Southern Mediterranean Countries and Africa, where the strife for fresh water is ever increasing and RES are abundant throughout the year. Solar Thermal Desalination uses solar thermal energy to distil seawater. This final year project makes part of a collaboration project with CUTEC Institute in Clausthal, Germany.

Figure 1: The solar still at the Pembroke RO plant
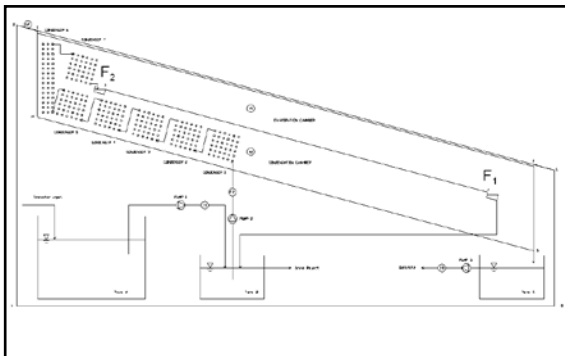
Figure 2: Schematic diagram of the still
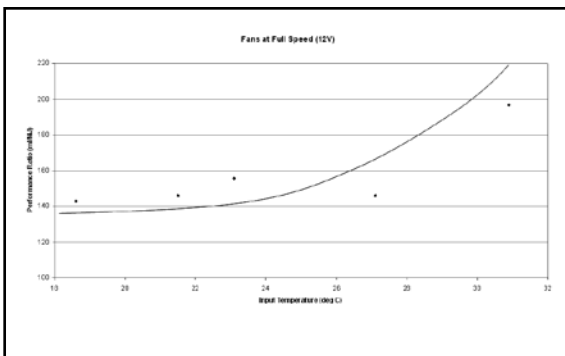
Figure 3. Performance Ratio

Project Objectives

The effect of the following parameters on the performance ratio of the solar still was analysed:
• input seawater temperature
• convection aids

System Design and Implementation

The input seawater temperature was varied by varying the flow rate of the fresh seawater supply and mixing it with return hot water from the plant. Two fans F1 and F2, were installed and their speed was varied in order to aid convection in the counter-clockwise sense according to Figure 2. All relevant temperatures, water flow rates, fan speed, humidity and solar irradiance were monitored using a computer logging system.

Results

It is evident that from the experiments conducted, the maximum performance ratio of 200 ml/MJ (ml of distilled water per MJ of solar energy) occurred at the maximum input seawater temperature and at the maximum air flow rate i.e. fans operating at full speed, producing a total of 5 litre/m^2/day.

ENHANCEMENT OF THE GEAR HOBBING MACHINE

Student: Adrian Sargent   **Supervisor: Ing. Francis E. Farrugia**

Introduction
The gear hobbing machine has been limited to producing only spur gears and 450 helical gears. This machine is able to produce a wide range of gears such as bevel gears, worms, worm-wheels, and possibly racks. This can be done by utilising equipment accessories which have not been used before and by machining small parts to be used in conjunction with these accessories.

Project Objectives
- Production of helical gears with any angle.
- Production of bevel gears.
- Production of worms and worm-wheels.
- Production of racks.
- Writing of a program to allow the user to obtain machine variables easily.

System Design and Implementation
- Research into gear theory and gear hobbing theory.
- Understanding the principles of the construction of the gear hobbing machine.
- Preparation of a manual for future users.

Results
Helical gears of 10^0, 30^0 and 60^0 together with bevel gears and worm-wheels have been produced while the possibility of racks and worms is still being investigated.

Tangential Hobbing

INVESTIGATION ON COILED HELICAL PIPES

Student: Jonathan Schembri   **Supervisor: Prof. Ing. Peter P. Farrugia**

Introduction
Achieving high heat transfers in a compact system is an asset, and in some circumstances, essential. Meeting such a requirement are helically coiled tubes which pertaining to their geometry configuration, accommodate large heat transfer areas within a small space, thus allowing higher heat transfers than their equivalent straight tubes. Such geometry is described through the curvature and torsion, to which a distorted secondary flow perpendicular to the main axial velocity is attributed. As helically coiled heat exchangers are extensively becoming more utilized, knowledge about their pressure drop, flow patterns, and heat transfer characteristics is very important.

Project Objectives
The purpose of this project was to study the development of the temperature field resulting from the secondary flow, and consequently define an overall convective heat transfer coefficient accordingly. A second investigation was carried out to obtain pressure drop versus flow rate data for helical coils experimentally. In both investigations, a constant wall temperature boundary condition is applied.

System Design and Implementation
Two physical models – having different pitches – of the heat exchanger were designed, built, and instrumented for both pressure and temperature measurements. For both exchangers, a cylindrical steel vessel having a diameter of 350 mm and 625mm of height was used. Coiled internally round the cylindrical vessel was a ten metre long thick walled polyethylene pipe of 24mm ID and 32mm OD shaped into a helical coil of ten turns having a regular pitch. A defined amount of continuously boiling water in the steel vessel surrounds the helical tube and imposes the condition of uniform wall temperature on the wetted area. A mesh system inserted along the tube outlet was instrumented using thirteen copper-constantan thermocouples set at different radii and circumferences in order to attain an indication of the developing temperature field across the tube outlet area. The effect of different flow rates along a number of specified coil lengths was studied, and their inlet and outlet temperatures were measured in order to obtain an overall Nusselt number which would then be compared to literature data.
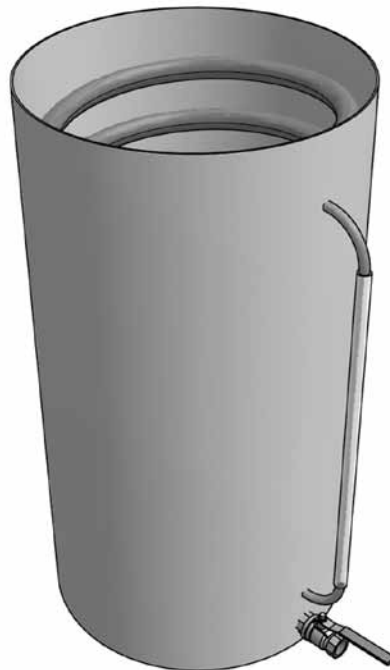
DESIGN, TESTING AND CONSTRUCTION OF A TORQUE CALIBRATION TEST BENCH

Name: Yevegene Sciberras   **Supervisor: Ing. Francis E. Farrugia**

Introduction
Calibration is often regarded as including the process of adjusting the output or indication on a measurement instrument to agree with the value of the applied standard, within a specified accuracy [1]. Hence it is important to have well calibrated tools, since improper calibrated tools will fail to achieve what they are expected to achieve.

Project Objective
The objective of this dissertation was to study the different methods for measuring torque and to find an efficient way to calibrate torque wrenches, since applying the correct torque to nuts and bolts is of great importance, as this usually ensures the safety of both the component and the user. Apart from making research, a test rig must be designed, built and eventually tested.

System Design and Implementation
- The test rig was designed in a way to simulate a transducer i.e. an electronic system where the corresponding strain is obtained according to the applied torque. On entering the strain in a particular equation, in addition of other material parameters, the actual torque will be obtained.
- In this design, strain is obtained by means of a strain gauge system which measures strain on the surface of a round bar once a torque is applied on it.
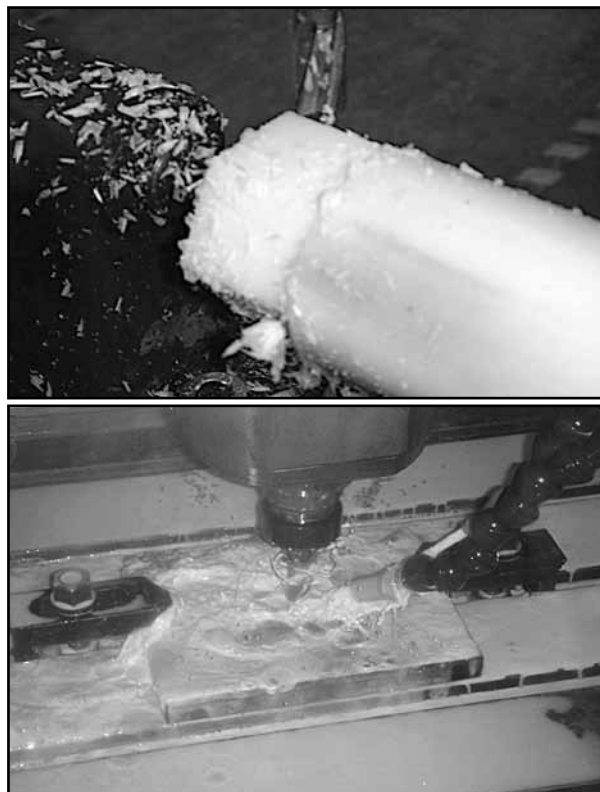
[1]. en.wikepedia.org/wiki/calibration (16/02/07)

A SOLAR-POWERED ABSORPTION REFRIGERATION SYSTEM

Student: Lucienne Scicluna   **Supervisor: Prof. Ing. Robert Ghirlando**

Background
Solar refrigeration is indeed considered an attractive alternative to conventional refrigeration especially with the increased regulations being placed on the use of renewable energy and the phase out of CFC's and hydrofluorocarbons (HCFC's). A solar-powered absorption refrigeration system is a process by which a refrigeration effect is produced by applying heat to a 'generator'. In fact in an absorption system, the compressor, which usually works by electrical input, is replaced by a generator and an absorber to create the pressure difference required for the refrigerant to flow. Solar energy is used to heat the generator and hence power the refrigeration system.

Project Objectives
- To design an optical system to reflectthermal radiation directly onto the surface of the generator of the ammonia/water absorption refrigeration system.
- To obtain a constant temperature of above 200°C and a power of 60W at the generator of the refrigeration system.

Project Methodology
- Literature review in the field of solar cooling.
- Research on optical systems and a study of optical principles which can be applied to concentrate solar energy to power the refrigeration system.
- Construction of the required setup for the system.
- Testing using two different optical systems to power the absorption refrigeration:- a Fresnel lens and a parabolic concentrator.
- Analysis of experimental data and comparison with data obtained from heater tests.

Results
A refrigeration effect was obtained by the use of a Fresnel lens which concentrates the solar radiation onto the generator. High temperatures such as 400°C were obtained at the generator while the lowest temperature obtained at the evaporator was -3°C.
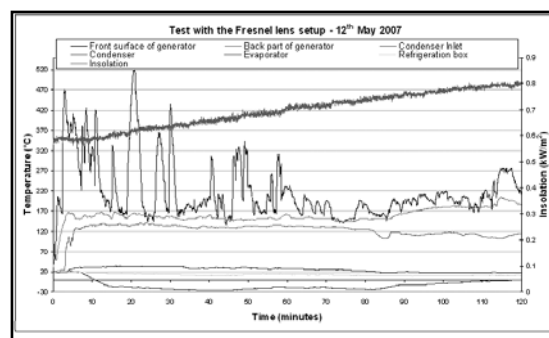
MACHINE HEALTH MONITORING

Student: Victor Spiteri   **Supervisor: Ing. Albert L. Sacco**

Introduction

Damage of lubricated components in rubbing (or sliding) contact gives rise to wear debris contamination of the oil. The composition, shape, size and concentration of these particles give clear indication of the state of the machine. These parameters may be measured through the use of Electron Microprobe Analysis (EMPA). This technique of machine health monitoring is particularly useful in large machinery were vibration testing may not be practicable.

Project Objectives

The objectives of this dissertation are to analyse various oil samples in order to investigate the applicability, reliability and costs of using such a technique in monitoring of a machine.

System Design and Implementation

Firstly, all the necessary research on the theory behind electron microprobe analysis was carried out. This involved various fields of study, particularly analytical chemistry and applied physics. Once enough knowledge was gathered, various samples were collected from I.C. engines. The samples were selected from machines which had been in use for different number of years. This enabled the comparison of the wear pattern to the usage time of the machine.

The necessary tests were then conducted on an Energy Dispersive X-ray (EDX) Spectrometer coupled with a Scanning Electron Microscope (SEM). This instrument reads the energy emitted as X-rays by the trace metals when an electron beam is directed onto the sample. Thus the emitted energy is detected and through examination of the results, quantitative data is obtained of the trace metal within the sample.
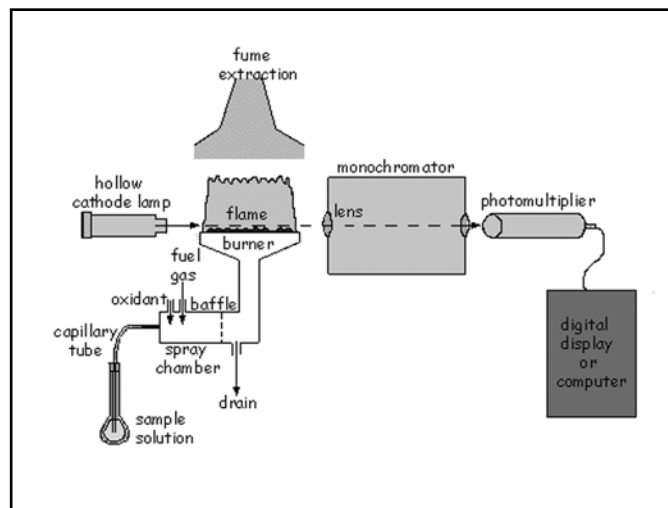
Electron microprobe analysis setup

EVALUATION AND CONCEPT DEVELOPMENT OF AN AUTOMATED HANDLING SYSTEM FOR METHODE ELECTRONICS MALTA LTD.

Student: Ilona Anne Sultana   **Supervisor: Dr Ing. Conrad Pace**

Introduction

The project deals with the handling of the rubber mat which forms part of the toggle CD3XX switch shown in the diagram. This is found on the steering wheel of some Ford models and controls the radio frequency, the CD/MP3 tracks and the volume. The task has been done in collaboration with Methode Electronics Malta Ltd.

Currently, the rubber mats are being handled by the operators onto the jig where they are assembled automatically. The replacement of manual handling by an automated process would signify an improvement on the present method since automation eliminates the possibility of human error and manual inconsistency.

Project Objectives

The project objectives focus on providing an evaluation of the automated handling of the rubber contact sheet. The main objectives of the system to be developed are:
- Elimination of manual handling of the parts on to the jig for assembly.
- Achievement of a constant rate process which is independent of human performance.
- Completion of the process within a shorter time than that done manually. Since more parts should be produced per hour, this will also help to make the whole concept cost effective as a higher turnover is obtained.
- The necessity that the rubber mats are sorted and oriented in an appropriate way so that they can be automatically handled by a system onto the jig.

System Design and Implementation

The principal evaluation carried out in the project includes the use of a specific design process to assess the problem of manual handling and to compare the advantages and disadvantages of all the possible solutions. The evaluation is split into two parts:
- Handling of the rubber mats but maintaining the current packaging.
- The possibility of alternative packaging. This means intervening at the stage before the rubber mats arrive at Methode Electronics Malta Ltd.

If the present method of packaging was to be maintained, it is necessary that the rubber mats are oriented and sorted in an appropriate position to be handled by the system and placed on the jig for assembly. Hence, this would entail the need for a feeding system apart from a handling system. Therefore, alternative packaging was recommended thus enabling the rubber mats to be already positioned for direct handling onto the jig. This greatly reduces the time and cost of the overall system.

For the most promising solution to be implemented, all the possibilities had to be compared to one another on the basis of:
- The application and functioning of the concept in practice.
- Time in terms of Production Rates.
- Cost of implementing the solution.

DESIGN OPTIMISATION AND ANALYSIS OF A LOCK BOLT

Student: Liana Vella   **Supervisor: Dr Ing. Martin Muscat**

Introduction

This project focused on the design optimisation, failure mode determination and analysis of a lock device which forms part of an Electrical Steering Column Lock System. Such a system is a security device installed in cars for prevention against theft and therefore its design has to meet stringent security regulations. Furthermore, being a safety critical component, it also has to meet safety regulations.

Project Objectives

The aim of this project was to determine the optimum design parameters, namely material properties and geometry, of a lock bolt which forms part of a more complex locking device for the steering column. This was achieved by using various design tools, prototyping, destructive testing and failure mode analysis.

System Design and Implementation

Initially research was carried out in order to gain more knowledge on the main parameters affecting the design of the bolt, such as more information on the Steering Column Lock System and choice of material. Information on the bolt was also gained through benchmarking which eventually lead to the generation of several design proposals which were then checked through simulation and results compared to the ones that are required from the bolt. Prototypes were then generated for designs yielding the expected properties. These were used for concept verification. Testing involved the design of a test rig that simulates the steering column interface and subjecting the lock bolt to parameters involved in vehicle approval testing standards. The results obtained from testing were then analysed to determine the failure modes and their effect in meeting vehicle approval requirements.
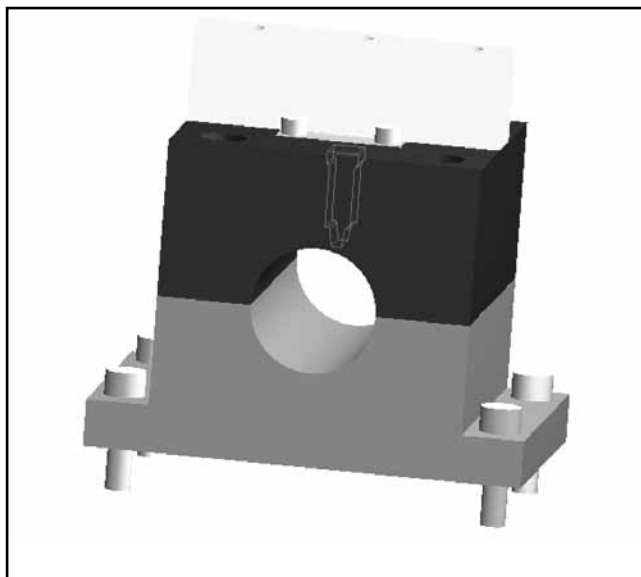
Test rig design simulating Lock bolt in Lock Housing

INVESTIGATING THE HEAT TRANSFER PERFORMANCE OF A HYBRID ENERGY SYSTEM OPERATING IN DIFFERENT CLIMATIC ENVIRONMENTS

Student: Warren Vella   **Supervisor: Prof. Ing. Peter P. Farrugia**

Background

As fossil fuel prices have been increasing drastically during the past years, the cost of energy and its sustainability is undoubtedly a global concern. In this scenario it has become increasingly important to develop energy efficient processes and seek for alternative resources, especially renewables. However, in certain applications, renewable energy sources are not reliable. Hybrid power systems address such situations by combining renewables with conventional fuels.

Project Objectives

The study dealt with a prototype of a hybrid power system developed by a German Engineering firm, INENSUS GmbH. The optimised product is intended to be placed on the global market. The prototype located in Clausthal-Zellerfeld, Germany, incorporates a small scale wind turbine, a diesel generator, and photovoltaic panels as power sources. The system is designed to supply off-grid electrical loads to telecommunication antennas, households or small workshops.

All the electrical and electronic equipment of the system is housed in a standard sea-freight container. Equipment includes lead acid batteries, electronic inverters, a personal computer, and also a diesel generator and diesel tanks. The major difficulty being encountered with this prototype is the temperature increase inside the container, since this is affecting negatively the overall performance of the system.

The primary objectives of this project were as follows:
• To gather relevant data of the container system being investigated.
• To develop a software model (using MATLAB® - Simulink®) that simulates the heat transfer performance of such a system.
• To validate the simulation model with the data obtained from Clausthal-Zellerfeld.
• To simulate the heat transfer performance for different countries by using climatic data obtained from various weather stations.
• To analyse the outcomes of the simulation model and suggest possible actions for improvement.

Results

For each country investigated, the simulation results indicated that the major source of temperature increase is the solar heat gain, and that the internal heat gains are relatively minimal.

It was concluded that in certain countries, the system does not perform efficiently due to high internal temperatures. Two possible measures to improve the prototype performance in such situations are the use of suitable insulating material, and shielding from solar radiation.
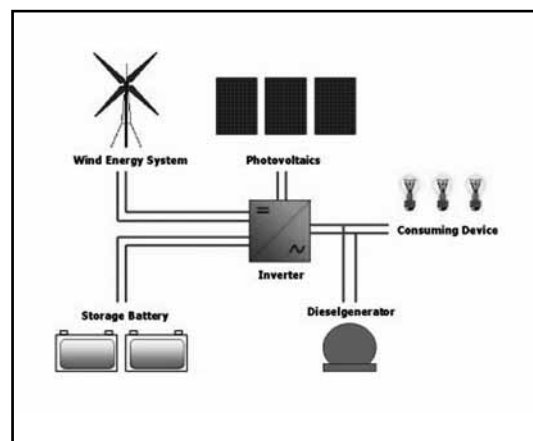
DESIGN OF A COSMETIC CASE MANIPULATOR

Name: Andrew Vella Zarb   **Supervisor: Dr Ing. Michael A. Saliba**
Industrial partner: Toly Products   **Co-Supervisor: Dr Ing. Jonathan C. Borg**

Introduction
In today's manufacturing environment, remaining competitive often involves reducing waste and thus developing a leaner system. This waste may be both material and time.

The vast range of plastic injected products made by Toly, means that a lot of part specific tooling is needed. Depending on the batch of product being made, the particular mould tool is mounted to the injection machine. Each individual mould tool used requires a custom made robot end-effector to unload the moulded parts. With each compact case produced having on average three moulded parts, one can appreciate the vast number of tools required to produce a range of hundreds of compact cases. This means that hundreds of end-effectors are needed.

Objectives
The main objective of this project is to design a new, universal manipulator end-effector in order to reduce the time needed in fabricating and mounting the custom-made end-effectors used. The end-effector designed is to be highly flexible, thus accommodating as large a range of mould tools as possible.

System Design and Implementation
• Literature search on manipulators, flexible manufacturing and other related fields.
• Problem statement and boundary definition, using design tools like the Product Design. Specification (PDS) and Quality Function Deployment (QFD).
• Generation of Conceptual designs using design tools like Morphological charts.
• Concept evaluation and selection, based on Failure Mode and Effect Analysis (FMEA) and decision matrices.
• Embodiment design of the selected concept, including detailed designs.
• Testing and conclusions of design solution.
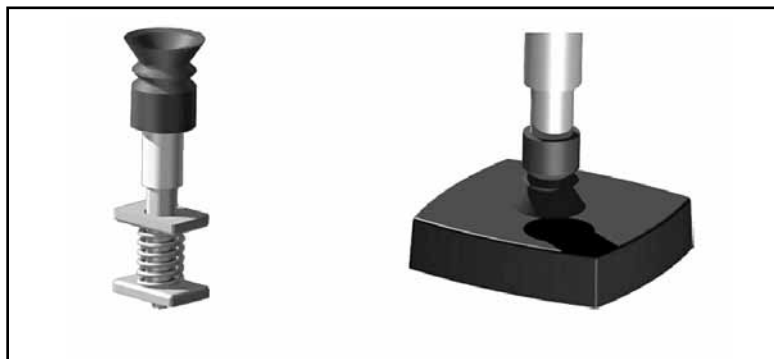
The conceptual manipulator fixtures designed

DESIGN OF A "UNIVERSAL MIRROR CUTTING" DIS-ASSEMBLY SYSTEM

Student: Cathryn Xuereb **Supervisor: Dr Ing. Jonathan C. Borg**
Co-supervisor: Dr Ing. Conrad Pace

Introduction
This project deals with the automation of the releasing of round mirrors scribed in mirror strips and was carried out in collaboration with Toly Products Malta Ltd. This company specializes in the production of high quality plastic packaging components used for cosmetic, fragrance, skin care and other complementary products. A paramount criterion in the releasing of such mirrors is that they should be free of defects especially aesthetic ones. An automated releasing system would help to achieve such result and it will also aid the company to improve its competitiveness by cutting down unnecessary waste.

The universal mirror cutting dis-assembly system is made up of four parts: input loading system, grooving system, releasing system and output storage system. A number of concepts were generated for each subsystem and the most promising concepts were selected using the appropriate design tools. This project focuses mainly on the releasing system. A prototype of the releasing system was built and tested and the remaining concepts for the other subsystems were simulated using computer programs.

Project Objectives
These main objectives of this project were:
• Problem analysis.
• Design of a universal releasing machine that caters for round mirrors whose diameter ranges from 40mm to 70mm.
• Design including concept animations of an automated universal mirror separation machine.

Project Methodology
This project was carried out as outlined hereunder:
• Literature review in the field of design and automation.
• Detailed problem analysis.
• Generation of various concepts for each part of the universal mirror cutting dis-assembly system.
• Concept analysis and selection.
• Computer simulation of concepts.
• Building and testing releasing concept.

TESTING OF AUSTEMPERED DUCTILE IRON GEARS

Student: Christopher Zammit   **Supervisor: Prof. Ing. Maurice Grech**

Introduction
High power gears are traditionally manufactured from low carbon steel which is then carburized and heat treated. This offers a tough core and hard wear resistant case with improved fatigue properties. Carburizing is however a high temperature process involving high cycle times and is thus associated with problems of high cost and distortion during heat treatment. Gear manufactured of surface engineered austempered ductile iron may potentially solve these problems. Furthermore due to the graphite such gears may be more silent, lighter and exhibit better self lubricating characteristics.

Project Objectives
Identical austempered ductile iron and carburized gears were manufactured and tested under the same conditions. In this manner the wear rate for ADI gears could be compared to a benchmark. The ADI gears were machined and treated at two austempering temperature following which shot peening was applied to the surface. Generally ADI gears are austempered at temperatures around 250ºC.

System Design and Implementation
In this work steel and ductile iron gears were machined from blanks of purchased material. Steel gears were carburized and heat treated following standard procedures. Ductile cast iron samples were austenitised at 900ºC for 1 hour and then austempered at 250ºC and 375ºC so as to obtain a typical lower ausferritic and upper ausferritic structure respectively. Shot peening was applied to the austempered ductile iron gears so as to improve the surface characteristics of the material. It is believed that in addition to the traditional benefit of inducing compressive stresses, shot peening might even transform some of the meta stable austenite to martensite. In this respect it is possible that structures containing a larger austenite volume fraction would benefit more from the shot peening process. These gears would be tougher then those austempered at 240ºC and would thus have better bulk properties. This is why in this work we included gears austempered at 360ºC.

To test the gears manufactured a test rig was designed and built. This took a fair part of the total time dedicated to the project. Gear of carburized steel, austempered iron and shot peened austempered iron were tested using the machine show below and identical conditions. Tests are presently in progress. The results obtained would be compared.
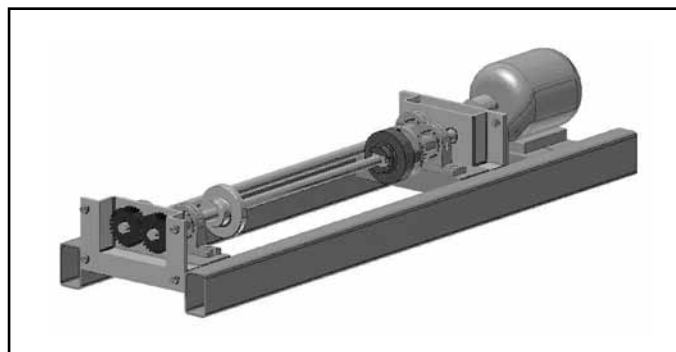
Gear testing rig built for thesis

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