University of Malta
L-Università ta' Malta

Annual Activity Report

2012 - 2013

Msida Traffic Lights

Option 1

Option 2

Option 3

Image © 2012 GeoEye

Google

Department of Systems and Control Engineering

SCE

Cover picture shows the route choices at the Valley Road input to the Msida junctions, in a transport modelling system.

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1. Introduction

This year's Annual Activity Report, the fifth one in the series, is the first to be compiled by the undersigned in my new role as Head of the Department of Systems and Control Engineering. It is therefore appropriate to thank Professor Simon Fabri who has masterfully headed this young and vibrant department since its founding in 2007. Professor Fabri has indeed made it possible for all the members of the Department to contribute to the best of their ability leading to the growth of the Department and to many achievements; this is to the benefit of the undergraduate and postgraduate students who seek our services and to the staff who may advance their career and reach their aspirations through the Department.

Every year the Department takes sustainable steps forward that make it – and us – grow. It is a noteworthy event that during this academic year two students were awarded their doctorate in the area of brain signal analysis, one being a staff member of the Department, thus strengthening the Department's academic complement. The Department has also broadened its research activities and identified new niches in which it may contribute while sustaining a strong peer-reviewed publication record.

The Department has further developed its research and teaching links with international institutions. The Department has also kept its various outreach appointments, such as the EU Robotics Week, Science in the City, Discover University, several radio and television interviews and articles in the printed media. This is a worthy activity that takes much more time than meets the eye and contributes to bringing science and engineering to young children and older folk alike – a special thank you is due to all the Department's academic and support staff members who work together to make these outreach activities successful and enjoyable for all, always at the cost of their much limited time.

I end my first introduction to the Department's annual report series, by sincerely thanking each and every member of the Department for the dedication they have for this work. I look forward to a new academic year which would be as fruitful as all the past years and just as pleasurable to all.

30th September 2013 **Prof. Kenneth P. Camilleri**
Head of Department

2. Staff Members

Associate Professors:

Prof. Ing. Kenneth P. Camilleri, *B.Elec.Eng.(Hons.), M.Sc. (Sur.), Ph.D. (Sur.), MIEE, SMIEEE, ACIArb* – <u>Head of Department</u>
Prof. Ing. Simon G. Fabri, *B.Elec. Eng. (Hons.), M.Sc. (Sheff.), Ph.D. (Sheff.), SMIEEE*

Lecturers:

Dr Kenneth Scerri, *B.Eng. (Hons.), M.S. (Oakland), Ph.D. (Sheff.), MIEEE*
Dr Ing. Marvin K. Bugeja, *B.Eng. (Hons.), Ph.D. (Melit.), MIEEE*
Dr Tracey Camilleri, *B.Eng. (Hons.), Ph.D. (Melit.), MIEEE*

Assistant Lecturer:

Ms Alexandra Bonnici, *B.Eng. (Hons.), M.Phil. (Melit.), LLCM(TD), MIEEE*

Visiting Academics:

Ms Luana Chetcuti, *B.Eng. (Hons.)*
Ing. Andre Sant, *B.Eng.(Hons). M.Sc., MIEEE*

Systems Engineer:

Ing Stefania Cristina, *B.Eng.(Hons). M.Sc. (till April 2013)*
Ms Lucianne Cutajar, *B.Eng. (Hons.) (since October 2013)*

Laboratory Officer III:

Mr Noel Agius

Administrative Assistant:

Ms Allison Sultana, *Dip. Mgt., MBA (Exec) (till September 2013)*
Ms Sanchia Lentini, *(since September 2013)*

3. Research activities

The Department is involved in several research projects, most of which are partly financed through internal and external funding sources. The majority of these projects, which are led by academic staff members, include the participation of postgraduate students whose research contributions lead to the award of Doctoral or Master degrees.

The Department has a strong research track record backed by external funding and peer-reviewed publications, as well as other credentials, in the specific areas of image processing and computer vision, automated sketch and scribble image analysis and interpretation, 3D image acquisition and processing, biomedical image processing, biomedical signal processing, brain signal (EEG) analysis, brain-computer interfacing, nonlinear and adaptive control, robotics, spatio-temporal modelling and analysis, pollution modelling and transport modelling. The Department's activity in these areas is manifested at various levels and through various instruments, but it is especially strongly and consistently manifested in various Research Projects; the main projects that have been in preparation, ongoing or concluded during academic year 2012/13 are describe in the following sections.

3.1 Low Cost 3D Head Acquisition

Main investigators: Prof. Kenneth P. Camilleri and Ms Stefania Cristina.

This research originated as an industry-academia collaborative project funded by a grant from the National RTDI Programme 2004 which has now formally concluded. It involved the development and implementation of a low-cost 3D object rapid-acquisition system, specifically for the acquisition of the 3D data of a person's head. A combination of simple projected patterns and multiple view passive correspondence together with novel algorithms to exploit the multi-view redundancy were developed and integrated into a working system. Further work is ongoing related to this research whereby the developed algorithms are being formalized in order to establish the limits of performance and improve computational efficiency.

Specific algorithms developed within this project and their performance were presented at, and published in the proceedings of, the 8th International Conference on Informatics in Control, Automation and Robotics (ICINCO 2011) in the Netherlands in July 2011. The project was also featured at the IET *Present Around the*

World (PATW) Competition 2012, locally and in Paris, and in November 2012, the project consortium was nominated for the prestigious Malta Engineering Excellence Awards 2013 and was among the five short-listed entries.
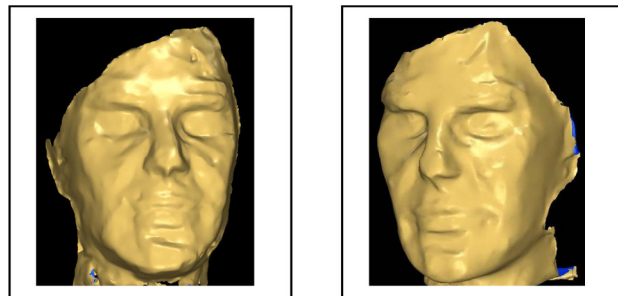
Surface maps of a mannequin head obtained
using the 3D acquisition system.

3.2 Nonlinear, Adaptive and Intelligent Control

Main Investigators: Prof. Simon G. Fabri, Dr Marvin K. Bugeja

This research project is realized through a number of interlinked activities coordinated by the main investigators. These activities focus on the development, design and application of modern methodologies for nonlinear, adaptive and intelligent control systems.

During the past year, the neural network dual adaptive control schemes developed recently by the department for trajectory control of mobile robots were extended and rigorously analysed for more complex and generic multiple-input/multiple-output systems. The performance of various estimation algorithms used for real-time adjustment of the neural network weights were rigorously analysed and evaluated. These include the extended and the unscented Kalman filter, where the latter was shown to exhibit distinct advantages in control performance but at the cost of significantly increased computational effort. This work has resulted in two distinct conference papers, one presented at the European Control Conference 2013 in Zurich and the other at the ICINCO13 conference in Reykjavík. Another aspect of this project focuses on the use of dual control methodologies for adaptive control of extremum seeking Hammerstein systems. This work, which involves the collaboration of Prof. Björn Wittenmark from Lund Univesity in Sweden, is still on going.

3.3 Nonlinear control of a ball and plate system

Main Investigator: Dr. Marvin Bugeja

This project aims to investigate nonlinear control methods on a ball and plate balancing system—designed and built within the department specifically for this research. Simply stated, the control challenge is to balance a ball—or even make it track a desired trajectory—on a flat plate, solely by tilting the plate relative to the horizontal plane. This problem is of particular interest to the control community because it is open-loop unstable and more importantly because it exhibits nonlinear and multivariable dynamics. The project uses both simulation-based and physical experiments to study and evaluate the performance of a number of both linear and nonlinear control methods, including: state-space control, optimal control and sliding-mode control. The project is also investigating the use of visual feedback for real-time control, which undoubtedly is also a highly active research area with a multitude of real-world applications.


Ball & plate experimental setup

3.4 Robot Control

Main Investigators: Prof. Simon G. Fabri, Dr. Marvin K. Bugeja and Dr. Kenneth Scerri

Projects in this area concentrated on various control aspects of robot control on different robotic platforms, including mobile robots and robotic manipulators.

One particular thread of this research investigates various Simultaneous-Localization and Mapping (SLAM) algorithms to enable a wheeled mobile robot to build a map of its environment and simultaneously (and continuously) estimate its location within this map. In the original SLAM problem, better known as *passive SLAM*, the robot is manually steered around the environment it is required to map. However a more challenging and recent problem, with numerous practical applications, is that of autonomous exploration where the robot is required to drive itself around the environment in a way that aids the SLAM process, *i.e.* to acquire a more accurate map in less time (in comparison to random roaming). In literature this is known as *active SLAM.* This work investigates both passive and active SLAM algorithms via simulations and physical experiments using PowerBot, a commercial mobile robot intended for such research. This robot is fitted with several high-end sensors, including a laser range-finder and sonar belt.
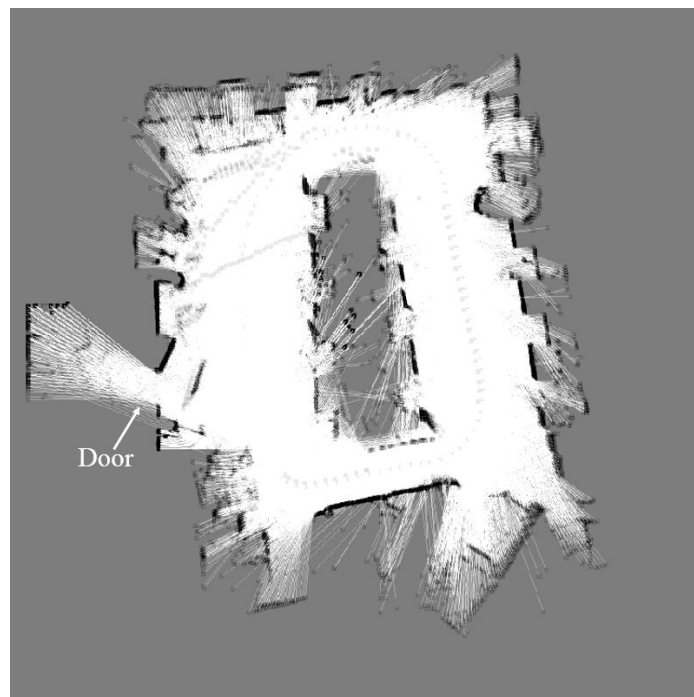
Map of the Control Systems Laboratory as obtained by EKF-SLAM on PowerBot

Exploration and mapping algorithms (SLAM) were implemented and investigated on PowerBot, one of the research mobile robots recently acquired by the department, as well as trajectory control intended to reduce measurement uncertainty.

Active collaboration with the University of Le Havre in France on the design of visual-tracking algorithms for mobile robots led to the acceptance of a conference paper to

be presented at the IEEE Conference on Decision and Control in December 2013. This work was complemented by an undergraduate project where the proposed algorithm was implemented and tested in real-time on a physical mobile platform in the laboratory.

Mobile robot platform

Manipulator modelling and control

3.5 EEG Signal Processing Methods for Brain Computer Interfacing

Main investigators: Prof. Kenneth P. Camilleri, Dr Owen Falzon, Dr Tracey Camilleri, Prof. Simon G. Fabri

This project was funded by a research grant from the University of Malta and the Malta Government Scholarship Scheme which provided support for one research student. The project involved the analysis of electroencephalographic (EEG) data which refers to brain signals recorded non-invasively from a set of electrodes placed on the human scalp. Processing of these signals is necessary to extract relevant features which can help to distinguish the underlying mental state or task. If this classification is robust, then it can be used to gain more insight on the dynamics of the signal or as a control signal to allow brain to computer communication.

One area of investigation in this project was the application of switching multiple models to automatically segment EEG data into different mental states. Through a supervised learning stage, expert models are developed to learn the characteristics of the different states. These are then used for the automatic segmentation of the data which is a computationally efficient process since the models have been pre-trained. Two areas of application that have been investigated were the identification of spindles and K-complexes in sleep EEG data and mental states typical in EEG data used for brain to computer interfacing. The proposed approach was also developed further to allow for the identification of mental states which are not trained for a-priori. This allows the system to learn new models to represent these new states and gives further insight to the clinician on the dynamics of the EEG data.

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A Brain Computer Interface (BCI) system is a communication system where a person has the ability to communicate with a computer through his or her brain signals rather than using the peripheral nerves and muscles. Generally electroencephalographic (EEG) data is recorded non-invasively from the human subject and this is then processed to extract reliable features to classify the tasks being performed, such as left/right hand movements, foot movements or tongue movements. These tasks are then mapped into computer based commands to move a cursor on a screen or select from sets of letters, amongst other examples.
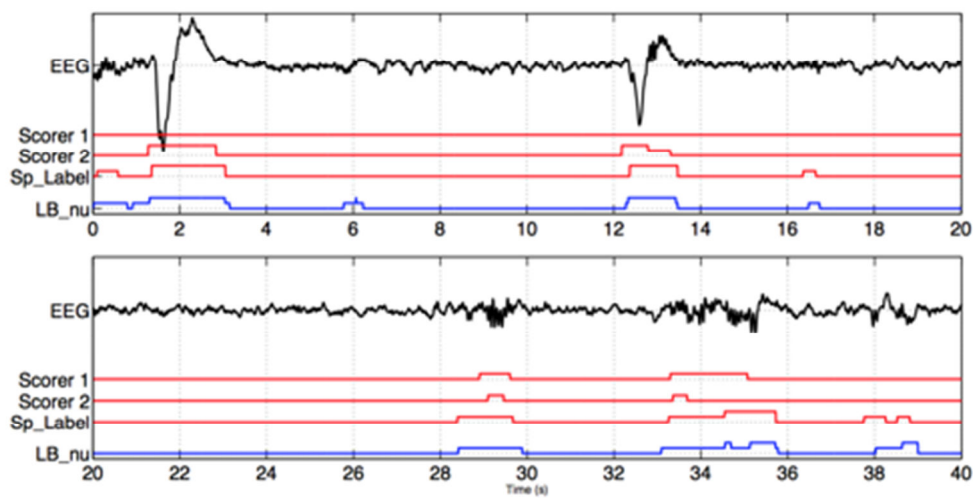
Segmentation and labeling of Sleep EEG data

One area of investigation that is presently being pursued concerns the application of switching multiple modelling techniques to segment EEG data into different mental tasks, applying expert models to each task and using this knowledge for asynchronous brain computer interface applications. Rather than extracting features from the EEG to characterize the mental tasks and then feeding these to a classifier to determine the class the current data belongs to, the multiple modelling technique uses pre-trained expert models to predict the EEG data and uses the residual within a Bayes classifier to find the most probable model out of the candidate set. This has the advantage that once training of the models is performed, segmentation and labelling of new data is done in a more computationally efficient manner.

Another area of investigation concerns the use of phase information to improve the performance of brain-computer interfaces. Two different algorithms based on the widely used common spatial patterns (CSP) technique have been developed. The 'phase synchronisation'-based common spatial patterns (P-CSP) method extracts phase synchronisation information between all possible EEG channel combinations and maximises the separation between two mental states based on this information.

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The method has been shown to perform more efficiently that the direct phase-locking value (PLV) measures generally used to separate data based on phase synchronisation levels. The second method that has been developed, namely the analytic common spatial patterns (ACSP) method, separates two classes of data by using both the amplitude differences as well as phase differences between the EEG channels. This method also yields a set of complex-valued spatial patterns which can be separated into distinct amplitude and phase components, allowing for a more accurate representation of the underlying activity for each mental state when compared to the conventional CSP approach.

SSVEP BCI application
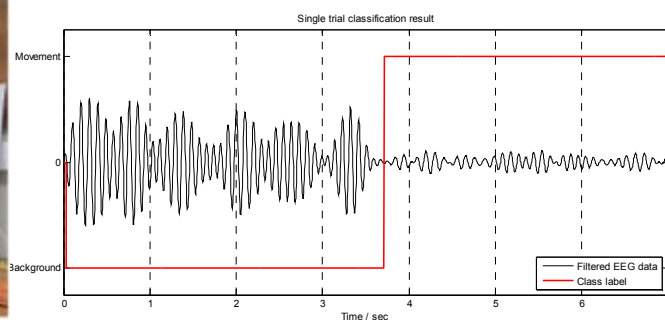
Segmentation and labelling of EEG

3.6 Real-time Brain-Computer Interface Platform

Main investigators: Dr Tracey Camilleri, Prof. Kenneth P. Camilleri, Dr Owen Falzon

This project is funded by a research grant from the University of Malta and is planned for a period of 3 years. Brain-computer interfaces (BCI) provide a means of communication and control which is dependent only on a user's thoughts and mental activity. Electrical brain signals obtained using electroencephalography (EEG) recording equipment can be processed and converted into commands for control and communication, making such systems particularly useful for locked-in individuals. The goal of this project is to design and build a real-time, modular brain-computer interface platform that can also be used to be operated in real-time to test new algorithms and protocols for BCIs. The platform would also allow us to consider the practical aspects of various BCI protocols and interfaces for users in a real living environment.

In this project two BCI applications have been analysed, one based on motor imagery and the other on steady-state visual evoked potentials (SSVEPs). These applications have shown that the latter is more practical as it requires less training. In view of this a real time SSVEP-based music player system was developed to demonstrate the feasibility of using these potentials for control. The system was tested on six healthy subjects with very promising results. The developed platform allows us to test different signal processing algorithms and can be easily extended to cater for other applications that might be necessary to meet the needs of people with limited mobility or who are locked-in.

The next step of this project is to test the system with a wireless headset to make the application more feasible to use outside the laboratory and also develop an app which allows a person to use this system directly from a tablet. So far a real-time implementation using the g.tec EEG equipment currently available in the biomedical engineering lab has been designed and tested with real subject recordings. Limitations in communicating with a software programme through motor imagery such as left and right hand movements have been identified. These problems will now be addressed, giving more training to the subjects using the system to get better control of their mental activity.

A wireless EMOTIV system for EEG data recording is also being purchased through this grant, allowing us to use more user friendly setups and giving us the possibility of comparing performance with the higher standard EEG equipment currently available. This equipment is planned to be used by undergraduate students with the goal of using other modalities that allow brain-to-computer interface control in real time environments.
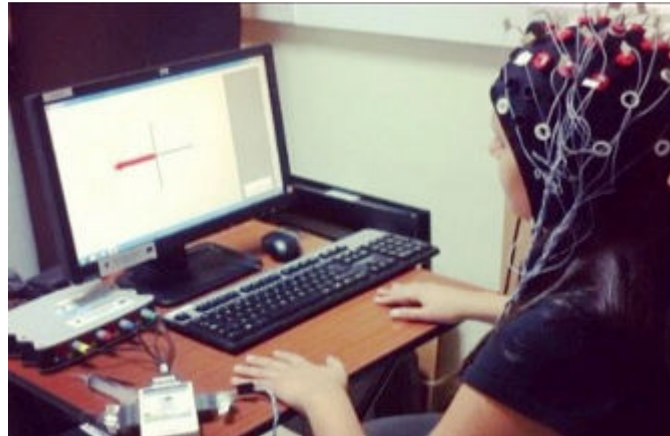
The real-time BCI platform in useSetup for the SSVEP-based BCI application

3.7 Transport Modelling Applied to the Maltese Traffic Network

Main investigators: Dr. Kenneth Scerri and Ms. Luana Chetuti Zammit.

This research originated from the investigators efforts towards the modelling of air pollution patterns over the Maltese islands. A significant dependency between air pollution measurements and traffic flow has been observed for various pollutants. Since limited traffic data is available for the arterial flow over the Maltese islands, traffic models have been developed to estimate this behaviour. The starting points are two data sets gathered by Transport Malta (TM) namely, daily counts over a small number of Maltese roads and an Origin-Destination (OD) survey carried out in 2010. Through the amalgamation of these two sets of data, the traffic flow counts over all important roads of the network have been measured with excellent accuracy. These traffic measures included in the pollution models have significantly improved the pollution predictions available. This work has been presented in the 2013 flagship transportation conference of the IEEE, held in The Hague in October 2013.
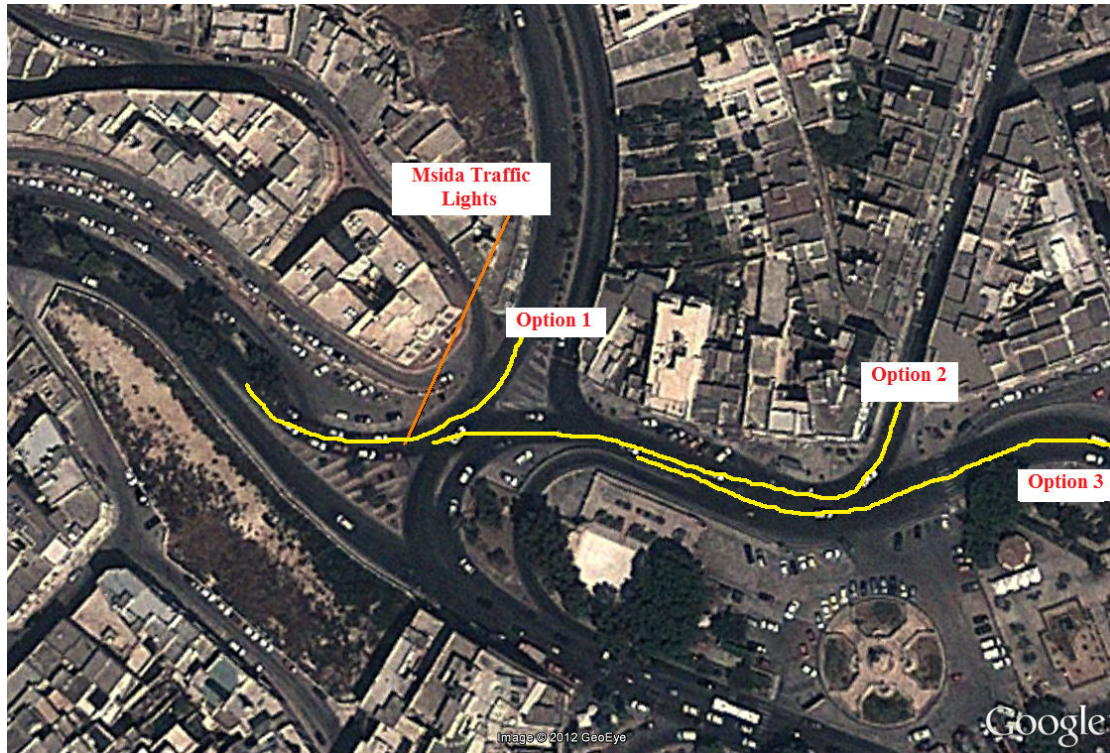
Route Choices at the Valley Road Input to the Msida Junctions

3.8 Spatio-temporal Analysis of Pollution Data

Main investigators: Dr. Kenneth Scerri, Ms. Luana Chetcuti Zammit and Ms Nicollette Formosa in collaboration with Dr. Maria Attard and Ms. Therese Bajada at the Institute of Sustainable Development at the University of Malta.

The work on this project over the last 12 months has focused on extending the theoretical work previously carried out to 2 separate data sets measuring pollution. Both air and marine pollution models are being developed based on novel spatio-temporal methodologies. The aim is to obtain computationally efficient models capable of analyzing pollution dispersal and predict future behaviour. Air pollution models have been developed for air pollutants measured over the Maltese islands while marine models are being tested on data gathered by autonomous marine vehicles in the Norwegian Fjords. It is envisaged that these models will also be applied to study the marine pollution patterns in the Mediterranean focusing on measures gathered around the Maltese islands. Work is also underway to develop simple add-ins of these models to the main GIS packages for non-technical users to benefit from these developments.

The Slocum Glider used to gather data for this study.

3.9 Cognitive Vision for Sketch Understanding

Main investigators: Prof. Kenneth P. Camilleri and Ms Alexandra Bonnici

While human observers can interpret sketches as 3D objects easily, the same cannot be said for machine vision. This work therefore draws upon our previous experience through collaboration on the "Early Stage Design for Rapid Prototyping" project to develop image processing algorithms that allow sketches to be interpreted as 3D objects.

Artistic sketches will typically contain cues that aid the human interpretation of the sketches. These cues are useful in the geometric interpretation of the sketch and in this research project, we investigate how these cues can be used as constraints on the geometric interpretation of edges, in a cue-constrained edge labelling algorithm.

In order for the edge labelling to be applied in an automated manner, the sketch must first be pre-processed such that the edge strokes are identified and organised into chromosomes, the junctions identified and given their proper geometric identifier and any shading cues extracted from the sketch. The extraction of line

strokes is typically carried out through vectorisation algorithms. These however assume that the drawing is easily separable into foreground and background, which is not necessarily the case with images having shading and shadows. For this reason, we investigate alternative vectorisation algorithms that are based on signatures obtained from circular sampling circles placed at strategic points in the image. By comparing the signature obtained from the sampling circles with canonical signatures obtained from line strokes and junction points, it is possible to determine whether a particular sampling circle is located on a line, or is approaching a junction point. This allows us to extract the edge strokes from shading strokes from the drawing. Furthermore, the signature obtained from a sampling circle which is located on a junction point can be used to identify the geometric label of the junction.

(a)   (b)

(c)   (d)

Place a sampling circle on a line medial axis

Obtain the grey-level signature from this circle

Compare signature with canonical form to label the node and repeat until all image is vectorized

Drawing background includes shadow
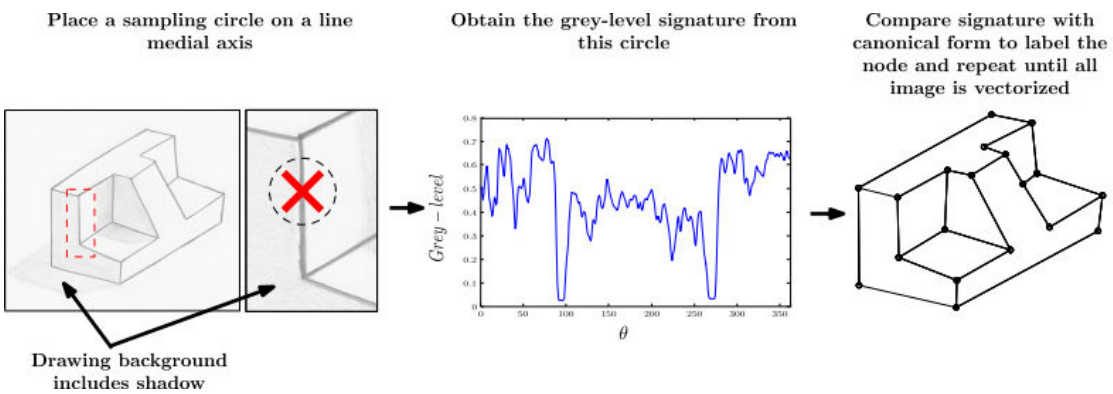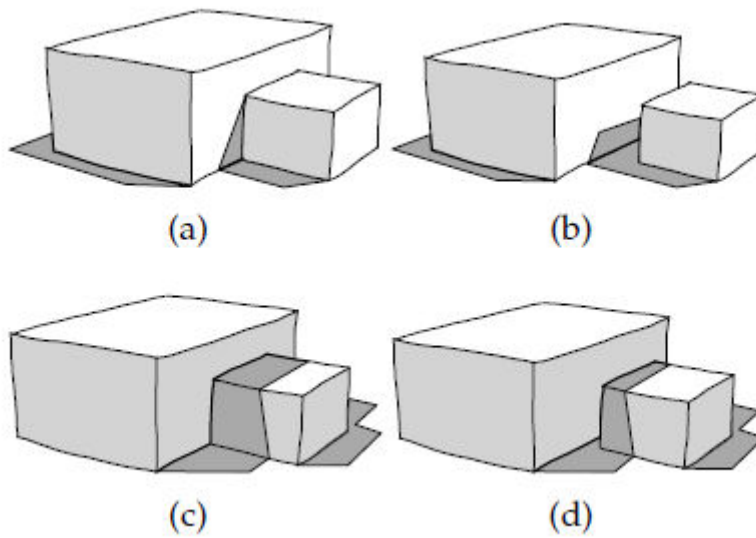
3.10 Internal Research Seminar Series

In academic year 2012/13, the department launched a new research initiative known as the *Internal Research Seminar Series (IRSS)*. This consists of a regular series of presentations, held more or less every other month, where departmental staff members or postgraduate research students deliver a presentation to the department on their research activities. The aim of this initiative is to offer an opportunity where members can present and discuss their latest research work in a relaxed, informal and open manner between colleagues. The series for this academic year, coordinated by Prof Simon Fabri, comprised the following presentations:

IRSS 2012-2013

The Analytic Common Spatial Patterns Method for Brain-Computer Interfaces

Owen Falzon   19 Oct 2012

The common spatial patterns (CSP) method, originally developed to identify abnormal components in clinical EEG data, has become an established and widely adopted method for mental state discrimination in brain-computer interfaces. Nevertheless, the method has a number of limitations, one of which is its failure to consider the explicit influence of amplitude and phase components in the EEG data. We have developed a method, namely the analytic common spatial patterns (ACSP) method, which tackles this limitation by considering an analytic representation of the EEG signals. In this talk, the details of the ACSP method and the advantages the method provides with respect to the conventional CSP algorithm, both in terms of classification performance as well as in terms of the accuracy in the representation of the underlying classes of EEG data, will be discussed.

Describing Traffic through Mathematics

Kenneth Scerri   19 Dec 2012

Mathematical modelling of urban vehicle transportation is a significant tool in combating traffic and its hazardous effects on air quality, our health and - last but not least – our mood. This talk will focus on traffic assignment models applied to the prediction of a driver's choices when deciding in favour of one route for his (or her)

trip. The mathematics behind the description of the roads in the network will be briefly presented, leading to the optimization algorithms classically used to assign traffic to the network. The optimally assigned traffic is surprisingly similar to the human choice – an observation that will be briefly discussed. Unfortunately, classical traffic assignment methods suffer from some serious limitations thus motivating the development of the novel Hierarchical Bayesian model and the supporting methods presented in this talk. The need for this model will be further motivated by an example based on the arterial traffic network of Malta. Initial results will be presented to further validate the usability of the proposed methodology.

Switching multiple models for EEG data analysis

Tracey Camilleri   22 Feb 2013

Autoregressive modelling is one of the standard techniques for Electroencephalographic (EEG) data analysis. Although adaptive variants exist to cater for the nonstationary property of the EEG, these models assume slow changing dynamics making them unsuitable to represent transient phenomena.

This presentation will discuss the applicability of an Autoregressive Switching Multiple Model (AR-SMM) framework for the analysis of EEG data. This is a natural extension of autoregressive models suitable for the representation of systems with temporal multimodality as is manifested in various EEG applications. This approach has been applied on both simulated and real EEG data where it is shown to offer a unified framework which allows for the identification of multiple transient events, it requires very little training data, it is a good alternative to manual scoring and it can be used as an analytical tool to obtain further insight on the dynamics of the EEG data, particularly when using a self-organising approach to learn new states.

A Cue-Constrained Genetic Algorithm for Line Labelling of Line Drawings

Alexandra Bonnici   26 Apr 2013

Line drawings are well known to exhibit geometric ambiguities, resulting in drawings that can have multiple interpretations. However, drawings are used to present design concepts to peers in fields such as engineering design, where it is imperative that the observer interprets the drawing in the same way as the designer for effective communication. Designers therefore use cues, prompting the observer to resolve the geometric ambiguities and achieve the desired interpretation. This talk will focus on two cues, namely table-lines (which convey information about the position of the object in space) and shadows (which convey information about the geometry of the object). These cues can be

used in a line-labelling context, allowing a cue-constrained genetic algorithm to overcome the ambiguities present in the sketch, labelling intentionally ambiguous line drawings according to some desired interpretation.

Image Processing in Capsule Endoscopy: Classification of Digestive Organs

Carl Azzopardi   31 May 2013

Capsule Endoscopy is a technique designed to wirelessly image the small intestine within the gastrointestinal (GI) tract, using a small ingestible capsule. It unfortunately necessitates long screening sessions by the clinician, mainly due to the vast amount of images it generates per patient. In order to partially facilitate this process, previous studies have proposed image processing algorithms to automatically segment the GI tract into its constituent organs, and to thus identify the region of interest. In this work, we propose to encode the anatomical topology of the GI tract itself when carrying out dimensionality reduction on visual feature vectors that describe the capsule images. To this end, we suggest a novel adaptation of a technique called Locality Preserving Projections, and results show that this achieves an improved performance in organ classification and segmentation, at no additional computational or memory cost. We also compare the performance of Random Forest Classifiers as an alternative to Support Vector Machines.

4. Student Projects and Supervision

4.1 B.Eng. students

Project title	Student	Supervisor
Electromyographic Signal Analysis during Gait	Aquilina Maria	Dr O. Falzon Prof. K. Camilleri & Dr Mark Sacco (co-supervisors)
The use of CSP for a Motor Imagery Based BCI	Axisa Joseph	Dr T. Camilleri
Traffic Assignment Models of the Maltese Arterial Network	Baldacchino Stephanie	Dr K. Scerri
EMG-based Control of a Robotic Arm	Bezzina Paul	Dr T. Camilleri

Statistical Spatio-Temporal Fusion of Pollution Measurement	Borg Dora Lee	Dr K. Scerri
Autonomous Exploration and Mapping using a Mobile Robot	Ciantar Patrick	Dr M. Bugeja
Neural Network Implementation using FPGA's	Galea Glenn	Dr M. Bugeja
Vision-based Tracking and Remote Control of a Mobile Robot	Gauci Norbert	Dr M. Bugeja
Development of a System to Acquire and Visualise Foot Posture and Plantar Pressure	Grech Josef	Dr O. Falzon Prof. K. Camilleri & Dr A. Gatt (co-supervisors)
Driving a Mobile Robot using Steady-State Visually Evoked Potentials	Sapiano George	Prof. K. Camilleri
Mobile Robot Trajectory Control for Measurement Uncertainty Reduction	Schembri Disney	Dr K. Scerri
An Investigation of Dynamic Control Strategies for Robotic Manipulators	Vassallo Nicholas	Dr K. Scerri

4.2 M.Sc. students

Project Title	Student	Supervisor
3D model based object recognition using assembly of discrete primitives	Agius David Paul	Prof. K. Camilleri
Date Driven Spatio-Temporal Modeling	Chetcuti Luana	Dr. K. Scerri, Prof. S. Fabri
SSVEP-based Brain-Computer Interface (BCI) System for a Real-Time Application	Rosanne Zerafa	Dr. T. Camilleri Dr. O. Falzon
Nonlinear Control of a Ball and Plate System with Visual Feedback	David Debono	Dr. M. Bugeja

4.3 M.Phil. / Ph.D. candidates

Research Title	Candidate	Supervisor
Combining the X-basis of vision to provide a valid 'human vision' interpretation of scribbled drawings	Bonnici Alexandra	Prof. K. Camilleri
Multiple modelling of EEG data to classify different mental states	Camilleri Tracey	Prof. K. Camilleri, Prof. S. Fabri
Eye-Gaze Tracking for Human-Computer Interaction, Behaviour Analysis and Communication	Cristina Stefania	Prof. K. Camilleri
Representation and Knowledge Extraction from Multiview Image and Video	DeRaffaele Clifford	Prof. K. Camilleri
EEG Signal Phase Analysis for Brain-Computer Interfacing	Falzon Owen	Prof. K. Camilleri
Modelling Spatial Context in Maltese Sign Language Recognition from Video Sequences	Borg Mark	Prof. K. Camilleri, Prof. M. Alexander

5. External lecturers and visitors

From the University of Bristol, U.K…

On the 1st October 2012, the department invited Dr. Andrew Zammit Mangion from the School of Geographical Sciences at Bristol University, to deliver a public talk entitled Modelling and Predicting Space-time Behaviour from Large Data Sets.

From the University of Le Havre, France…

In November 2012, the Department hosted three staff members from the University of Le Havre in France: Dr. Francois Guerin, Dr. Florence Lecroq and Mr. Frederic

Chaigne. Dr. Guerin presented a mini course on the programming of FPGAs and their application to control engineering. Dr. Lecroq and Mr. Chaigne provided technical support for the installation and networking of PLC equipment in the Control Systems Engineering laboratory. This visit was funded under the EU Socrates-Erasmus programme.

From Kingston University, U.K…

On the 17th May 2013, the department invited Dr. Raphael Grech from the Faculty of Computing, Information Systems and Mathematics at Kingston University to deliver a public talk entitled *Multi-Robot Vision - "Robots learning how to see"*

With the team during exploration at Tas-Silg

Underwater robot demonstration on campus

6. Teaching activities

The Department is responsible for teaching several study-units within the B.Eng.(Hons) programmes in Electrical and Electronic Engineering, Mechanical Engineering and the B.Sc.(Hons) ICT course in Communications and Computer Engineering. It participates in the M.Sc. course on Sustainable Environmental Resource Management that is jointly offered by the University of Malta and James Madison University (JMU) from the USA. With the help of the Centre for Biomedical Cybernetics, the Department also offers two-study units in the M.Sc. in Medical Physics course offered by the Medical Physics Unit in the Faculty of Health Sciences.

A selection of study units offered by the Department in 2012/2013		
SCE1201	Dynamic Systems and Signals 1	5 credits
SCE2111	Automatic Control Systems 1	5 credits
SCE2213	Automatic Control Systems 2	5 credits
SCE2110	Automatic Control Systems 1	6 credits
SCE2210	Introduction to Control Systems	5 credits
SCE3113	Automatic Control Systems 3	5 credits
SCE3216	Automatic Control Systems 4	5 credits
SCE3112	Control Systems Technology and Automation	5 credits
SCE3101	Dynamic Systems and Signals 2	5 credits
SCE3205	Dynamic Systems and Signals 3	5 credits
SCE3204	Image Analysis and Computer Vision	5 credits
SCE4101	Computational Intelligence 1	5 credits
SCE4102	Systems Theory	5 credits

7. Staff publications (Oct 2012 ~ Sep 2013)

Muscat M., Muscat Baron Y., Muscat Baron R., Brincat M., Camilleri K.P., Azzopardi C., Cristina S., Falzon O., Thermographic studies of the pregnant uterus, 8th Malta Medical School Conference, November 2012.

Muscat M., Muscat Baron Y., Muscat Baron R., Brincat M., Camilleri K.P., Azzopardi C., Cristina S., Falzon O., Comparison of thermographic imaging of the pregnant uterus with and without spontaneous rupture of membranes, 8th Malta Medical School Conference, November 2012.

Muscat M., Muscat Baron Y., Muscat Baron R., Brincat M., Camilleri K.P., Azzopardi C., Cristina S., Falzon O., Standardization of the methodology in foetal thermography, 8th Malta Medical School Conference, November 2012.

Azzopardi C., Bigeni J., Camilleri K.P., Vella S., Muscat Baron Y., Cachia M.J., The methodology for a three dimensional kinematic study of gait in charcot neuroarthropathy, 8th Malta Medical School Conference, November 2012.

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L. Chetcuti Zammit, K. Scerri, M. Attard and T. Bajada, "Computationally Efficient Estimation of High-Dimension Autoregressive Models - with Application to Air Pollution in Malta", Xjenza Online Vol.1, No.6, pp. 42-50, March 2013.

L. Chetcuti Zammit, K. Scerri, M. Attard, T. Bajada, "Bayesian Hierarchical Modelling of Traffic Flow", 1st Institute for Sustainable Development National Conference, Ricasoli, Malta, November 2012.

8. Staff academic activities

Staff Member	Activities

Ms. A. Bonnici

Reviewer or committee member for international conferences and journals, including:

- The Eurographics Workshop on Sketch Based Interfaces and Modelling.
- Computer and Graphics Journal.

Dr. Ing. M. K. Bugeja

Member of the Faculty's Board of Studies (Electrical Stream)

Member of the Faculty's Board of Accreditation

Member of the Faculty's Ad hoc Committee on Assistant Lecturer Loading

Coordinator for the Faculty's third year study unit ENR3008 - Team Project

Coordinator of the EU Robotics Week on behalf of the SCE department.

Reviewer for several conference and journal submissions, including:

- IEEE Transactions on Systems, Man and Cybernetics (Part B).
- International Journal of Systems Science.
- Neurocomputing (International Journal by Elsevier)

Prof K. P. Camilleri

Head, Department of Systems and Control Engineering.

Chairman, Support Staff Work Resources Committee.

Project Leader (Biomedical Engineering Sub-project) of the ERDF Project "Strengthening of the Analytical Chemistry, Biomedical Engineering and Electromagnetics RTDI Facilities"

Director, Centre for Biomedical Cybernetics.

Reviewer for journal submissions, including:

- IEEE Transactions on Image Processing.
- IEEE Transactions on Signal Processing.
- IEEE Signal Processing Letters.
- IEEE Computing in Science and Engineering.
- IEEE Transactions on Systems, Man and Cybernetics: Part A
- Journal of Electronic Imaging.
- Optical Engineering.
- Expert Systems.
- International Journal of Systems Science

Reviewer or International Programme Committee member of several international conferences, including:

- The Tenth IASTED International Conference on Biomedical Engineering (BioMED 2013).
- Sixth International Workshop on Intelligent Interfaces for Human-Computer Interfacing (IIHCI-2013).
- Seventh International Conference on Advanced Engineering Computing and Applications in Science (ADVCOMP 2013).
- 20th European Signal Processing Conference (EUSIPCO 2012)
- 21st International Conference on Pattern Recognition (ICPR 2012)
- The Third IASTED International Symposia on Imaging and Signal Processing in Healthcare and Technology (ISPHT 2013)
- The Ninth International Conference on Intelligent Environments (IE 2013)

Member on the Editorial Board of the International Journal on Advances in Intelligent Systems.

Member on the Editorial Board of the Research Journal of Information Technology.

FP7 Expert Project Proposal Evaluator

Dr. T. Camilleri	Member of the Faculty's MSc by Research Board of Studies
	Assisted in the organization of the Biomedical Engineering Exhibits for Discover University
	Coordinator for the Faculty's third year study unit ENR3008 - Team Project
	Reviewer for journal submissions including:

- Journal of Selected Topics in Signal Processing
- Journal of Biomedical Engineering and Control
- IEEE Transactions on Biomedical Engineering

IEEE Malta Student Branch Adviser and member of the IEEE Malta Section committee.

Prof S. G. Fabri	Member of the Administrative Council of the European Control Association (EUCA).
	Member on the Editorial Board and Associate Editor of the International Journal of Systems Science.
	Member on the Editorial Board of the International Journal on Advances in Intelligent Systems.
	Reviewer for journal submissions, including:

- IEEE Transactions on Automatic Control.
- IEEE Transactions on Neural Networks and Learning Systems.
- International Journal on Advances in Intelligent Systems.
- Journal of Precision Engineering and Manufacturing.
- International Journal of Advanced Robotic Systems.
- International Journal of Adaptive Control and Signal Processing.
- Journal of Process Control

Reviewer or committee member for several international conferences, including:

- 8th IFAC Symposium on Intelligent Autonomous Vehicles IAV 2013

- Seventh International Conference on Advanced Engineering Computing and Applications in Sciences, 2013
- International Conference on Informatics in Control, Automation and Robotics, 2013
- International Conference on Robotics and Automation, ICRA 2013
- 9th IFAC Symposium on Nonlinear Control Systems
- The IEEE Multiconference on Systems and Control 2013
- The International Conference on Unmanned Aircraft Systems ICUAS13
- IEEE Conference on Decision and Control 2013

Project Leader of ERDF Project 082: "Modernizing the University of Malta's Control Systems Engineering Laboratory".

Member on the University boards of The Institute for Sustainable Development and The Institute of Linguistics.

Coordinator of the department's *Internal Research Seminar Series*.

Dr. K. Scerri	Member of the Faculty Board

Member of the Faculty PR group (till February 2013)

Member of the Faculty Doctoral Committee

Member of the Faculty Internal Affairs group

Student advisor for international exchange programs.

Member of the cross faculty *Transport Information Systems and TelemAtics* (TISTA) Research Group.

Reviewer for submissions to the IEEE Transactions on Signal Processing.

Review for the Seventh International Conference on Advanced Engineering Computing and Applications in

Science (ADVCOMP 2013).

Collaborator with the Institute for Sustainable Development and the Faculty of ICT at the University of Malta on the project of Geoinformatics and Transport Modeling.

9. Prizes, awards and appointments

Doctoral degree

In January 2013 Ms Tracey A. Camilleri was awarded the Ph.D. degree from the University of Malta for successfully defending her doctoral thesis entitled "Multiple Modelling of EEG Data to Classify Different Mental States".

Promotions

The Council of the University of Malta promoted Dr Tracey A. Camilleri to the grade of Lecturer with effect from January 2013.

Appointment as Faculty Representative on Senate

In July 2013, Dr Marvin K. Bugeja was elected to represent the Faculty of Engineering on the Senate of the University of Malta.

10. Participation in courses, meetings and overseas visits

Research visit at Brno University of Technology, Czech Republic:

In March 2013 Dr. Ing. Marvin Bugeja visited the Department of Mechatronics at Brno University of Technology, hosted by the head of department Dr. Robert Grepl. Dr. Bugeja delivered lectures and practical sessions on "Introduction to Nonlinear Systems Analysis". Moreover, he discussed possibilities of joint research projects and lecturing visits between the two departments.

Attendance at meeting of the General Assembly of the European Control Association:

In July 2013 Professor Simon G. Fabri attended a meeting of the European Control Association (EUCA) which was held at ETH in Zurich. Prof. Fabri is the Malta representative on the General Assembly of EUCA.

Participation at ECC13 and ICINCO 2013:

In July 2013 Professor Simon G. Fabri presented a paper at the 2013 European Control Conference (ECC13) in Zurich and co-chaired the *Adaptive Control 1* session at the same event. Shortly afterwards he presented another paper at the 2013 International Conference on Informatics in Control, Robotics and Automation (ICINCO 2013) in Reykjavík, Iceland.

Participation in the CNRS EEGLAB Workshop in Aspet, France:

In June 2013, Professor Kenneth P. Camilleri, Dr Tracey A. Camilleri and Dr Owen Falzon participated in the intensive 5-day EEGLAB Workshop 2013 which was held in Aspet, France.

Participation in SSNR 2013

In September 2013, Dr Tracey Camilleri and Dr Owen Falzon participated in the summer school for neurorehabilitation – Engineering for Clinical Practice held in Elche Spain.

Participation in Expressive 2013

In July 2013, Alexandra Bonnici presented a paper in the Sketch Based Interfaces and Modelling track of the Expressive workshops in Anaheim, USA.

11. Collaboration with third parties

International collaboration…

Dr. Kenneth Scerri collaborated with the Department of Automatic Control and System Engineering at the University of Sheffield, UK and the Department of Electrical and Electronic Engineering at the University of Melbourne, Australia on Spatio-Temporal Modelling for Systems Biology.

Dr. Ing. Marvin Bugeja and Professor Simon G. Fabri collaborated with Dr. Francois Guerin from the University of Le Havre in France on Vision Based Target Tracking of Wheeled Mobile Robots. Preliminary results from this work are accepted for presentation at the Decision and Control CDC to be held in December 2013.

Popular media and outreach activities…

Malta Café Scientifique:

A department staff members delivered a public talk as part of the Malta Café Scientifique series held at the Inspirations! Café, St. James Cavalier in Valletta. Dr. Kenneth Scerri's talk entitled *Into the looking glass* was held on the 13th March 2013.

Student Shadowing Weeks

In November 2012 and March 2013, the Department offered placements for Student Shadowing offering opportunities to secondary school students to shadow the technical work that the technical staff of the Department carries out in the Control Systems Lab and the Biomedical Engineering Lab. The feedback provided by students and the Department technical staff was positive and indicated that this was a fruitful experience for all those involved.

European Robotics Week:

The department led the Faculty's participation in the local activities of the European Robotics Week which was held from the 24th to the 30th November. This European-wide innovative event was coordinated by the European robotics community and supported by the European Robotics Coordination Action (euRobotics) which is funded by the Seventh Framework Programme on Information and Communication Technology. Activities took place simultaneously over sixteen European countries, including Malta, to engage robotics technology stakeholders such as manufacturers, universities and research institutes, to organize outreach activities targeted to students and the general public on the theme of robotics. The objective is to highlight the importance of robotics as an emerging technology in modern application areas, and to use the robotics platform as a vehicle to encourage students in taking up careers and educational programmes in science, technology, engineering and mathematics (STEM). The turnout at the Faculty of Engineering was very encouraging, where a total of about 50 secondary school children visited the robotics set ups and demonstrations over three mornings. These included hands-on mobile-robot programming workshop sessions organized and delivered by the

Systems and Control (SCE) department and demonstrations with various robotic manipulators in the Industrial Automation Laboratory of the Department of Industrial and Manufacturing Engineering.

Press articles, TV and magazines:

Professor Kenneth P. Camilleri, Dr. Tracey Camilleri and Dr. Owen Falzon appeared in a television programme discussing the research activities within the University of Malta, where biomedical engineering related projects were highlighted. This programme, called 'Ta Barra Minn Hawn', was broadcast on TVM during Science in the City 2013.

The work on transport modeling and analysis carried out by Dr. Kenneth Scerri has featured in two articles in the popular media, namely the *Times of Malta* of the 5th June 2013 and the spring 2013 issue of *Think* magazine. Dr. Scerri has also appeared in the television program *Indigo* discussing the future of transportation in Malta.

Dr Tracey Camilleri also appeared in the One TV programme Indigo, held on Friday 13th September, with the topic discussed being the Bionic Human.

Kids on Campus Summer School:

The department participated in the Kids on Campus summer school by giving three interactive workshops on the 2nd, 6th and 7th August for children aged between five and six years. In these workshops, the Lego Mindstorm robots were used to introduce the concepts of obstacle detection and avoidance. A further hands-on workshop for ten year old children was held on the 9th August. During this workshop, a series of games were used to introduced the children to different concetps of systems and control engineering. A thermal imager was used to locate thermally conspicuos objects in the foyer of the Faculty of Engineering, the Vicon motion system was used to play an adaptation of the game 'Simon Says' whereby the children had to guess the pose from a skeletal model of a child selected as 'Simon', while Lego Mindstorms robots were programmed by the children to perfrom object detection and avoidance as well as shoot a ball.

Locating thermally significant objects hidden in the foyer

Placing markers to create skeletal models with the Vicon system

Foreign Student Placements and Internships:

In collaboration with the Centre for Biomedical Cybernetics, the Department hosted a number of foreign students in its Biomedical Engineering Department this year starting with: Mr Joris Wils and Ms Nina Stuer, biomedical engineering students from the Katholieke Hogeschool Kempen, in October 2012; Ms Francesca Lauretti, a graduate in biomedical engineering from 'La Sapienza', Rome, in March 2013; Mr Andre Falzon and Mr Gerard Hogan, biomechanical engineering students at Cork Institute of Technology, Ireland, in March 2013; Ms Mathilde Bouvier, biomedical engineering student at Polytech Marseille, France, in May 2013; IAESTE exchange student Mr Mateusz Gora from the AGH University of Science and Technology in Krakow, Poland, in July 2013; and Mr Alexandre Hamon, from ICAM, Toulouse, France, in September 2013.

Discover University:

During the Discover University week, the department organized a series of two hands-on workshops in the Systems and Control laboratory 'Programming with Lego Mindstorms' was attended by (60) students from (3) different schools. Through this workshop, the students were introduced to concepts of robot control via the Lego Mindstorms robots. 'What! No Photoshop' was attended by 60 fifth formers from three different schools. This workshop introduced the students to the basic image processing algorithms that drive common imaging apps on smart-phones. In addition, a talk 'Machine Interpretation of Sketches' was given in the main pavillion on campus.

Science in the City

For Science in the City which was held on the 27th of September 2013, the department had a stand at the Upper Barrakka in Valletta displaying two brain computer interface applications. One of the exhibited applications was a music player controlled solely through brain signals which are evoked by visual flickering stimuli. The other application was an interactive setup aimed specifically for children who were given the chance to wear a wireless headset and control the facial expressions of an avatar using only their brain signals. This exhibit was well attended by the general public.

Science in the City –
Music player controlled with brain signals

Science in the City –
Interactive Setup with wireless Headset