University of Malta
L-Università ta' Malta

Annual Activity Report

2015 - 2016

Department of Systems and Control Engineering

SCE

Annual activity report for the year 2015 - 2016, published by the

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Faculty of Engineering
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Cover picture shows an interactive eye-controlled game where the user controls the mouse cursor by the eye and head movements alone in order to hover over randomly appearing smileys, as part of the PhD project Eye-Gaze Tracking by Video-based Joint Head and Eye Pose Estimation by Stefania Cristina.

Contents

1. Introduction

This report highlights the main activities of the Department of Systems and Control Engineering spanning research, teaching, outreach and service to the community - a report that shows a vibrant small community delivering substantially in all quarters against the odds of negligible research funding and severely limited resources.

With regard to research activities, the Department is working in highly topical areas such as intelligent control, mobile robots, computer vision, biosignal human computer interfacing, and transport modelling. These areas have provided opportunities for postgraduate and doctoral students as well as researcher employment, yielding an average fractional article equivalent per person of more than 1.0, a figure comparable to that of reputable and well-funded universities for the science and engineering area.

With regard to teaching activities, it is noteworthy that the Department has kept its teaching services to various programmes outside the Faculty. This was also a special year in view of having the proposed taught Masters in Signals, Systems & Control approved by Senate, after receiving excellent reviews from the external review process. We look forward to the launch this full-time M.Sc. - the first for the Department and the Faculty - in October 2017. The Department has also kept a healthy population of postgraduate research and doctoral students - it is clear however that substantial national and university investment in postgraduate and doctoral scholarships is required to raise this population above the critical point.

I am also very grateful for the support provided by the Department members to the outreach programmes that engage young children and older pupils in a suite of technical exercises. I believe that we will reap the rewards of this thankless effort in five to ten years' time, by which time we may have forgotten the seeds we sow today.

Unfortunately, my expectation that the new laboratory space would be functional by the end of this year was vain. It is a pity that the efforts to refurbish 300m^2 of prime quality real-estate for three academic departments have not found the requisite support so much so that I regret that the space will not be functional before the end of the next academic year, that being only a possibility with an unquantifiable probability.

Despite the limitations and setbacks, the Department goes from strength to strength. I am deeply grateful to each and every member of the Department.

30th September 2016 **Prof Ing. Kenneth P. Camilleri**

Head of Department

2. Staff Members

Professors:

- Prof Ing. Kenneth P. Camilleri, *B.Elec.Eng.(Hons.), M.Sc. (Sur.), Ph.D. (Sur.), MIEE, SMIEEE, ACIArb* – **Head of Department**
- 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* - on special leave of absence
- Dr Ing. Marvin K. Bugeja, *B.Eng. (Hons.), Ph.D. (Melit.), MIEEE*
- Dr Tracey Camilleri, *B.Eng. (Hons.), Ph.D. (Melit.), MIEEE*
- Dr Dr. Alexandra Bonnici, *B.Eng. (Hons.), M.Phil. (Melit.), Ph.D. (Melit.), LLCM(TD), MIEEE*

Assistant Lecturer:

- Ing. Luana Chetcuti Zammit, *B.Eng. (Hons.), M.Sc.(Eng.)*

Visiting Academics:

- Mr. David Debono, *B.Eng. (Hons.), M.Sc.*
- Mr. Julian Mercieca, *B.Eng. (Hons.)*
- Ing. Andre Sant, *B.Eng.(Hons). M.Sc., MIEEE*
- Ms. Rachael Darmanin, *B.Eng. (Hons.), M.Sc.(Eng.)*

Systems Engineers:

- Ing. Stefania Cristina, B.Eng.(Hons). M.Sc. (Melit.), MIEEE, MIET
- Ms. Lucianne Cutajar, *B.Eng. (Hons.)*

Senior Laboratory Officer:

- Mr Noel Agius

Clerk:

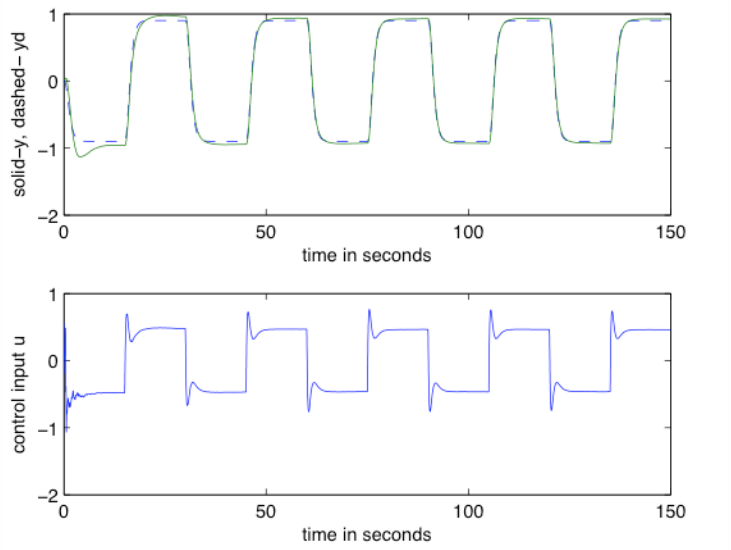
- Ms Sanchia Lentini

3. Research Activities

3.1 Research Projects

- **Nonlinear, Adaptive and Intelligent Control**
  Main investigators: Prof Ing. Simon G. Fabri

  This ongoing research focuses on the development, design and application of modern methodologies for nonlinear, adaptive and intelligent control systems. In particular, dual adaptive control methodologies in continuous-time - a domain that is only explored very sparsely in this context - are being investigated. By utilising a cost function of the explicit type, together with continuous-time Kalman filtering and appropriate low-pass filters to avoid signal differentiation, realizable suboptimal methodologies that exhibits the desirable properties of dual control are being sought for continuous-time dynamic systems.



Dual control in continuous-time

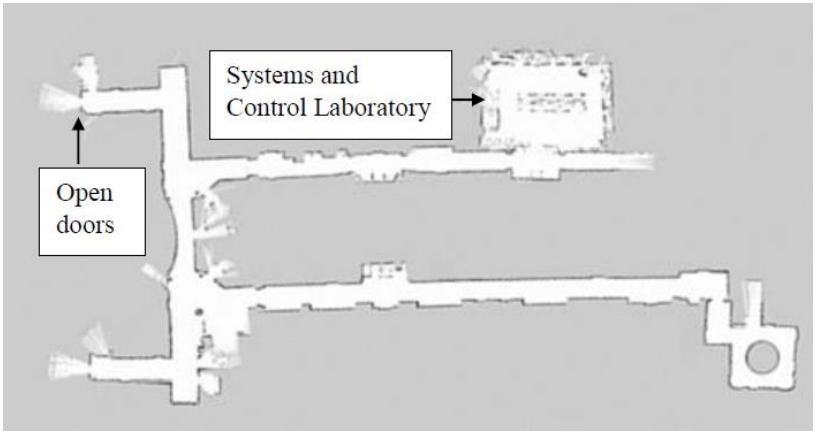
- **Autonomous Exploration, Mapping and Navigation with Mobile Robots**
  Main investigators: Dr. Ing. Marvin Bugeja
  Research students: Ms. Rachael Darmanin, Ms. Danica Theuma

  This year saw the conclusion of a Masters by research project (student: Rachael Darmanin) focusing on autonomous exploration and mapping for mobile robots. The proposed design consists of three main components, namely: a Simultaneous Localization and Mapping (SLAM) algorithm, an exploration strategy, and a path planning/following algorithm. SLAM is a process through which the robot creates a

map of its environment and at the same time estimates its location within the map. The exploration strategy is used by the robot to select the next best waypoint in order to expand its charted territory accurately, and at the same time improve self-localization. The path planning/following algorithm is used by the robot to plan and execute a safe path to the selected waypoints, in the presence of static and/or dynamic obstacles. In particular, this work contributed to the robotics community by providing ROS implementations of three exploration strategies. Moreover, these strategies were validated and compared on a real mobile robot, Powerbot, equipped with a laser rangefinder and running ROS. This work was published in a conference paper presented at the 13th International Conference on Informatics in Control, Automation and Robotics 2016.

Powerbot navigating a populated environment

Building on the technical knowledge and skills acquired from this project, a subsequent Final Year Project (*student:* Danica Theuma) investigated further the mapping and navigation processes in ROS. In this project the student implemented a system that enabled a wheeled mobile robot to navigate in a populated and obstacle-cluttered environment using a preloaded map. Practical applications of this work include but are not limited to: delivery robots in urban environments, and robotic guides in museums and city centres.



An autonomously generated map of the Faculty's ground floor

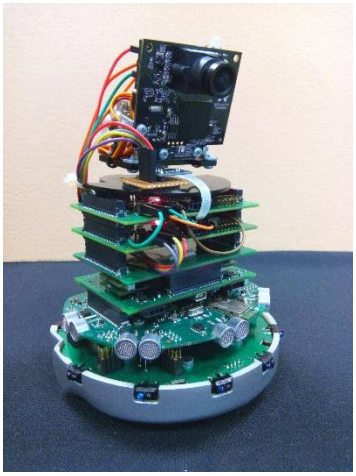
- **Robot Control**

  Main investigators: Prof Simon G. Fabri, Dr. Ing. Marvin K. Bugeja
  Research students: Mr. Marlon Galea, Ms. Clare Saliba

  Projects in this area study various aspects of robot control on different platforms, including mobile robots and robotic manipulators.
  There has been a continuation on the work concerning the development and integration of the in-house five degrees-of-freedom robotic manipulator designed and constructed in the Control Lab over a number of years.


CAD drawing of the 5-DOF Control Lab manipulator

Another project, on mobile robotics, (*student:* Ms. Clare Saliba) developed a system that enabled a Khepera III wheeled mobile robot to be commanded, via speech, to autonomously search for and follow a specific coloured target in an unknown, obstacle-cluttered environment. This project is a continuation of previous final year projects on the same theme.



Khepera III equipped with the CMUcam5

Path taken by Khepera III while approaching a target (the yellow robot on the left)

- **CT Radiation Doses in Nigeria: Establishment of Diagnostic Reference Levels and Radiation Dose Optimisation**

  Main Investigators: Prof Simon G. Fabri, Dr. Francis Zarb (Department of Radiography, Faculty of Health Sciences), Prof Mark McEntee (Brain and Mind Research Institute, The University of Sydney, Australia)

  Research student: Mr. Idris Garba

  Computed Tomography (CT) procedures are considered as high radiation dose examinations. In view of this, every country is encouraged by international regulatory

agencies such as the IAEA and ICRP, to develop Diagnostic Reference Levels (DRLs) that aim to establish radiation levels that should not be exceeded where good practice is applied, without compromising the quality of the scans for clinical purposes in the interest of patient protection. The aim of this project is to establish national DRLs for CT examinations in Nigeria for the purpose of radiation dose optimisation.

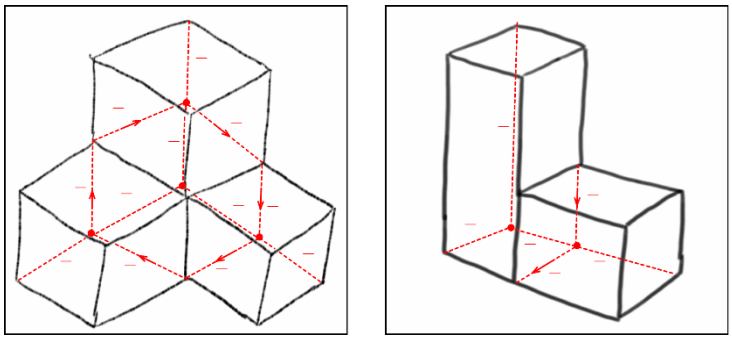
The study will apply quantitative methodologies with a cross sectional research design identifying the radiation dose in terms of Computed Tomography Dose Index (CTDI) and Dose Length Product (DLP) for CT examinations. Both retrospective and prospective approaches will be adopted. Retrospective dose data for the initial radiation dose assessment will be collected for adults and paediatrics by extracting relevant information from the Digital Imaging and Communication in Medicine (DICOM) header of the digital data file generated by the scanners or, in the event that the DICOM header is not available, by manual filling of a questionnaire. This data will be used to identify those centres where high or possibly unnecessary radiation exposure is used. Meanwhile, another data sheet will be used to collect data for the prospective re-evaluation of the radiation dose after optimisation for centres where there is unnecessary high radiation dose value with respect to other CT centres or countries. The optimisation will be carried out through adjustment of the CT scan parameters (kV, mAs, slice thickness, pitch) while maintaining acceptable image quality for diagnostic purposes.

- **Cognitive Vision for Sketch Understanding**
  Main investigators: Prof Ing. Kenneth P. Camilleri, Dr. Alexandra Bonnici

  Human observers, can interpret sketches as 3D objects quite easily, using the artistic cues that are often introduced to the sketch to deduce the geometric shape of the sketched object. Replicating this interpretation on a machine is however, not a trivial task and the same artistic cues that humans use to aid the interpretation, increase the difficulties of the machine pre-processing required to identify these cues from the sketch strokes that define the shape of the object. In the work carried out thus far, we have obtained a vectorised representation of the sketch, distinguishing the drawing edges from the sketched shadow cues. Moreover, we have obtained a geometric interpretation of the sketch's edges, allowing us to identify the basic geometric structure of the object.
  The sketched drawing however, will typically contain only the visible component of the object, while in order to fully reconstruct the object, it will be necessary to obtain information about those parts of the object which are hidden from view. Although

such hidden views can be drawn by the user, creating what are referred to as wireframe drawings, these additional strokes require a higher degree of skill and drawing accuracy than what is usually expected in rough sketches, particularly by non-expert sketchers.

Thus, our work focuses on using the edge geometry interpretation of the visible edges to deduce the hidden object shape. This we achieve through the use of a genetic algorithm approach which allows us to search for possible hidden geometries, using the visible edges to constrain the search space.



- **Eye-Communicate - Robust, Cost-Effective Eye-Gaze Technology for Assisted Communication**

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

  The prospect of communicating by eye gaze to provide an alternative communication channel for disabled persons is becoming increasingly appealing. Although this approach has generated worldwide interest, eye-gaze technology is presently hampered by various open issues which slow down its widespread use. One limitation which remains prevalent is the prohibitive cost associated with eye-gaze tracking systems, hindering access by those persons who may potentially benefit from this technology from actually affording it. This project, therefore, proposes to investigate suitable methods to address open issues associated with eye-gaze tracking, while at the same time seeking low-cost solutions that may be afforded by the individual consumer and which permit the user to move naturally without demanding additional equipment other than the required cameras.

  Further work was carried out this year to develop eye-gaze tracking algorithms requiring minimum calibration and free head movement. Several data collection sessions have been carried out with the collaboration of personnel from the Access to Communication and Technology Unit (ACTU) and persons with cerebral palsy, which permitted the collection of data on which the developed algorithms could be

evaluated. Parts of the work carried out during this project have been published in the Journal of Computer Vision and Image Understanding (CVIU) and the Journal of Machine Vision and Applications (MVA).

- **Visual object recognition based on textual descriptions**
  Main investigators: Dr. Albert Gatt, Prof Ing. Kenneth P. Camilleri, Ing. Stefania Cristina
  Research Students: Mr. Marc Tanti

  This research project is being undertaken in collaboration with the Institute of Linguistics seeks to combine the computer vision expertise of the Department with linguistic description of images provided by the Institute. In this project, the aim is to generate linguistic captions for images and seek methods that can generate descriptions of objects by recognition of its parts.

- **A brain computer interface system based on visually evoked potentials**
  Main investigators: Dr. Tracey Camilleri, Prof Ing. Kenneth P. Camilleri, Dr. Owen Falzon, Ms. Rosanne Zerafa
  Research Students: Ms. Kimberlin Bartolo, Mr. Matthew Aquilina

  One of the most intuitive brain computer interface (BCI) systems is that based on visually evoked potentials. In such a system, the brain signals of a subject gazing at specific visual stimuli are recorded through electroencephalography (EEG) and processed in real time to allow the subject to control an application. This project focuses on the practicality aspect of the system by developing techniques that make it possible to use this BCI in everyday life. This will require the system to have a short training session, uses a wireless EEG headset, caters for the idle period where the subject does not want to issue a command, has a fast response time, zero false detections and is comfortable to use over long periods of time.

  This year the project focused on two particular applications:

1. Music player controlled by brain signals
   The platform of the music player was developed by Ms. Rosanne Zerafa in her MSc. This year Ms. Kimberlin Bartolo and Ms. Rosanne Zerafa focused on reducing the training time needed to start using the music player, which originally was of 21 minutes. The analysis so far showed that training on a menu with the largest number of simultaneously flickering stimuli is enough to guarantee reliable classification

performance and avoids the need of re-training for each possible menu in the music player interface. This was shown to reduce the training time down to 13 minutes. Further work on this topic is currently ongoing where the aim is to recruit more subjects to be able to quote more generalizable results.

Using the brain-controlled Music Player

2. Robot controlled by brain signals

   The goal of this project was to control a Lego mindstorms robot using an SSVEP based BCI where stimuli flickering at different frequencies would control different movements of the robot such as forward and backward movements as well as rotation to the left or right directions. This project focussed on the use of the Enobio system for EEG recording, which offers a gel based wireless solution to record EEG signals and the possibility of having a visual display shown simultaneously with the flickering stimuli so that the user can track the location of the robot. This system requires a 5min training time and has proved to be a good demonstration tool to showcase how an SSVEP based BCI application works.

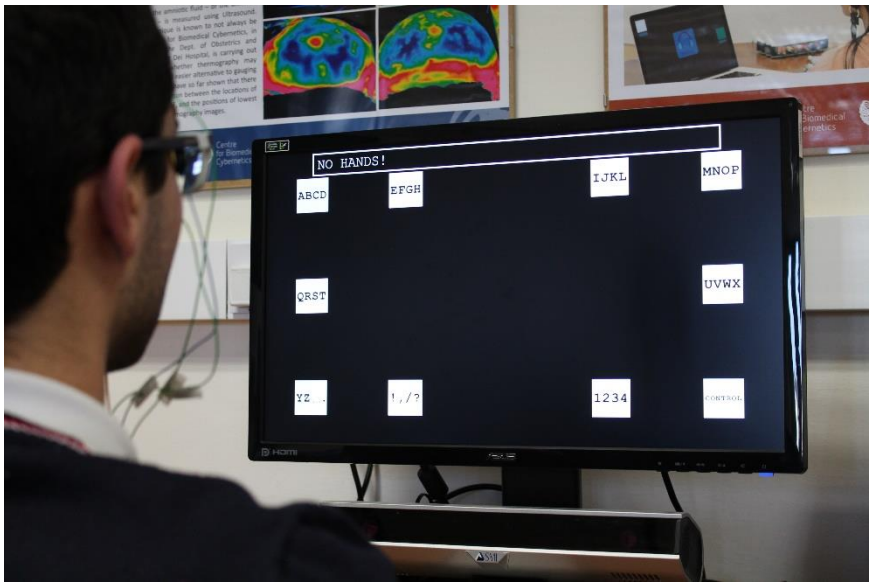
Demonstration of Robot Control by brain signals in Science in the City 2016

- **Controlling a computer application using EOG signals**
  Main investigators: Dr. Tracey Camilleri
  Research Students: Mr. Nathaniel Barbara

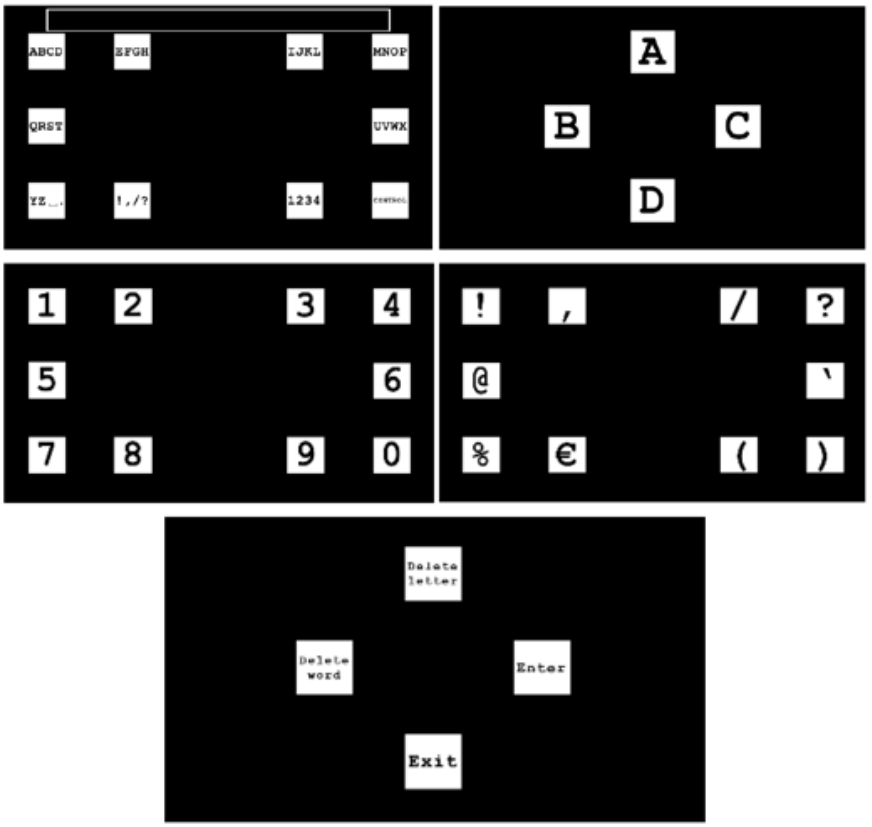
  Bio-signal based human computer interface (HCI) systems are a good alternative to standard touch based interfaces, offering subjects with motor impairments an alternative means of communication. This project investigated the use of electrooculography (EOG) in such HCIs, where specifically the use of a wireless EOG glasses currently on the market, known as the JINS MEME, comprising three dry electrodes on the nose pads and nose bridge, is compared to the standard two-pair gel-based EOG electrode configuration. A saccade classification accuracy of 70.69% and a blink accuracy of 95.13% were obtained using a threshold-based classification algorithm on the EOG data collected through the JINS MEME, which were found to be comparable to the 75.32% and 93.38% saccade and blink detection accuracies, obtained using the conventional setup.

  The two EOG recording modalities were then used to interface a real-time menu-driven speller application. In this case average writing speeds of 6.44 and 7.11 letters per minute were achieved when the keyboard was interfaced using the gel-based electrodes and the JINS MEME, respectively. Such results compared well to the writing speed of 7.37 letters per minute obtained when the keyboard was interfaced by a video-based eye gaze tracker.

This work will be presented at the IEEE International conference on Systems, Man and Cybernetics in Budapest, Hungary between the 8-12th October 2016.



Using the EOG-controlled speller



The EOG-controlled speller (a) Main-menu, (b)sub-menu, (c) numbers menu, (d) punctuation menu, (e) control menu

- **EMG based control of a robotic arm**

  Main investigators: Dr. Tracey Camilleri, Dr. Ing. Marvin Bugeja

  Research Students: Mr. Christian Zammit, Mr. Sean Kenneth Grech, Mr. Paul Bezzina

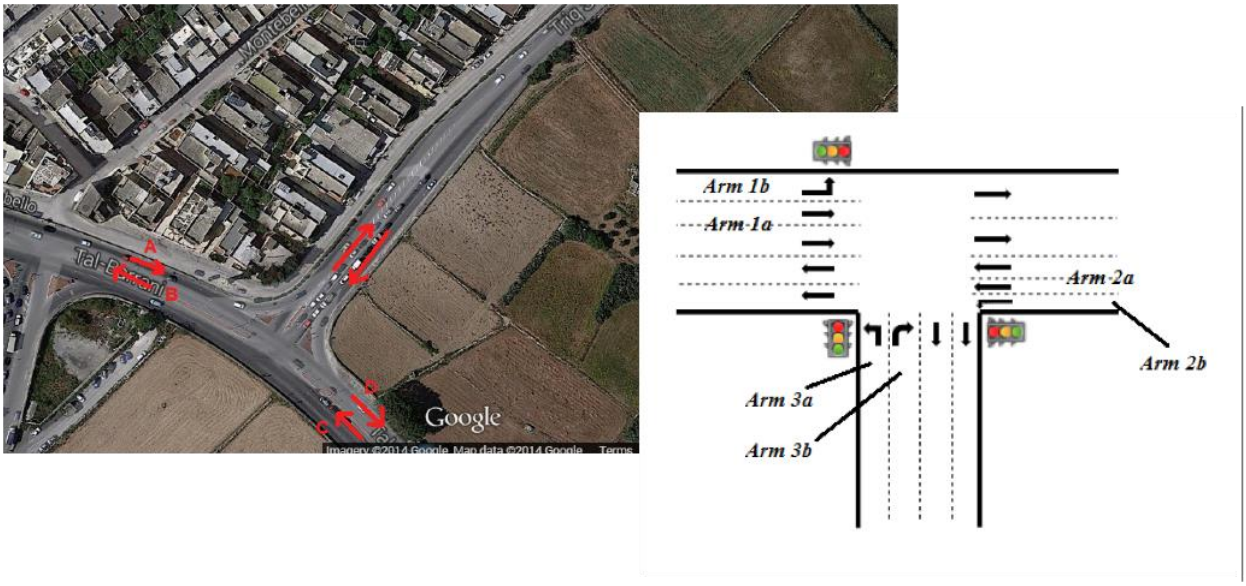
  The aim of this project was to develop a human machine interface (HMI) for the control of a robotic arm manipulator, through the use of non-invasive surface electromyographic (EMG) signals. These signals can provide information on the position of a current movement being performed, or in the case of amputees, give details on the movement that the person wants to perform. Many commercial prosthetic devices have attempted sequential control of different upper limb joints, but these make everyday movements very difficult to perform. Current research is focused on developing a reliable prosthetic device which incorporates simultaneous control of different joints.

  This year the project focussed on developing a model which converts EMG signals from multiple muscles to elbow and shoulder angles for real time, simultaneous and proportional control. Models for 7 different single and simultaneous joint movements were implemented and the project focussed on the comparison of three different neural network structures to find which gives the best representation between the EMG signals and corresponding joint angles. A multilayer perceptron (MLP), a time delayed neural network (TDNN) and a recurrent neural network (RNN) were tested, with results over 5 subjects showing that there is no statistically significant difference between the performance of the three networks. Thus the MLP, which has the most simple configuration, was concluded to be the best model to represent the relationship between the EMG signals and the corresponding shoulder and/or elbow joint angles.

Real-time wrist position control application

- **Transport Modelling and Control Applied to the Maltese Traffic Network**
  Main investigators: Prof Ing. Simon G. Fabri, Prof Maria Attard (Institute for Sustainable Development and Climate Change), Dr. Kenneth Scerri.
  Research student: Ing. Luana Chetcuti Zammit

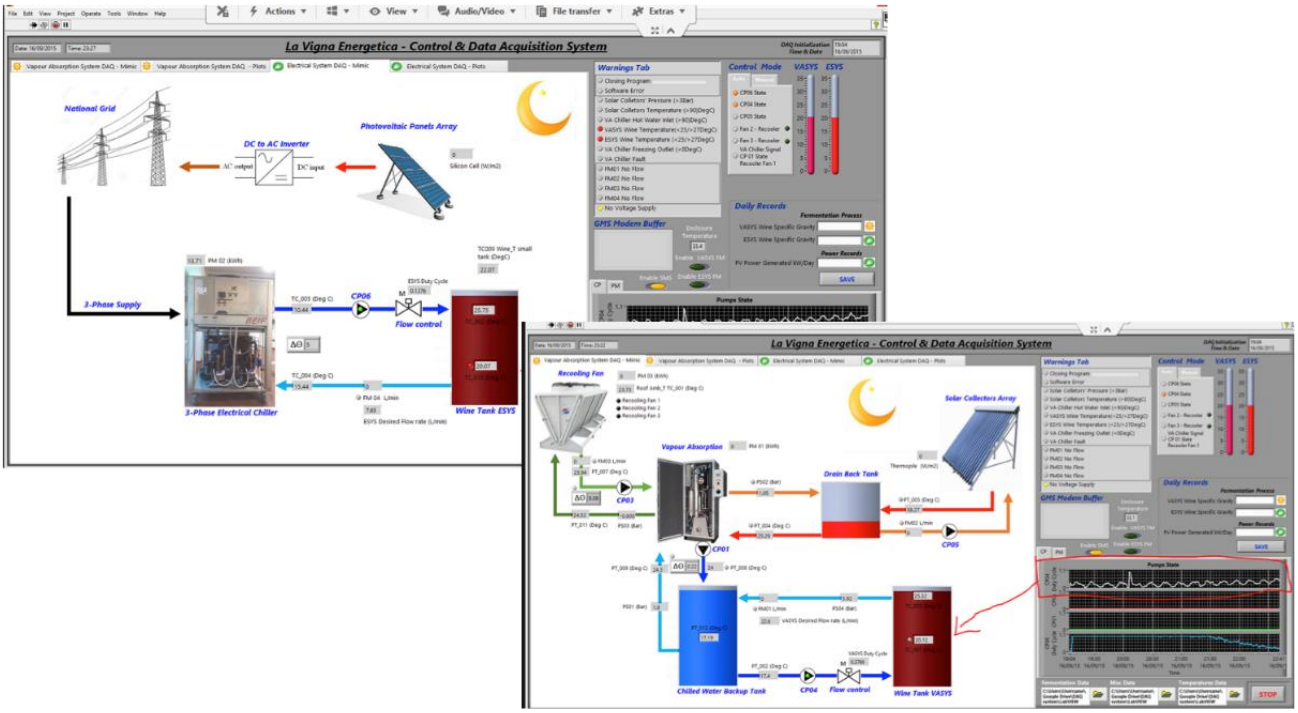
  This work focuses on the development of cost effective intelligent traffic management systems in an urban environment. Through the use of off-the-shelf inexpensive sensors and a novel modelling methodology, various control strategies are being investigated for the online switching of traffic light timing. Such control has the potential to minimize queue lengths at congested junctions, thus reducing both the travel time through the junction and the emission of hazardous pollutants, as well as autonomously adapting itself to time-varying conditions so as to optimise traffic flow in the presence of altering traffic densities or junction constraints. Recent developments in this work have been presented at the 2016 Mediterranean Conference on Control and Automation and several technical reports.



- **Data Monitoring and Control of Solar Cooling Systems for Industrial Wine Production**
  Main investigators: Prof Simon G. Fabri in collaboration with Prof R. Ghirlando (Institute for Sustainable Energy)
  Research student: Mr. Joseph Agius

  This project includes the investigation, modelling, controller design, implementation and testing of an automated temperature control and data monitoring system for two solar powered cooling systems installed at the Wine Research Centre in Buskett, Malta.

This work was linked to an Italia-Malta 2007/13 Cross-Border Cooperation Programme project entitled *Vigna Energetica*. In order to regulate the temperature of fermenting wine at the desired levels, two different solar-driven cooling systems technologies are used: a conventional electrical-chiller operating alongside a grid-connected photovoltaic system, and a vapour-absorption chiller driven by heat from solar collectors. The designed computer-controlled automated system integrates all the components of the plant such that the temperature of the wine is automatically regulated at its optimum level using a Model Predictive Control methodology, while data is continuously monitored for supervision and performance analysis, leading to an objective and systematic comparison between the two cooling systems so as to quantify which is the most reliable, efficient and feasible in terms of temperature control and energy efficiency. Results from this work have been presented at the 2016 Mediterranean Conference on Control and Automation, an MSc dissertation and a submission to the 2016 Annual Conference of the Institute for Sustainable Energy.



3.2 Internal Research Seminar Series

IRSS 2015-2016

Phase-based SSVEPs for a Real-Time Brain-Computer Interface

Norbert Gauci 29 Jan 2016

In recent years, brain-computer interface (BCI) systems have emerged as a technology that can be used to develop a direct communication pathway between the human brain and the external environment. BCI systems can provide a promising solution for individuals with severe motor disabilities to enhance and/or restore their communication capabilities and motor functions. Among the various neurophysiological phenomena that can be used to drive BCI systems, steady-state visual evoked potentials (SSVEPs) have gained increasing popularity because of the high information transfer rate (ITR) and high accuracy that these can provide. SSVEPs are oscillatory responses in the electroencephalography (EEG) that are detected over the occipital and parietal regions of the brain. A typical SSVEP-based BCI system consists of a set of uniquely coded visual stimuli that when a user attends to them, evoke a distinctive SSVEP response, allowing them to make a specific selection.

Conventional SSVEP systems adopt frequency analysis techniques to extract magnitude characteristics that can be used to discriminate between multiple visual targets. Since SSVEPs are phase-locked to the target stimulus, phase analysis techniques have also been used in several SSVEP systems. Although the feasibility of frequency and phase analysis techniques was demonstrated in several studies, no detailed comparison was found in literature that investigates whether the combined use of these techniques can enhance the performance of the BCI system. On this basis, an offline study was conducted to investigate whether the target identification accuracy of an SSVEP-based BCI system can be improved by combining magnitude and phase characteristics in the decoding process of SSVEP signals. Moreover, this study also investigates whether the performance of an SSVEP system can be enhanced by selecting subject-specific frequencies. The results obtained from this offline study were used to guide the design of a real-time BCI system to control a multi-functional motorised bed.

The proposed online system consists of eight targets, seven visual stimuli and an idle state, that were presented to the users to evoke SSVEP response. Each visual stimulus is associated with a particular function of the motorised bed while the idle state represents the no action state where the bed remains stationary. The results demonstrate that the BCI system can successfully discriminate between different SSVEP signals achieving a high ITR of 82.73 bits/min with an accuracy of 72.03% across eight participants, when considering 1 s segments of EEG. An average ITR of 57.18 bits/min with a target detection

Autonomous Exploration and Mapping using Mobile Robots

Rachael Darmanin 16 Mar 2016

The discovery of uncharted territories has been one of the greatest and earliest fascinations of mankind. Exploration of unknown environments mostly leads to the creation of a map of the terrain being explored. Robotics finds itself in the midst of the necessity for exploration and mapping. Until recent years, robotic mapping of environments had been performed by manually steering the robot around the environment while it uses its onboard sensors and algorithms to construct a world model. Novel research has revealed techniques through which both the robot navigation during exploration, and the mapping process are performed autonomously. In general, an autonomous exploration and mapping robotic system consists of three main components: Simultaneous Localization and Mapping, SLAM, exploration and a path planning (motion control) component. SLAM is a process through which the robot creates a model of the physical environment (mapping) while at the same time estimates its location within that map (localization). Moreover, given a current robot location in the map, an exploration strategy decides upon the next best location in the environment that the robot should visit in order to expand its charted territory and improve localization. Finally, the path planning and motion control component is responsible for the safe planning and execution of a path for the robot from its current location to a goal location. This work aims to investigate the state-of-the-art techniques that can be used to design and implement such a robotic system. For this purpose, the research robot, PowerbotTM, equipped with Robot Operating System (ROS) – a software development framework for robots – was used. The modularity of the implemented scheme enabled three different exploration strategies to be experimentally validated on PowerbotTM, running the same SLAM, path planning and motion control components, in a real-life environment. This work contributes to the robotics community by providing ROS implementations of three exploration strategies. In addition these strategies are validated and compared on a real robot running ROS. The experimental results show that there is a statistically significant difference between the performance of the three strategies. These differences are analysed and discussed in detail in this study.

Autonomic control for road network management

Luana Chetcuti Zammit 10 June 2016

A major component of Intelligent Transport Systems (ITS) is the timing of signal controlled traffic light intersection which adapts itself so as to optimize the flow of vehicles through the road network. Traffic light timing optimization is a complex problem because it requires an optimal solution at each junction in the network. Moreover, the complexity of the system increases with multiple junctions, as the state of one traffic light influences the flow of traffic towards other connected junctions. Another complication is the fact that the flow of traffic changes constantly, depending on the time of day, the day of the week, and the time of year. Roadworks, accidents and inclement weather conditions, such as flooding,

further influence the complexity and performance of the system. Traffic light timing optimization requires either car-to-car or car-to-infrastructure communication or the installation of sensors at traffic junctions to capture and control the traffic conditions. Car-to-car or car-to-infrastructure communication heavily rely on cooperative agents that share or exchange information, to achieve better system-wide performance. Communication can result in a complicated timely process, with the complexity increasing significantly with the number of agents in the system. Communication can also lead to slow response to detect abrupt changes in the network structural changes caused by flooding, road accidents etc. Cooperative agents inevitably suffer from communication noise, which introduces another layer of complexity for the traffic systems. Moreover, online data given from the sensors can be used to control the traffic light timings in real-time, thus making the system traffic-responsive. However, such infrastructural installation and maintenance costs are a burden and should be kept to a minimum. Measurement inaccuracies possibly resulting from sensors can lead to inappropriate control of traffic lights and hence should be kept to a minimum. Furthermore, human intervention is required to provide primitive route diversion recommendations when subject to network structural changes. Such human intervention might not guarantee the optimal use of the available network capacity. Traffic networks are characterized by highly complex structures and dynamic behaviour typified by time-varying parameters, jump dynamics and unpredictable disturbances. The task of controlling this kind of system is therefore a considerable challenge, when expected to operate safely, reliably and efficiently within several operating conditions and with as little human intervention as possible. Realizing the limitations of the above mentioned current practice, the need to design self-managing systems, which self-handle the complexity and uncertainties and thus reduce human intervention to minimum is of utmost importance.

In order to contribute to the self-management of a traffic network, particularly control of a signalized-intersection, the traffic flow dynamics within a junction should be analysed. Hence, a data-driven, macroscopic, heterogeneous traffic junction model in state-space form is proposed in this work, which makes use of queueing theory. To contribute to the self-management of the network, several self-estimation algorithms are proposed in quasi real-time, to jointly estimate the process and measurement noise, model parameters and states, describing the traffic flow dynamics under different traffic conditions. The proposed iterative algorithms make use of the Expectation Maximization algorithm. Despite the successful application of EM methods to several fields, their potential utility to traffic flow models is explored in this work. The proposed algorithms were tested and validated on several signalized 3-arm junctions. The results obtained are promising in accuracy and point towards the innovative application of the EM algorithm to traffic flow models.

3.3 Internal Research Workshop Series

This academic year, the Department launched a series of research workshops for staff and postgraduate research students allocated to the Department and the Centre for Biomedical Cybernetics, as well as close research collaborators from other departments or institutes.

The aim is to have a regular series of sessions where a speaker presents a specific research topic, area or application in some detail, using a typical "workshop/tutorial" format. Contributions need not be innovative or original, though such topics are not excluded. Interaction with participants is highly encouraged through active discussion, hands-on exercises etc. as relevant.

IRWS 2015 - 2016		
Prof Ing. Simon Fabri	Optimal Control and Estimation - Part 1	18 November 2015
Prof Ing. Simon Fabri	Optimal Control and Estimation - Part 2	16 December 2015
Dr. Ing. Marvin Bugeja	Stochastic Nonlinear Estimation	3 February 2016
Dr. Tracey Camilleri	System Identification - Part 1	13 April 2016
Prof Ing. Kenneth Camilleri	Slow Feature Analysis	27 April 2016
Dr. Tracey Camilleri	System Identification - Part 2	25 May 2016
Dr. Alexandra Bonnici	Localization and Mapping using Computer Vision	15 June 2016

4. Student Projects and Supervision

4.1 B.Eng Students

Project Title	Student	Supervisor
Controlling a Computer Application Using EOG Signals	Nathaniel Barbara	Dr. Tracey Camilleri
Reducing Training Time in SSVEP Based BCI Systems	Kimberlin Bartolo	Dr. Tracey Camilleri
Optical Music Recognition of Piano Sheet Music	Joseph Bezzina	Dr. Alexandra Bonnici
A Brain-Computer Interface for Rapid Image Searching	Elysia Calleja	Dr. Owen Falzon Prof Kenneth P. Camilleri

Foetal Thermography	Annelie Ciantar	Dr. Owen Falzon
System Integration and Control of a Mini Robotic Manipulator	Marlon Galea	Prof Ing. Simon G. Fabri
EMG Based Control of a Robotic Arm in 3D Space	Christian Grech	Dr. Tracey Camilleri Dr. Ing. Marvin Bugeja
An EEG-Based Biometric System	Andrea Lia	Dr. Owen Falzon
Voice Commanded Mobile Robot for Search and Follow Operations in Unknown Environments	Clare Saliba	Dr. Ing. Marvin Bugeja
Emotion Recognition from Physiological Signals	Jurgen Seychell	Prof Ing. Kenneth P. Camilleri
Non-Photorealistic Rendering of Scenes	Kenneth Terribile	Dr. Alexandra Bonnici
Autonomous Robot Navigation in a Populated Environment	Danica Theuma	Dr. Ing. Marvin Bugeja
Finger Movement Detection Using the Electromyogram	Glen Mark Zammit	Prof Ing. Prof Ing. Kenneth Camilleri Prof Michael Saliba

4.2 M.Sc. Students

Project Title	Student	Supervisor
Data Monitoring and Control of Solar Cooling Systems for Industrial Wine Production	Mr. Joseph Agius	Prof Ing. Simon G. Fabri Prof Ing. Robert Ghirlando
Autonomous Exploration and Mapping with Mobile Robots	Ms. Rachael Darmanin	Dr. Ing. Marvin K. Bugeja
Brain-computer interfacing by motor imagery	Mr. Edward Zammit	Dr. Owen Falzon Prof Ing. Kenneth P. Camilleri
Automated Analysis of Thermal Images for Peripheral Vascular Disease Monitoring	Mr. Jean Gauci	Dr. Owen Falzon Prof Ing. Kenneth P. Camilleri

4.3 M.Phil. / Ph.D Students

Project Title	Student	Supervisor
Vectorisation and Interpretation of Drawings with Artistic Cues	Ms. Alexandra Bonnici	Prof Ing. Kenneth P. Camilleri

Modelling Spatial Context in Maltese Sign Language Recognition from Video Sequences	Mr. Mark Borg	Prof Ing. Kenneth P. Camilleri Prof Marie Alexander
Autonomic Control for Road Network Management using Geocomputational Tools	Ing. Luana Chetcuti Zammit	Prof Ing. Simon G. Fabri Prof M Attard
Eye-Gaze Tracking by Video-based Joint Head and Eye Pose Estimation	Ing. Stefania Cristina	Prof Ing. Kenneth P. Camilleri
CT Radiation Doses in Nigeria: Establishment of Diagnostic Reference Levels and Radiation Dose Optimisation	Mr. Idris Garba	Prof Ing. Simon G. Fabri Dr. Francis Zarb Prof Mark McEntee
Visual Object Recognition based on Textual Descriptions	Mr. Marc Tanti	Dr Albert Gatt Prof Ing. Kenneth P. Camilleri
An Enhanced Wearable System for Kinematic and Kinetic Gait Analysis	Mr. Nikiforos Okkalidis	Dr. Owen Falzon Dr Dr. Ing. Marvin Bugeja, Dr Alfred Gatt Prof Ing. Kenneth P. Camilleri

4.4 Postdoctoral scholars

Project Title	Student	Supervisor
Neural Correlates of Upper Limb Somatosensory Impairments and Recovery after Stroke: An EEG Investigation	Dr. Lisa Tabone	Prof Ing. Kenneth P. Camilleri, Prof Geert Verheyden (Katholieke Universiteit Leuven, Belgium)

4.5 Summer Internships

Project Title	Student	Supervisor
Controlling a mobile robot using brain signals	Mr. Matthew Aquilina	Dr. Tracey Camilleri
Implementation of brain computer interfacing for EEG comparative study	Mr. Cedric Moubri-Tournes	Prof Ing. Kenneth P. Camilleri,
Implementation of brain computer interfacing for EEG comparative study	Mr. Gaétan Lelu	Prof Ing. Kenneth P. Camilleri,

5. External Lecturers and Visitors

5.1 External Lecturers and Visitors

From the University of Oxford

On Friday 18th March 2016, Dr. Michael Sapienza gave a talk entitled "Wearable Personal Assistant for the Visually Impaired: Computer vision algorithms for scene reconstruction, recognition and understanding".

From the Brno University of Technology, Czech Republic

In March 2016, the Department hosted Prof Robert Grepl, the head of Department of Mechatronics of Brno University of Technology in the Czech Republic. Prof Grepl, delivered a lecture and a number of laboratory sessions to second year mechanical students (as part of the SCE2210 study-unit) on the use of Matlab and Simulink to model and simulate linear dynamic systems.

From Harvey Mudd College, USA

Professor Christopher Clark from the Laboratory for Autonomous and Intelligent Robotics at Harvey Mudd College presented a two-day Autonomous Robot Workshop to department staff and students on the 24th and 25th August 2016. The workshop introduced the key concepts of robot navigation through hands-on learning using Matlab for simulation of a differential drive robot navigating autonomously.

5.2 Foreign Student Placements and Internships

From the École supérieure d'ingénieurs de Rennes (ESIR), France

In collaboration with the Centre for Biomedical Cybernetics, the Department hosted Mr. Cédric Moubris-Tournes and Mr. Gaetan Lelu, two engineering undergraduate students from the École supérieure d'ingénieurs de Rennes. These interns assisted the in a currently ongoing, eeg-related internal research project by the SCE and CBC. Work assigned to the interns included the capturing of EEG data from a number of subjects, over a number of sessions as well as interfacing to Matlab EEG software found at the biomedical engineering laboratory.

Visit by JINS Company Ltd Officials

On the 16th of September 2016, Tadashi Shimizu (Project manager) and Yuji Uema, representative of JINS company limited based in Japan, were hosted by Dr. Tracey Camilleri and Prof Ing. Kenneth Camilleri and toured round the biomedical engineering lab. Discussions were held about the use of their EOG glasses for the control of a virtual

keyboard, a project developed as a final year project by Mr. Nathaniel Barbara, under the supervision of Dr. T. Camilleri.

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 also participates in the M.Sc. course in Language and Computation organised by the Institute of Linguistics and the M.Sc. in Environmental Management and Sustainability organised by the Institute of Earth Systems.

A Selection of study units offered by the Department in 2015/2016		
SCE1201	Dynamic Systems and Signals 1	5 credits
SCE2111	Automatic Control Systems 1	5 credits
SCE2213	Automatic Control Systems 2	5 credits
SCE2112	Control Systems 1	5 credits
SCE2210	Introduction to Control Systems	5 credits
SCE3110	Control Systems 2	6 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
ENR3008	Team Project	5 credits
SCE4101	Computational Intelligence 1	5 credits
SCE4102	Systems Theory	5 credits
LIN5508	Language and Embodied Agents *(part of)*	10 credits
IES5009	Introduction to System Dynamics	6 credits
OMS5004	Data Resources in Operational Oceanography (part of)	10 credits
ENR5006	Research Methods (part of)	

Clinical and Physiological Data Analysis (CAPDA) Course

Two academics from the Department contributed to the organisation and delivery of the first of a series of courses provided under the auspices of the Centre for Biomedical

Cybernetics which is targeted for individuals who are interested in the acquisition and analysis of clinical and physiological signals and who may not possess any prior technical knowledge, as well as for individuals with a technical background who may be interested in clinical and physiological data analysis. This first course was held between the 11th and 22nd July 2016 and consisted of 5 modules, specifically:

- EEG Fundamentals
- Practical EEG
- Signal Processing
- MATLAB
- EEGLAB

Professor Ing. Kenneth Camilleri prepared and delivered the Signal Processing module while Dr. Tracey Camilleri prepared and delivered the practical EEG module and the EEGLAB module.

7. Staff Publications (October 2015 - September 2016)

D. Buhagiar, T. Sant, M. Bugeja, "A Comparison of Two Pressure Control Concepts for Hydraulic Offshore Wind Turbines", Journal of Dynamic Systems, Measurement and Control, J. Dyn. Sys., Meas., Control., vol. 138, no.8, 2016

S. Cristina, K. P. Camilleri, “Model-Based Head Pose-Free Gaze Estimation for Assistive Communication”, Computer Vision and Image Understanding, vol. 149, pp. 157- 170, Aug. 2016

R. Darmanin, M. Bugeja, “Autonomous Exploration and Mapping using a Mobile Robot Running ROS”, in *Proc. of the 13th International Conference on Informatics in Control, Automation and Robotics (ICINCO)*, pp. 208-215, Lisbon, Portugal, Jul. 2016, DOI: 10.5220/0005962102080215

S. Cristina, K. P. Camilleri, "Model-free non-rigid head pose tracking by joint shape and pose estimation", Machine Vision and Applications, pp. 1- 14, Jul. 2016

A. Bonnici, K. P. Camilleri, "An Evolutionary Approach to Determining Hidden Lines from a Natural Sketch', IEEE Symposium on Visual Languages and Human-Centric Computing, Cambridge, UK, Sep. 2016 (Accepted)

S.G. Fabri, J.A. Agius, R. Ghirlando and R. Axisa, “Modelling and Temperature Control of a Wine Fermentation Process with Solar Cooling”, in *Proc. of the 24th Mediterranean Conference on Control and Automation – MED’16*, pp. 985-990, Athens, Greece, Jun. 2016

L. Chetcuti Zammit, S.G. Fabri and K. Scerri, “Joint State and Parameter Estimation for a Macro Traffic Junction Model”, in *Proc. of the 24th Mediterranean Conference on Control and Automation – MED’16*, pp. 1152-1157, Athens, Greece, Jun. 2016

T. Camilleri, K.P. Camilleri, S. G. Fabri, “Using switching multiple models for the automatic detection of spindles”, *1st international conference on Sleep Spindling*, Budapest, Hungary, May 2016.

A. Agius Anastasi, O. Falzon, K. P. Camilleri, M. Vella, R. Muscat, "Quantitative Scoring and Neurophysiological Signal Indices for Poststroke Motor Function Assessment and Prognostication", 20th European Congress of Physical and Rehabilitation Medicine, Lisbon, Apr. 2016.

J. Gauci, O. Falzon, K. P. Camilleri, C. Formosa, A. Gatt, C. Ellul, S. Mizzi, A. Mizzi, K. Cassar, and N. Chockalingam, "Automated Segmentation and Temperature Extraction from Thermal Images of Human Hands, Shins and Feet", *IFMBE Proceedings, XIV Mediterranean Conference on Medical and Biological Engineering and Computing 2016*, vol. 57, pp. 275-280, Greece, Mar. 2016.

N. Gauci, O. Falzon, T. Camilleri, K. P. Camilleri, "An Analysis on the Effect of Phase on the Performance of SSVEP-based BCIs", *IFMBE Proceedings, XIV Mediterranean Conference on Medical and Biological Engineering and Computing 2016*, vol. 57, pp. 134-139, Greece, Mar. 2016.

R. Zerafa, T. Camilleri, O. Falzon, K. P. Camilleri, "A Real-Time SSVEP-Based Brain-Computer Interface Music Player Application", *IFMBE Proceedings, XIV Mediterranean Conference on Medical and Biological Engineering and Computing 201*6, vol. 57, pp. 173-178, Greece, Mar. 2016.

8. Staff Academic Activities

Dr. A. Bonnici

Administrative

Dr. Bonnici is a member on the Faculty's Board of Studies (B.Eng electrical stream). She also coordinates the Department's involvement in the Discover University.

Academic

Ms. Bonnici is a reviewer or committee member for international conferences and journals, including: The Eurographics Workshop on Sketch Based Interfaces and Modelling and Computer and Graphics Journal.

Dr. Ing. M. K. Bugeja

Administrative

Dr. Bugeja is a Faculty representative on Senate. He is also a member on the Faculty Board, Faculty's Board of Studies (M. Sc. in Language and Computation) and a member of the Faculty's IT affairs committee.

Academic

Dr. Bugeja is a reviewer or programme committee member for several conferences and journal submissions, including the IEEE Transactions on Cybernetics, the International Journal of Systems Science, Neurocomputing, the International Journal by Elsevier and the International Conference on Informatics in Control, Automation and Robotics.

Prof Ing. K. P. Camilleri

Administrative

Prof Camilleri is the Head of the Department of Systems and Control Engineering. He is also the Director for the Centre for Biomedical Cybernetics and occupies the post of Chariman in the Doctoral Committee of the Centre for Biomedical Cybernetics and MSc by Research Board of Studies of the same Centre for Biomedical Cybernetics. Prof Camilleri is also a chairman in the Support Staff Work Resources Fund Committee and a member (*ex officio*), Electrical & Electronic Engineering Board of Studies, Faculty of Engineering Board. Prof Camilleri serves as a project proposal evaluator for Horizon 2020 project proposals.

Academic

Prof Camilleri is the project leader (Biomedical Engineering Sub-project) of the ERDF Project "Strengthening of the Analytical Chemistry, Biomedical Engineering and Electromagnetics RTDI Facilities", a Principal investigator for the National R&I Fund Award R&I-2012-057 'Eye

Communicate' and a Co-investigator for the National R&I Fund Award R&I-2013-028 'TIPMID'. Prof Camilleri is a member on the Editorial Boards of the Journal of Neuroscience Methods, the International Journal on Advances in Intelligent Systems and of the Research Journal of Information Technology. He is a reviewer for several 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, Neuroscience Methods and Brain Computing Interfacing Journal (Taylor & Francis). He is also a Reviewer or International Programme Committee member of several international conferences, including: The Tenth International Conference on Advanced Engineering Computing and Applications in Science (ADVCOMP 2016), The Thirteenth International Conference on Intelligent Environments (IE 2016) and the International Conference on Computer Analysis of Images and Patterns (CAIP 2016). Prof Camilleri is a member on the Editorial Board of the International Journal on Advances in Intelligent Systems.

Dr. T. Camilleri

Administrative

Dr. Camilleri is a member of the Faculty's MSc by Research Board of Studies and also a member of the IEEE Malta Section committee and the Malta Neuroscience Network. Dr. Camilleri hosted the opening ceremony of the Faculty of Engineering exhibition and also assisted in the organisation of the first Brain Awareness Week held in Malta between the 14th and 18th of March 2016

Academic

Dr Camilleri is a reviewer for journal submissions including: Journal of Selected Topics in Signal Processing, Journal of Biomedical Engineering and Control and IEEE Transactions on Biomedical Engineering. She is also an advisor for the IEEE Malta Student Branch.

Ing. Luana Chetcuti Zammit

Administrative

Ing. Chetcuti Zammit is an IEEE member and also a member of the COST Actions: TU1004 - Public Transport Passenger flows in the era of ITS and TUD1102 - Towards Autonomic Road Transport Support Systems.

Academic

Ing. Chetcuti Zammit is a reviewer for the international conference: 2016 Australian Control Conference. She is also part of the Short Term Scientific Missions under TransITS – COST Action TU1004 entitled 'Transit and Assignment Modelling' and Short Term Scientific Missions under TransITS – COST Action TUD1102 entitled 'Multi-Agent Model Predictive Control: A review of its application in Intelligent Transport Systems'.

Prof Ing. S. G. Fabri

Administrative

Prof Fabri is the project leader of the ERDF Project "Modernising the University of Malta's Control Systems Engineering Laboratory", he is a member of the Administrative Council of the European Control Association (EUCA) and also a member of the Government Engineering Profession Board. Prof Fabri is lead co-chair of the 25th Mediterranean Conference on Control and Automation that is to be held in Malta at the Valletta Campus on the 3rd - 6th July 2017. Also, Prof Fabri is a member on the University Academic Resources Funds Committee and the Board of the Institute of Linguistics, the Board of the Institute for Climate Change and Sustainable Development, the Malta Neuroscience Network and the Doctoral Committee of the Centre for Biomedical Cybernetics. Prof Fabri coordinates the department's *Internal Research Workshop Series*.

Academic

Prof Fabri is a member on the Editorial Board of the International Journal on Advances in Intelligent Systems and also a member on the Editorial Board as well as associate Editor of the International Journal of Systems Science. Prof Fabri is co-investigator in the National R&I funded project R&I-2015-042-T 'Speechie'. He is a reviewer for several journal submissions, including: the International Journal on Advances in Intelligent Systems, Transactions of the Institute of Measurement and Control, the International Journal of Control, the Journal of Vibration and Control, Mathematical Problems in Engineering and IEEE Transactions on Systems, Man and Cybernetics.

Prof Fabri is a Reviewer Committee Member for several international conferences, including: Tenth International Conference on Advanced Engineering Computing and Applications in Sciences, 2016, the International Conference on Informatics in Control, Automation and Robotics, 2016 and the fourteenth Mediterranean Conference on Medical and Biological Engineering and Computing, 2016.

9. Participation in courses, meetings and overseas visits

9.1 Participation at MED 16

In June 2016 Professor Simon G. Fabri and Ms. Luana Chetcuti Zammit participated in the 2016 Mediterranean Conference on Control and Automation (MED16) held in Athens, Greece. Prof Fabri chaired the Process Control session and presented a paper on temperature control of wine fermentation. Luana Chetcuti Zammit presented another paper on dynamic modelling of traffic junctions.

9.2 Research visit at Brno University of Technology, Czech Republic

In May 2016 Dr. Ing. Marvin K. Bugeja visited the Department of Mechatronics at Brno University of Technology, hosted by the head of department Prof 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.

Dr. Ing. Marvin Bugeja during his visit at Brno University of Technology, Czech Republic

9.3 Participation in the BMVA Technical Meeting

On Wednesday 24th February 2016, Dr. Alexandra Bonnici participated in the BMVA technical meeting entitled SketchX Human Sketch Analysis and its Applications. During this meeting Alexandra presented a poster on the work carried out in image vectorisation.

10. Collaboration with Third Parties

Visit by Professor Patrizio Campisi

Between the 18th and 22nd of April 2016, Professor Patrizio Campisi from the Universita' di Roma III, Italy, visited the Department for discussions with Professor Prof Ing. Kenneth Camilleri, Dr. Tracey Camilleri and Dr. Owen Falzon with a view to collaborating in the area of biometry, in particular by using the electroencephalographic (EEG) signal.

Visit to Professor Xiaoyi Jiang

Between the 2nd and 4th of May 2016, Professor Kenneth Camilleri visited the University of Muenster, Germany, to meet Professor Xiaoyi Jiang and discuss research collaboration opportunities, in particular in the area of biomedical imaging.

Research collaboration with the Department of Mechanical Engineering on Hydraulic Offshore Wind Turbines

Over the past two years Dr. Ing. Marvin K. Bugeja collaborated with Prof Tonio Sant and Mr. Daniel Buhagiar from the Department of Mechanical Engineering on a research project dealing with hydraulic offshore wind turbines. This collaboration resulted in the publication of a journal and a conference paper.

11. Public Outreach

11.1 Participation in the Junior College Career Week (Think ahead...which course?)

On the 1st December 2015, Dr. Alexandra Bonnici attended the Junior College Career's week between 09:00 and 16:00. During this day, Alexandra gave a talk to Maths and Physics students which explained the different facets of a career in Engineering as well as course requirements and job prospects. She then spent the rest of the day demonstrating several students' projects to show the practical aspect of Engineering.

11.2 Participation in the Giovanni Curmi Higher Secondary Career Week

On the 17th February 2016, Dr. Alexandra Bonnici attended the Career's week held at the Giovanni Curmi Higher Secondary, Naxxar. During this day, Alexandra gave a presentation which explained the different facets of a career in Engineering as well as course requirements and job prospects. She then spent the rest of the day demonstrating several projects including demos of robotics, computer vision and EEG signal analysis.

Dr. Bonnici representing the Department at the Career's week, higher Secondary

11.3 Discover University

The Department participated in the Discover University activities by offering secondary schools the opportunity to choose any one of four workshops entitled:

- Think. See. Hear
- What! No Photoshop?
- Big Robots, Small Robots
- Hot Pictures

These workshops, which were each of one-hour duration, served to provide students with a hands-on introduction to concepts of signal processing, image processing and robotics. These workshops were held every Wednesday throughout the academic year.

11.4 Visit by Form 2 students from the Archbishop's Minor Seminary

On the 18th November, a group of 25 Form 2 students from the Archbishop's Minor Seminary spent their morning with the Department, in which they were given a talk about the different aspects of Engineering, following which, the students were exposed, through hands-on tasks to concepts of robot programming, image and signal processing.

11.5 Kids on Campus Summer School

During the months of July and August, Dr. Alexandra Bonnici hosted seven workshops for the Kids on Campus Summer school. Two of these workshops were carried out with six year old children who were given Lego Mindstorms robots pre-programmed to move forwards, use the touch sensor to reverse and turn upon bumping into an object and the ultrasonic sensors to reverse and turn upon sensing that an object is near. Through these workshops, children were introduced to the concepts of robotics and sensors. The remaining five workshops were conducted with 11 to 13-year-old children and consisted of

- three Lego Mindstorms workshops, in which students could program robots to use the touch sensor and the ultrasonic sensor to avoid obstacles as well as the light sensor to track a path;
- one workshop on signal processing in which students worked with electromagnetic signals, brain signals and sound signals
- One workshop on thermal imaging in which students used the thermal camera to visually identify hot and cold items and then programmed a simple computer algorithm to segment an image into hot and cold segments; thus introducing the concept of images as sources of different information as well as concepts of image processing.

11.6 STEAM summer school workshops

On the 4th August, a group of 15 students aged between 8 and 11 from the STEAM summer school were given a hands-on workshop on programming Lego Mindstorms robots using the EV3 graphical programming language. Students were then shown a demonstration of robots which could be programmed such that, using a light sensor, the robot can follow a specifically marked path.

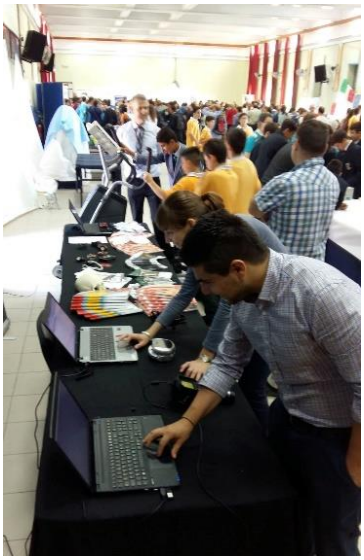
11.7 Kids @ PwC

On the 31st August and the 2nd September, the department hosted a total of 40 students aged 10 to 14 from the PWC Summer School. These students were given a two-hour hands-on workshop which consisted of thermal imaging, body motion tracking and robot programming.

11.8 ICT Accessibility for a Better Quality of Life

On the 26th October 2015, Professor Kenneth Camilleri delivered a talk on the use of technology to improve accessibility and independent living during a seminar organised by the Foundation of IT Accessibility (FITA) where he showcased a number of projects of the Department to demonstrate that the Department has the necessary knowledge and skills to develop technologies for a better quality of life.

11.9 National Design and Technology Expo 2016



Department members at the National Design and Technology Expo

In April 2016, members of the Department were present at the National Design and

Technology Expo held at Sandhurst Secondary School in Pembroke. The event was visited by several secondary schools from all over Malta as well as the general public. A stand was set up to demonstrate some of the work done by the Department, which included demonstrations of the thermal hand-held cameras, the Emotiv EEG headset and interactive image processing setups, as well as a demonstration of videos related to research work on robotics and eye-gaze tracking.

11.9 Biosignal my Machine - Malta Cafe Scientifique

In the course of history, changes have been made as to how humans interact with machines. While we still communicate using touch-based interfaces, such as keyboards, mice and touch screens, there is now an increasing trend of using signals in living beings which can be continually measured and monitored. In this manner, biosignals are being used as the control input.

The type of signals that can be used are brain electrical activity, muscle activity, eye movements, speech and motion and the list goes on. These human machine interfaces (HMI) systems which are biologically driven, offer an alternative means of communication not only to able-bodied subjects but more importantly provides a link to people with severe disabilities such as the locked-in syndrome to the outside world.

A discussion on this topic was presented by Dr. Tracey Camilleri as part of Malta Café Scientifique on the 11th of May at 7.30pm in the Cinema Room, at the St James Cavallier. The presentation included a live demonstration of the brain controlled music player and the use of a virtual keyboard controlled by eye movements.

11.10 Human Machine Interfaces - Science in the City 2016

The Department participated in Science in the City on the 30th of September 2016 by setting up a stand with various projects demonstrating different human machine interface applications. Five different demonstrations were presented, listed below:

- Brain controlled music player
- Virtual speller controlled using eye movements
- Eye Gaze tracking application
- Robot control using brain signals
- Use of Emotiv headsets for gaming applications

Some of the setups at Science in the City 2016 (from left to right); (a) eye-gaze tracker, (b) EOG controlled speller, (c) Brain-controlled music player, (d) Emotiv headsets setup for gaming applications

11.11 Press articles, TV and magazines

Visit to the Biomedical Engineering Laboratory

Visit by H.E the president of Malta. Brief tour of the lab showing outcomes from research projects performed in the Biomedical Laboratory such as the BCI Music Player and the BCI-Controlled Bed. Some of the equipment and services at the Biomedical Laboratory were also explained including a demo setup of a data acquisition system to be used for

monitoring a Persistent Vegetative State subject.

Press Articles

Professor Simon G. Fabri was invited to write an contribution on *Home Robotics* for the Sunday Times of Malta as part of a series of articles on future technologies sponsored by GO.

TV Programmes

- In October 2016, the Department featured in the TVM Programme Xarabank, as part of a feature for the ALS Malta. A demonstration of the EOG glasses and the BCI music player was presented.
- In December 2016, two programmes of Tebqa, a PBS programme shown on TVM were recorded in the laboratories of the Department. One programme featured the Control Systems Laboratory whilst the second programme treated the Biomedical Engineering Laboratory. In these programmes, the ERDF project through which the equipment of the Control Systems Engineering Laboratory was modernised and enhanced was presented as well as the ERDF project through which the Biomedical Engineering Laboratory was setup.
- In August 2017, the Department was featured on two different programs of 'Ghall-Frisk' aired on Net TV. The aim of the program was to give a general overview of the research going on within the Department in the areas of Systems and Control Engineering. In the first programme Dr. Ing. Marvin Bugeja and Ing. Luana Chetcuti discussed the areas of robotics and traffic modelling systems while in the second programme Prof Ing. Kenneth Camilleri and Dr. Tracey Camilleri talked about the areas of computer vision and biomedical engineering, particularly focusing on human machine interfaces.