University of Malta
L-Università ta' Malta

Annual Activity Report

2014 - 2015
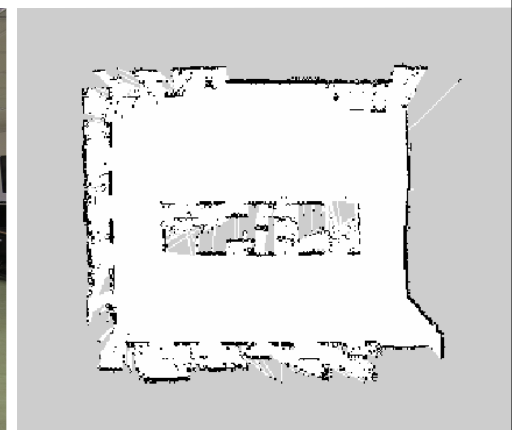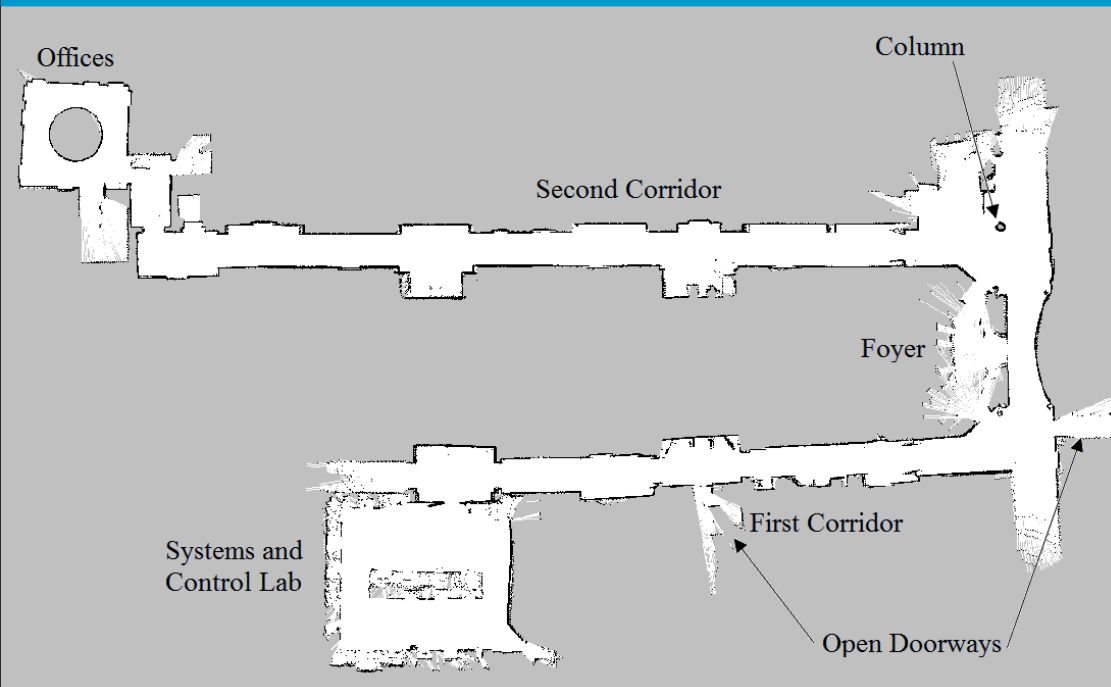
Offices

Column

Second Corridor

Foyer

First Corridor

Systems and Control Lab

Open Doorways

Department of Systems and Control Engineering

SCE

Cover pictures show a Powerbot exploring the control lab and its surrounding corridors, autonomously creating maps of the surroundings as part of the MSc project *Autonomous Exploration and Mapping with Mobile Robots* by Rachael Darmanin.

Contents

1. Introduction

The Department of Systems and Control Engineering seeks to provide high quality teaching and to perform solid research, aspiring to excellence as an academic department. This year the Department has sought to make advances in both these sectors. In the teaching sector, the Department has formalised its teaching Master's Programme of Studies and submitted formal proposals to the University to set up this postgraduate programme. In the research sector, the Department has looked at practices that may better improve the research environment. While these initiatives address two different service sectors, they are related. The success of a high quality postgraduate teaching programme, which is proposed to include a sizeable research dissertation component, will generate a cohort of graduate, and subsequently doctoral, students working at an advanced level in signals, systems and control, hence expanding the research activity of the Department; the successful implementation of a research environment will provide an essential cradle for research students to focus on frontier questions in the field. Thus, both initiatives are, at once, separate from each other and influenced by one another.

In support of the research environment, the Department has maintained a regular series of research seminars as part of the Internal Research Seminar Series and is now preparing for an intensive workshop series to be rolled out during academic year 2015/16. The clustering of the Department's offices was another effort in this direction. The new laboratory space granted to the Department, as part of a Faculty exercise for distributing available space among Faculty Departments, will allow the Department to, not only provide a better didactic service to the students, but also allocate decent space for research activities and better hosting arrangements for research staff and students - this new laboratory space is presently undergoing extensive refurbishment works and one may expect the space to be functional towards the end of the 2015/16 academic year.

In the meantime, this seventh Annual Activity Report shows that the Department has maintained a broad portfolio of research projects, guided research graduate and doctoral students, and regularly published in peer-reviewed international scientific journals and conferences. For all this I am indeed thankful to each and every member of the Department, all of whom work together in a team spirit for the benefit of all.

30th September 2015 **Prof Ing. Kenneth P. Camilleri**
Head of Department

2. Staff Members

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

Associate Professor
- 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*

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

Visiting Academics
- Ms. Luana Chetcuti, *B.Eng. (Hons.), M.Sc.*
- Mr. David Debono, *B.Eng. (Hons.), M.Sc.*
- Mr. Julian Mercieca, *B.Eng. (Hons.)*
- Ing. Andre Sant, *B.Eng. (Hons). M.Sc., MIEEE*

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 and Dr. Ing. Marvin K. Bugeja
  Research students: Matthew Camilleri and David Debono

This research focuses on the development, design and application of modern methodologies for nonlinear, adaptive and intelligent control systems. Over the past year, activities on control of nonlinear systems included: i) experimentation and successful implementation of a Reaction Wheel Inverted Pendulum system which achieves balancing through control of the reaction torques from a rotating flywheel attached to the body of the pendulum, and ii) experimentation and successful implementation of a Ball-and-Plate balancing system that employs a camera in the feedback loop of a sliding-mode control scheme. In the latter project, the control challenge is to balance a ball--or even make it track a desired trajectory--on a plate, solely by tilting the plate relative to the horizontal plane. This research project generated a conference paper presented at the 12th International Conference on Informatics in Control, Automation and Robotics 2015.

In adaptive control, work focused on the investigation of dual adaptive methodologies in continuous-time - a domain that is only explored very sparsely in this context. By utilising a cost function of the explicit type, a continuous-time Kalman filter and appropriate low-pass filters to avoid signal differentiation, a realizable suboptimal controller was achieved that exhibits the desirable properties of dual control for a linear system in continuous-time. This research generated a conference paper presented at the European Control Conference 2015. Current efforts are focussing on extending and generalising further these ideas.
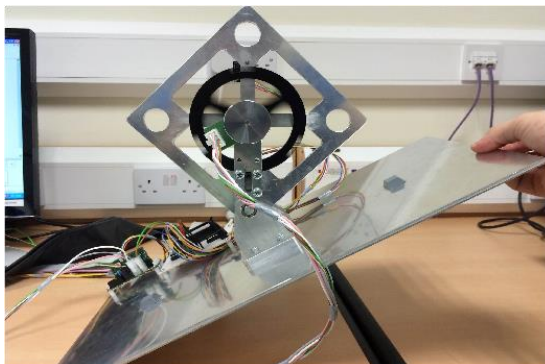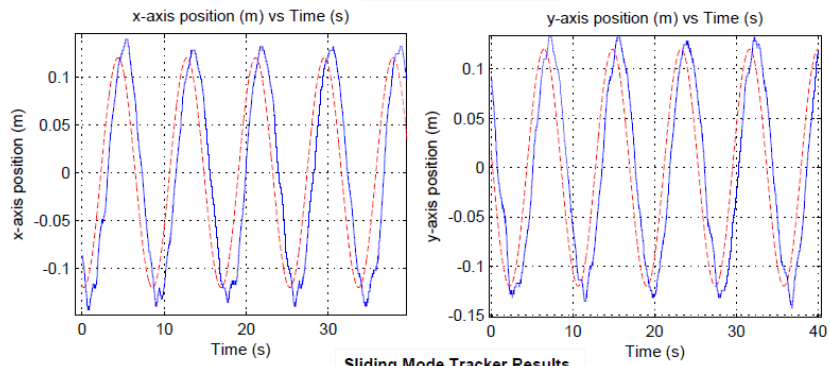

The Reaction Wheel Inverted Pendulum

The Ball and Plate Setup
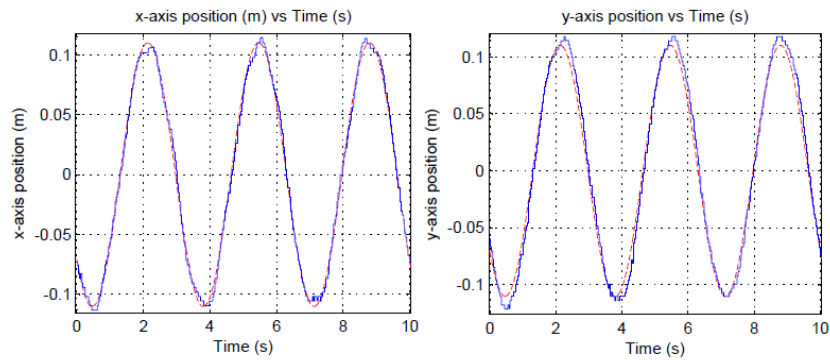
Experimental results for ball and plate setup
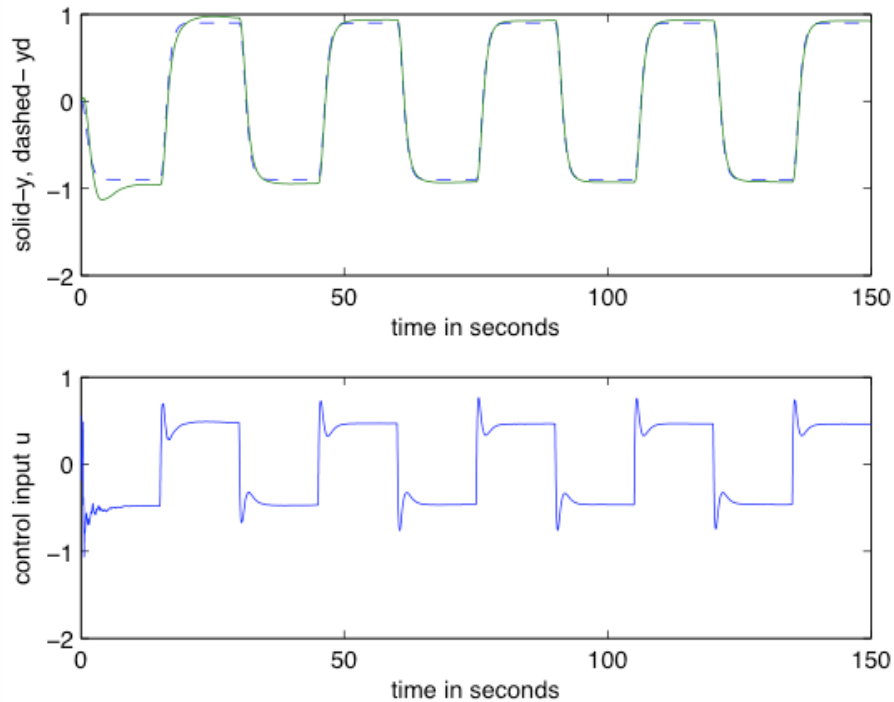
Results of dual control in continuous-time

- **Robot Control**
  Main investigators: Prof. Simon G. Fabri, Dr. Ing. Marvin K. Bugeja
  Research students: Rachael Darmanin, Jean-Luc Farrugia, Gabriella Pizzuto, Marlon Vella, Christian Spiteri

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

  In robotic manipulator control, various algorithms for joint position and force control of the end-effector were investigated and implemented in order to set up a system whereby a 5 degrees-of-freedom anthropomorphic manipulator is able to write text on a standard whiteboard with a felt-tipped pen. Force control is required so as to regulate the contact forces in order to produce legible marking without damaging the tip of the pen while at the same time, position control ensures that the desired text characters are marked on the surface.

  This year research in mobile robotics has mainly been focusing on autonomous robotic exploration and Human Robot Interaction (HRI). One project in particular (by Rachael Darmanin) investigated a number of exploration strategies that allow a mobile robot to drive itself around an unknown obstacle-cluttered environment and simultaneously build a map in real-time. The main challenge here is for the robot to select those

waypoints that lead it to generate an accurate map in a short time. The Simultaneous Localization and Mapping (SLAM) and the exploration algorithms were implemented within the Robot Operating System (ROS) framework. In fact, the main novelty of this work lies in the modular structure of the implementation within ROS. This implementation was experimentally tested on Powerbot, a research mobile robot, in a real-life environment.

Anthropomorphic Manipulator
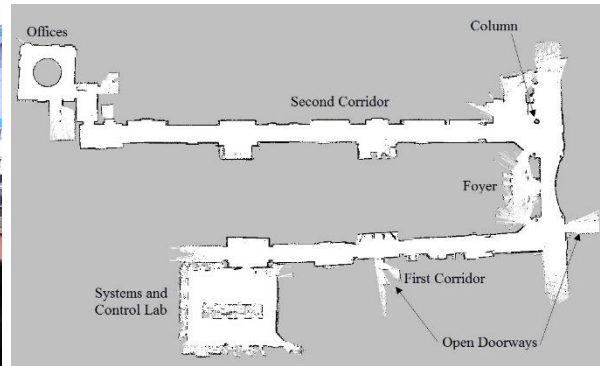
Powerbot exploring the Faculty's corridors (left), Map of the Faculty's ground floor generated by Powerbot autonomously (right)

Another mobile robotics project has focused on search and target tracking in the absence of a map. In this work the mobile robot (a Khepera III) is equipped with a single off-the-shelf camera (the CMUcam5) and is commanded to autonomously search for and track a particular target in an unknown, obstacle-cluttered environment. This research can have many applications in real life including search and

rescue. Another project investigates the use of a swarm of mobile robots for transportation of material. The aim of this work is to have a small group of mobile robots autonomously recognising and transporting a relatively larger object to a specific location. This involves cooperation and communication between the robots so to self-organise and swarm up in formations that make this transportation task possible.
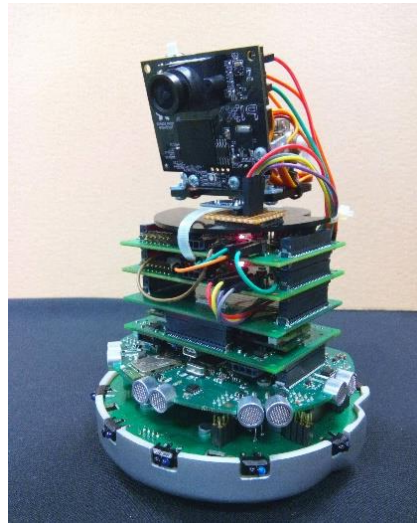
Khepera III equipped with the CMUcam

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

Human Robot Interaction (HRI) was investigated through a project involving speech recognition and speech synthesis modules that were programmed and integrated within an environment utilising a Khepera III mobile robot as a physical embodied agent. Through this system, the robot's speech recognition system is trained on a limited set of linguistic commands, such as "move forward 10cm", "reverse…", with

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the robot executing them after processing for understanding. The robot also interacts with the human through speech synthesis if required e.g. on detection of an obstacle that interferes with the commanded action.


```
/*-------------------------------------------------------*/
/*----------Speech Synthesizer (eSpeak) for Khepera 3----------*/
/*-------------------------------------------------------*/
/*--------------------Gabriella Pizzuto-----------------------*/
/*-------------------------------------------------------*/
/*---------------------Final Year Project 2015---------------------*/
/*-------------------------------------------------------*/

Robot: Please choose the speed from the ones available:

Option 1: Set slow speed

Option 2: Set medium speed

Option 3: Set fast speed

Awaiting serial command ...

Robot: Setting slow speed
Robot: Moving forward 30 centimeters
Robot: I have found an obstacle in front of me
Robot: Moving backward 30 centimeters
Robot: I have found an obstacle behind me
Robot: Rotating anticlockwise 30 degrees
Robot: I am ready for the next command
Robot: Rotating clockwise 60 degrees
Robot: I am ready for the next command
Robot: Moving forward 80 centimeters
Robot: Moving backward 10 centimeters
Robot: I am ready for the next command
Robot: Quitting now. Goodbye

Exiting now ...

/*------------------GOODBYE--------
```

Human Robot Interaction via speech recognition

- **Cognitive Vision for Sketch Understanding**
  Main investigators: Prof. Ing. Kenneth P. Camilleri and Ms 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. The work carried out in this project is two-fold, namely, we investigate how the sketched object edges can be identified from the cues in which they are embedded and how the artistic cues can be used to aid the geometric interpretation of the sketch.

  Sketched edges are typically extracted from an image by means of vectorisation algorithms. These however, assume that the drawing can be easily binarised but this is clearly not the case in images containing shading cues. Moreover, vectorisation algorithms typically require that a seed sampler is placed centred on the line strokes in the drawing and this is used to trace all line strokes in the drawing, requiring corrective measures to ensure that the sampler is always centred on the line strokes. We felt that

this was inefficient and for this reason, in this research project, we investigated geometry of the interaction of line strokes with a circle sampler and determined that from the intersecting point of the line stroke with the sampler, we can deduce the location and orientation of the line, even when this is off-centred from the centre of the circle sampler. For this reason, we propose the use of co-occurring sampling circles which accumulate evidence on the location and orientation of the drawing strokes and hence vectorise the drawing.

In addition, we define canonical representations of all cues that can be observed at a junction and use these canonical representations to define a junction-cue dictionary. This dictionary can then be used in a genetic algorithm framework to identify the edge interpretation label of each of the edges in the drawing, as shown in the figure below.

sketched drawing   vectorised result   edge label interpretation
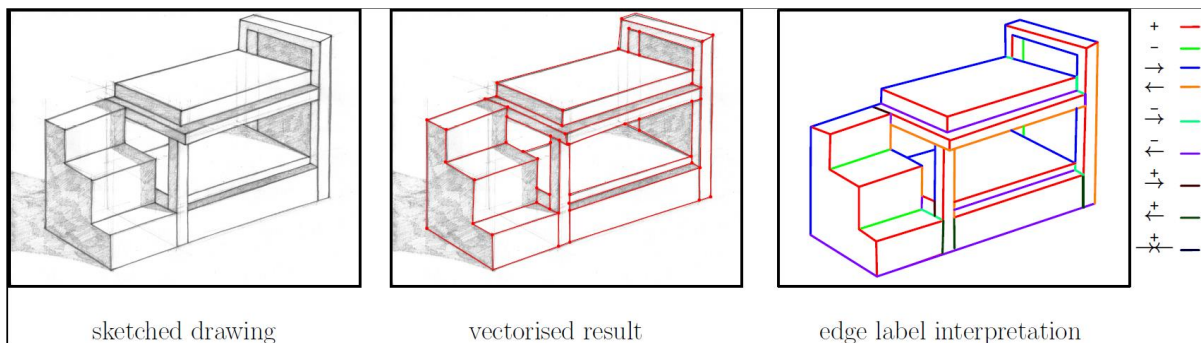
- **Eye-Communicate - Robust, Cost-Effective Eye-Gaze Technology for Assisted Communication**
  Main investigators: Prof. Ing. Kenneth P. Camilleri and Ing. Stefania Cristina

  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. Part of this work was published at the International Conference on Computer Analysis of Images and Patterns (CAIP 2016) held in Malta in September 2015.

- **A Brain Computer Interface System based on Visually Evoked Potentials**
  Main investigators: Dr Tracey Camilleri, Prof. Ing. Kenneth P. Camilleri, Dr Owen Falzon
  Research Students: Rosanne Zerafa, Charlene Chetcuti, Kimberlin Bartolo

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.

One of the students working on this project this past year studied mechanisms that could be used to detect the occurrence of command errors and demonstrated this by implementing a virtual keyboard on a monitor following the Bremen keyboard.

In the past years we have also developed a brain controlled music player which is based on steady state visually evoked potentials. In this case a set of flickering stimuli on an LCD screen act as the control buttons to activate various control signals such as choosing a track from a given list, increasing/decreasing the volume, playing or pausing a track etc. This year this application has been ported on a mobile phone to make it more accessible for people on the move. This necessitates an investigation on the effect of movement and extraneous stimuli distractors on the recorded EEG signal, an analysis of how the EEG signals change given a smaller screen and hence smaller stimuli, and developing the necessary tools to ensure that the system remains reliable and comfortable to use over long periods of time.

Brain Controlled Music Player

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

- **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: 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, while data is continuously being 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.
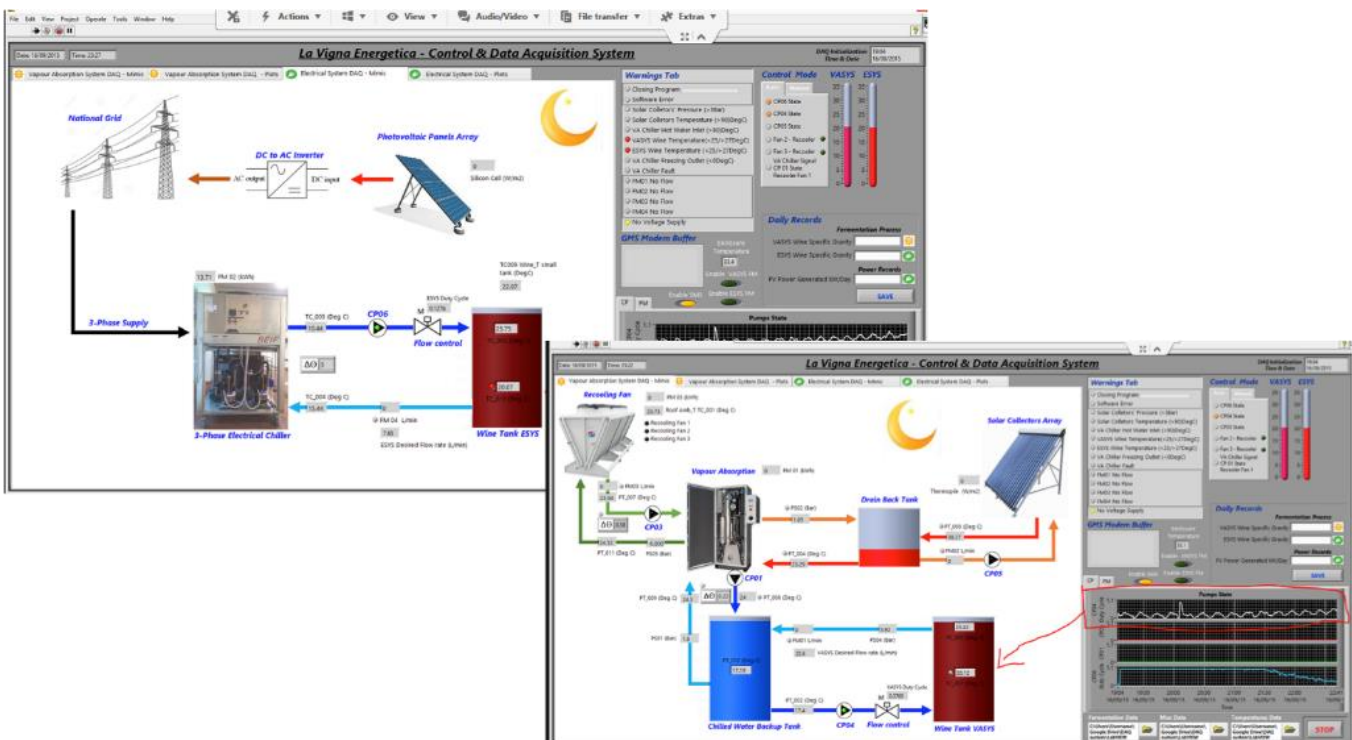
3.2 Internal Research Seminar Series

IRSS 2014-2015

Modelling for Marine Pollution

Nicolette Formosa   31 Oct 2014

Complex spatio-temporal interactions are exhibited in various natural systems as witnessed in meteorology and epidemiology. Due to the complexity of the interactions involved, known laws cannot fully describe the dynamics behind these processes. The study of these systems thus depends on measurements often taken at various discrete spatial locations through time by noisy sensors. Therefore scientists often necessitate interpolative, visualization and analytical tools to deal with the large volumes of data common of these systems. Various GIS software suites are available for these purposes which aim to provide interpolative functions to better visualise and analyse such data which however ignore the temporal behaviour of the process. To overcome this limitation, the aim of this research is to provide an interpolative tool that, based on a spatio-temporal model, obtains interpolative fields based on noisy measurements which utilise both the spatial patterns and the temporal evolution of the measurements

Unobtrusive and Pervasive Eye-gaze Tracking

Stefania Cristina   12 Dec 2014

Video-based eye-gaze tracking has been traditionally considered a desktop technology that often necessitates controlled conditions to operate, typically restricting the user to a stationary head pose or small head movement inside an indoor environment. Nonetheless, the advent of mobile devices and an increasing interest in capturing the natural human behaviour inside less constrained scenarios led to the emergence of a new paradigm referred to as pervasive eye-gaze tracking, which term denotes the capability of tracking the eye movements in daily life settings. This talk presents on-going work in developing a pervasive eye-gaze tracking platform. We propose a method to determine the point-of-regard on a monitor screen from low-quality images captured by an integrated camera inside a notebook computer, allowing natural head movement during tracking. Building upon the results obtained at this stage, we further propose a method to estimate the eye-gaze in 3-dimensional space, permitting larger eye and head movement with minimal user-calibration. Validation results will be presented to highlight the effectiveness of these methods in the context of pervasive eye-gaze tracking.

Nonlinear Control of a Ball and Plate System with Visual Feedback

David Debono   20 Feb 2015

The control challenge of the ball and plate problem 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. The problem is of particular interest to the control community because it is open-loop unstable and exhibits nonlinear and multivariable dynamics. Consequently, it is considered to be a standard control setup that is commonly used to demonstrate, test and validate various control methods. The design and challenges involved in constructing a novel ball and plate system with visual feedback will be presented. This will be followed with the evaluation of the implemented sliding mode control topology, and how it managed to obtain a faster and more accurate operation for continuously changing reference inputs.

Quantifying Atherosclerosis in Peripheral Vasculature using 3D Ultrasound Imaging

Carl Azzopardi   17 Apr 2015

Atherosclerosis is a widespread condition which results in accumulation of plaque in blood vessels. It is the leading cause behind cardiovascular and cerebrovascular disease – the prime killers in modern society. When diagnosing this condition, Ultrasound imaging presents a cheaper, safer and non-invasive modality when compared to other screening tools such as CT or MR Angiography. Classical Ultrasound methods based on Doppler imaging are unfortunately however, less effective than their CT / MR counterparts in certain circumstances. This project aims to develop novel techniques for clinically diagnosing the presence and severity of atherosclerotic plaque in peripheral vasculature using Freehand 3D Ultrasound Imaging. In this presentation, we will first review how atherosclerosis develops, as well as the present ultrasound techniques available for its diagnosis. We will then give a brief overview of the main stages of this project, discussing in some detail the techniques presently being explored for segmentation of ultrasound images.

3D Model Based Object Recognition using an Assembly of Discrete Primitives

David Paul Agius   29 May 2015

Recognizing different categories of objects is crucial for human interaction with the physical environment. This goal is as important to any technology that needs to interact autonomously within a similar setting. Current object categorization systems including visual based methods can be challenged when it comes to recognizing categories whose instances' geometries vary significantly, as this implies further complex alteration in object appearance. Alternatively, 3D model based representations are inherently more suited to handle complex geometries. However such approaches have been mostly restricted to exemplar based recognition. This poses as a limiting factor when it comes to representing categories that exhibit large intra---class variance. In this presentation, we present our

proposed 3D model based framework for capturing a category representative model. Different instances of each category are segmented into parts, and using graph matching techniques models are aligned with a canonical model. By comparing and learning part-‐‐part relationships rather than specific part properties, a compact category representation is formed without requiring any prior part labelling. By running our framework on instances obtained from a shape benchmark, we demonstrate that our approach offers a possible way forward to the currently open problem of generic object recognition.

4. Student Projects and Supervision

4.1 B.Eng Students

Project Title	Student	Supervisor
A Reaction Wheel Inverted Pendulum	Matthew Camilleri	Prof. Ing. Simon G. Fabri
Music Tutor: An Evaluation Tool for Music Performance	Luke Camilleri	Ms. Alexandra Bonnici
Neurofeedback Variation of SSVEP Stimuli in Brain-Computer Interfacing	Charlene Chetcuti	Prof. Ing. Kenneth. P. Camilleri
A Speech Interface for a Mobile Robot	Gabriella Pizzuto	Prof. Ing. Simon G. Fabri Mr. Mike Rosner
Object Search, Recognition and Following in a Cluttered Environment	Christian Spiteri	Dr. Ing. Marvin K. Bugeja
A Writing and Sketching Robot	Marlon Vella	Prof. Simon G. Fabri

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
Swarm Robotics for Object Transportation	Mr. Jean Luc Farrugia	Prof. Ing. Simon G. Fabri

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	Ms. Luana Chetcuti Zammit	Prof. Ing. Simon G. Fabri Prof. M Attard
Eye-Gaze Tracking for Human-Computer Interaction, Behaviour Analysis and Communication	Ing. Stefania Cristina	Prof. Ing. Kenneth P. Camilleri
Representation and Knowledge Extraction from Multiview Image and Video	Ing. Clifford De Raffaele	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

5. External Lecturers, Visitors and Student placements

5.1 External Lecturers and Visitors

From the University of Exeter UK

On the 7th January 2015, the department hosted Dr. John Joseph Valletta who presented a public talk entitled "Data-Driven Modelling: Applications in Type 1 Diabetes, Formula 1 and Malaria". Dr. Valletta described how data-driven approaches enable us to tap into information arising from complex, real-life situations to elucidate on the underlying system's processes, and thus improve our overall understanding of the system's dynamics. The use of such methodologies in three distinct areas was discussed, and it was shown how such approaches are key to modelling and understanding of complex systems.

From the Brno University of Technology, Czech Republic

In March 2015, 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.

5.2 Foreign Student Placements and Internships

From the Universite de Franche-Comte, France

In collaboration with the Centre for Biomedical Cybernetics, the Department hosted Ms. Claire Magnaud, a biomedical engineering undergraduate student from the Universite de Franche-Comte, France. Ms Magnaud worked on the electronic design and development of a low cost flickering stimulus system adequate for SSVEP-based BCI setups. The units consist of a 3x3 LED setup with adjustable frequencies and interchangeable LEDs, that also provide a separate output electrical signal in sync with the flickering stimuli.

From Brno University of Technology, Czech Republic

From October to December 2014 the Department hosted Mr. Vaclav Sova, a Ph.D. student in the Department of Mechatronics at Brno University of Technology. During his stay, Mr. Sova was supervised by Prof. Ing. Simon G. Fabri and Dr. Ing. Marvin K. Bugeja on his research project investigating the use of adaptive control for electronic throttles in automotive systems.

Services to Students from other Local Departments or Entities

Ms. Lara Cassar Delia, a student in Graphic Design and Interactive Media at MCAST Art & Design requested to use the eye-gaze tracker in the biomedical engineering laboratory to aid her capture data for her dissertation entitled "The study of Illustration Design implemented to evoke an emotional response to the viewer through cognitive psychological principles."

Ms. Jennifer Mallia requested the use of the eye-gaze tracker in the biomedical engineering laboratory to gather data for her Masters project. Ms Mallia is a student with the Department of Digital Arts, Faculty of Media and Knowledge Sciences at the University of Malta

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.

The department also held two seminars for the final year students who had their final year project supervised by academic staff from the department. These seminars were held in Dar Manwel Magri on the 14th March and 12th June. The aim of these seminars was to give the students an opportunity to present their final year project work in a similar ambience to when they are marked for their presentation. Although these sessions are not awarded any credits or do not influence the students' final project mark, they serve as good guide to the students, highlighting weak points and possible improvements of their work by other academics and technical staff present for these presentations.

A Selection of study units offered by the Department in 2014/2015		
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

7. Staff Publications (October 2014 - September 2015)

A. Bonnici, J. H. Israel, A. M. Muscat, D. Camilleri, K. P. Camilleri and U. Rothenburg, "Investigating user preferences in utilizing a 2D paper or 3D sketch based interface for creating 3D virtual models" Dept. of Systems and Control Eng., University of Malta, Msida, Malta, SCE-TR-2014-02, December 2014. Available Online [Jan. 5, 2014]

S.G. Fabri, B. Wittenmark, M.K. Bugeja, "Dual adaptive extremum control of Hammerstein systems", International Journal of Control, Taylor and Francis, vol. 8, no.6, pp. 1271-1286, 2015.

A. Bonnici, J.H. Israel, A.M. Muscat, D. Camilleri, K. Camilleri, U.Rothenburg, "Investigating User Response to a Hybrid Sketch Based Interface for Creating 3D Virtual Models in an Immersive Environment", in *Proc. of the 10th International Joint Conference on Computer Vision, Imaging and Computer Graphics, Theory and Applications*, pp. 470 - 477, Berlin, Germany, Mar. 2015

D. Buhagiar, T. Sant, M.K. Bugeja, "Control of an Open-Loop Hydraulic Offshore Wind Turbine using a Variable-Area Orifice", in *Proc. Of the ASME 34th International Conference on Ocean, Offshore and Arctic Engineering – OMAE'15*, St. John's, Newfoundland, Canada, May 2015.

A. Bonnici, K.P. Camilleri, " A Combined Junction-Cue Dictionary for Labelling Sketch Drawings with Artistic Shadows and Table-line Cues", in *Proc. of the Eurographics Symposium on Sketch-Based Interfacing and Modeling 2015*, Istanbul, Turkey, Jun. 2015.

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8. Staff Academic Activities

Ms. A. Bonnici
<u>Academic</u>

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
<u>Administrative</u>
Dr. Bugeja is a Faculty representative on Senate. He is also a member on the Faculty Board, Faculty's Board of Studies (B.Eng electrical stream), Faculty's Board of Studies (M. Sc. in Language and Computation) and a member of the Faculty's IT affairs committee. Dr. Bugeja is a member of the Faculty's ad hoc Committee on Assistant Lecturer Loading and a member of the Board of Studies for the new MSc in Language and Computation/Human Language Technology, by the Institute of Linguistics. Also, he is the coordinator of the EU Robotics Week on behalf of the SCE department.

Dr. Bugeja is a reviewer for several conference and journal submissions, including the IEEE Transactions on Systems, Man and Cybernetics (Part B), the International Journal of Systems Science, Neurocomputing, the International Journal by Elsevier. He is also a reviewer of the International Conference on Intelligent Robots and Systems (IROS 2015) and the International Conference on Informatics in Control, Automation and Robotics (ICINCO 2015).

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 Chairman in the Support Staff Work Resources Fund Committee. Prof. Camilleri serves as an 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 International Journal on Advances in Intelligent Systems and of the Research Journal of Information Technology and 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 Ninth International Conference on Advanced Engineering Computing and Applications in Science (ADVCOMP 2015), The Twelfth International Conference on Intelligent Environments (IE 2015) and the International Conference on Computer Analysis of Images and Patterns (CAIP 2015). Prof. Camilleri is a member on the Editorial Board of the International Journal on Advances in Intelligent Systems.

Dr. T. Camilleri

<u>Administrative</u>

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.

<u>Academic</u>

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 adviser for the IEEE Malta Student Branch.

Prof Ing. S. G. Fabri

<u>Administrative</u>

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 a member on the University Academic Resources Funds Committee and the board of The Institute of Linguistics. Prof. Fabri coordinates the department's *Internal Research Seminar Series*.

<u>Academic</u>

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. He is a reviewer for several journal submissions, including: the International Journal on Advances in Intelligent Systems, the International Journal of Adaptive Control and Signal Processing, 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: Ninth International Conference on Advanced Engineering Computing and Applications in Sciences, 2015, the International Conference on Informatics in Control, Automation and Robotics, 2015, IEEE International Conference on Vehicular Electronics and Safety, 2015, IEEE/RSJ International Conference on Intelligent Robots and Systems, 2015, and the IEEE 18th International Conference on Intelligent Transportation Systems, 2015.

9. Participation in courses, meetings and overseas visits

Research visit at Brno University of Technology, Czech Republic

In March 2015 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. Ing. Marvin K. 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. As a result of these discussions the two parties agreed to start collaborating on a particular research project. Part of this collaboration involved a PhD student from Brno University of Technology spending a few weeks working in the Control Laboratory of the University of Malta under the guidance of Prof. Fabri and Dr. Ing. Marvin K. Bugeja. This visit took place during October to December 2014.

VisionAir General Assembly

Ms. Alexandra Bonnici was invited to the general assembly of the VisionAir project to give a talk entitled 'Investigating the interplay of paper sketching and immersive sketching', highlighting the results obtained during the two trans-national access projects carried out in collaboration with the Division for Virtual Product Creation and Model-Based Engineering at the Fraunhofer Institute for Production Systems and Design Technology. VisionAir is funded by the European Commission under grant number 262044.

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

In July 2015 Prof. Simon G. Fabri attended the annual General Assembly meeting of the European Control Association (EUCA) which was held in Linz, Austria. Prof. Simon G. Fabri is the Malta representative on the General Assembly of EUCA.

Participation at ECC 15

In July 2015 Prof. Simon G. Fabri chaired the Adaptive Control I session and presented a paper at the 2015 European Control Conference (ECC15) in Linz, Austria.

Participation at the Expressive 2015

In July 2015, Ms. Alexandra Bonnici presented a paper at the Expressive 2015 conference which was held at Koc University in Istanbul, Turkey.

Participation at EMBC 2015

In August 2015 Dr Tracey Camilleri and Professor Kenneth Camilleri presented a paper at the 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society held at the Milano Conference Centre in Milan.

Participation at CAIP 2015

In September 2015, Dr Tracey Camilleri, Ing. Stefania Cristina, Mr. Mark Borg, Ms. Alexandra Bonnici and Professor Kenneth Camilleri presented papers at the Computer Analysis of Images and Patterns (CAIP) conference held at the Mediterranean Conference Centre in Valletta, Malta. They also attended tutorials, organised by the same conference committee, namely 'Distance-based classifiers: basic concepts, recent developments and application examples' presented by Prof Michael Biehl from the University of Groningen, 'Deep Learning and Life Logging - how far are we from being able to explain person's lifestyle using Computer Vision?' by Petia Radeva, and Mariella Dimiccoli, 'The Bag of Visual Words model and recent advancements in image classification' by Constantino Grana and Giuseppe Serra, and 'Connected and Hyperconnected Morphological Filters' by Michael Wilkinson.

10. Collaboration with Third Parties

Collaboration between University and the Ministry of Energy and Health on Clinical Gait and Motion Analysis

The University of Malta's Department of Systems and Control Engineering, its Centre for Biomedical Cybernetics, and the Ministry of Energy and Health have signed a Collaborative Agreement on Clinical Gait and Motion Analysis. Rector Professor Juanito Camilleri signed on behalf of the University of Malta, while Permanent Secretary Mr Joseph Rapa represented the Department of Health, in the presence of the Parliamentary Secretary for Health, Mr Chris Fearne.

The Biomedical Engineering Laboratory at the University houses a state-of-the-art Motion Capture System that allows for the precise measurement of human motion. This has many uses, ranging from scientific human motion study to film and game animation, with one main application being the clinical assessment of patients with motion problems. Until now, Maltese patients suffering from selected neuromuscular conditions have had to be assessed in the abroad to plan surgical interventions intended to improve these patients' gait.

Through the signing of this Agreement, the Department of Health and the University will be involved in creating cross disciplinary collaboration in the Engineering and Clinical areas. To this end the University of Malta is making its facilities and expertise available.

The collaboration aims to establish excellence in clinical gait and motion analysis, to provide an opportunity for clinical practitioners from the Department of Health to practice and obtain experience working on an advanced state-of-the-art Motion Analysis System and to provide an opportunity for clinical practitioners, academics and technical personnel from the University to work together in an inter-disciplinary team. This collaboration will open up possibilities to work on inter-disciplinary research projects involving the clinical and technical disciplines, to establish normative baseline gait data for the Maltese population, and to provide clinical gait analysis for the medically indicated patients who, to date, had been required to go abroad for such an analysis.

This initiative, led by Prof Ing. Kenneth P. Camilleri, found ample support from the University, and was realized through the continuous liaison with orthopedic surgeon, Mr Charles Grixti, advisor to the Ministry of Energy and Health.

Collaboration on Science in the City 2015

Prof. Ing. Simon G. Fabri collaborated with Dr. Albert Gatt from the Institute of Linguistics in the production of a TV documentary for Science in the City 2015. This documentary, produced by Studio 7 Co. Ltd. for Science in the City, explores the various interdisciplinary research projects and activities at the University of Malta that focus on linguistics, different aspects of language communication, and language-related technologies.

11. Public Outreach

11.1 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.

11.2 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 Engineering Laboratory such as the BCI Music Player and the BCI-Controlled Bed. Some of the equipment and services at the Biomedical Engineering Laboratory were also explained including a demo setup of a data acquisition

system to be used for monitoring a Persistent Vegetative State subject. This visit was reported on TVM news.

Press Release
Signing of the Gait Analysis agreement with Mater Dei Hospital which was then followed by a visit to the Biomedical Engineering Laboratory where the Vicon system is currently installed to demonstrate Vicon equipment and its use.

TV Programme
Talk on the Clinical Gait Agreement by Prof Ing. Kenneth P. Camilleri and Dr. Grixti on TVAM.

Documentary for Science in the City 2015
Prof. Ing. Simon G. Fabri and Prof. Ing. Kenneth P. Camilleri took part in the TV documentary *"Jien min jien?"* produced by Studio 7 for Science in the City 2015. They presented some of their research works that include aspects of linguistic communication. Prof. Fabri described the department's projects on human-robot interaction through speech synthesis and recognition, while Prof. Camilleri focused on the use of machine vision for automated translation of Sign Language gestures in real time.

11.3 Talk to Post-Secondary Career Guidance Practitioners
Ms. Alexandra Bonnici gave a talk "Engineering: A sensible career choice" during a seminar for post-secondary schools career guidance practitioners which was organised by the student advisory services of the University of Malta.

11.4 Saint Aloysius College Sixth form visit
On the 29th January, the department hosted a group of second year sixth form students from Saint Aloysius College who were attending the annual orientation day. These students were given various demonstrations of the research carried out within the department.

11.5 Malta Students Science Forum
On the 26th March 2015, Prof Simon Fabri delivered a keynote speech entitled 'The Drive for Driverless Cars' at the Malta Student Science Forum (MSSF) organised by the National Student Travel Foundation (NSTF). This activity is aimed at post-secondary students who discuss and present different topics on science and technology in a competitive spirit where

the winners are given the opportunity to participate in the London International Youth Science Forum.

11.5 Kids on Campus Summer School

The department participated in the Kids on Campus summer school by giving two interactive workshops on the 28th August for children aged ten to eleven years. The workshops introduced the children to two different research areas within the department. The workshop entitled 'What?! No photoshop!' introduced the students to the basic image processing algorithms that drive common imaging apps on smart-phones. While in the second workshop entitled 'Hot Pictures: Measuring heat without thermometers' the students used a thermal camera to distinguish between hot and cold cups, guiding each other to follow the path of hot cups through an arrangement of cups provided. Two additional workshops were given on the 6th August to children aged 5 and 6 years. In these workshops, students were shown demonstrations using Lego Mindstorms robots, introducing the children to the concepts of touch and ultrasonic sensors and their use in robotics.
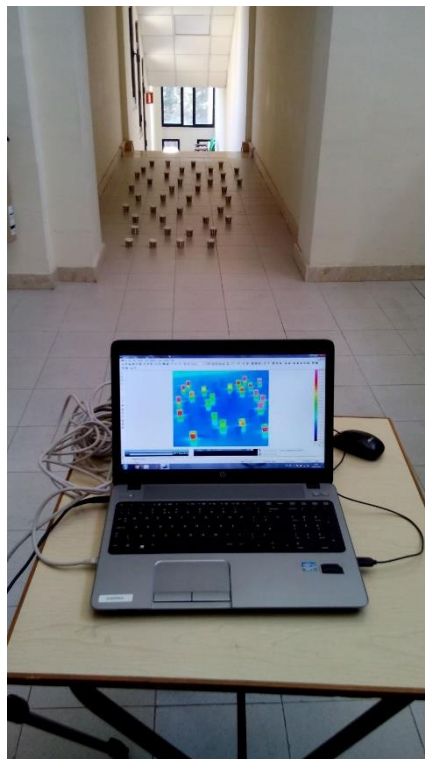
Setup for the workshop entitled 'Hot Pictures: Measuring heat without thermometers'

11.6 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 2 different secondary schools and G.F Abela Junior College Sixth Form. Through this workshop, the students were introduced to concepts of robot control via the Lego Mindstorms robots. 'What! No Photoshop' was attended by 60 students from three different schools. This workshop introduced the students to the basic image processing algorithms that drive common imaging apps on smart-phones.

'What! No Photoshop' workshop