Department of Systems and Control Engineering

Annual Report 2019 - 2020

L-Università ta' Malta
Faculty of Engineering

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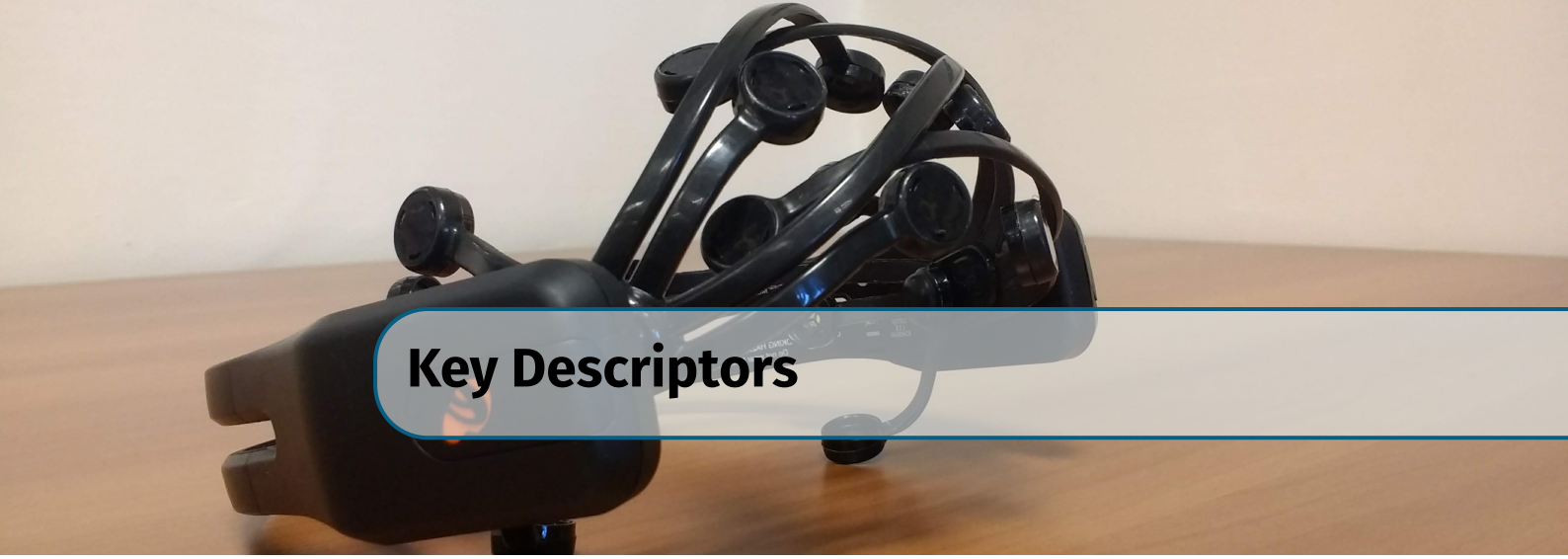


Key Descriptors

Members of Staff

Academics	8
Visiting Academics (a total of T4 appointments)	3
Systems Engineers	2
Senior Laboratory Officer	1
Administrative Staff	1

Externally Funded Members of Staff

Research Support Officer IV	1
Research Support Officer II	2
Research Support Officer I	1
Research Support Assistant	1

Research Projects

23

Research Funds

€247,984

Students

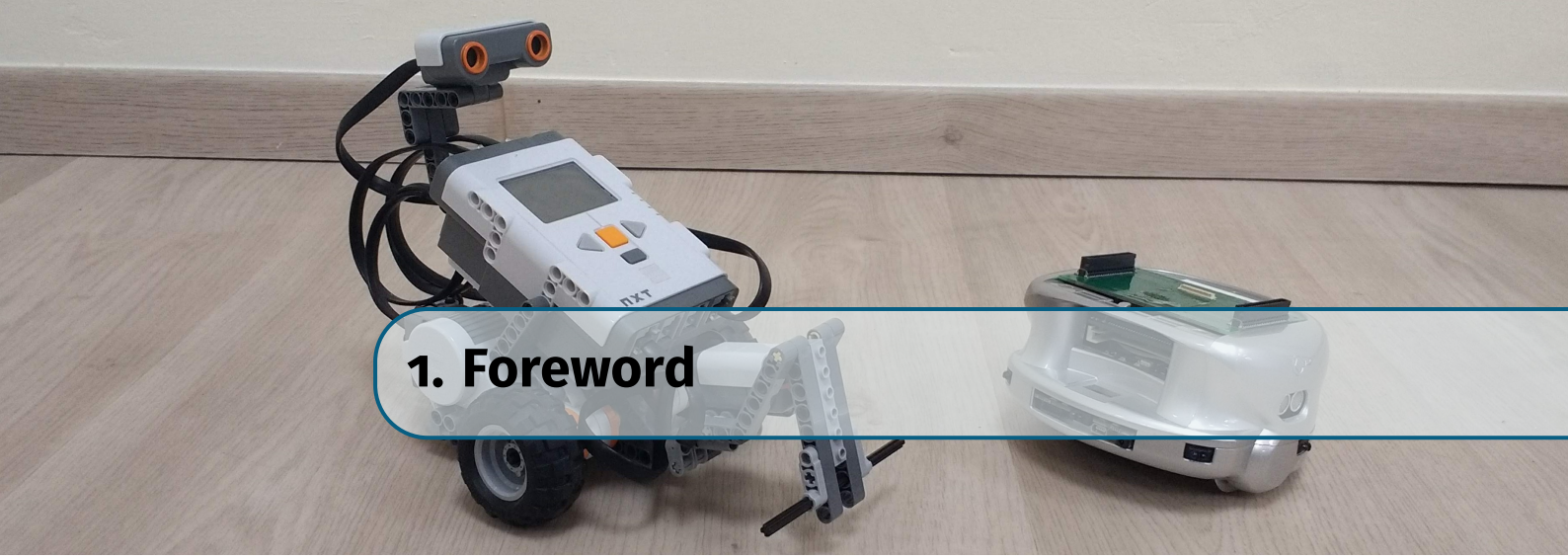
Supervision/Co-supervision of B.Eng. Final Year Students	10
Supervision/Co-supervision of M.Sc. by Research Students	12
Supervision/Co-supervision of M.Phil./Ph.D. Students	11

Peer-reviewed Publications

Conference papers	9
Journal papers	12

Teaching Activities

Postgraduate study units	14 (70 ECTS)
Undergraduate study units	12 (90 ECTS)
Pre-tertiary study units	3 (13 ECTS)



1. Foreword

The Department has maintained a steady course with respect to the key descriptors, increasing the number and grade of Research Support Officers (RSOs), journal publications and postgraduate supervision.

On top of the 70 ECTS and 90 ECTS worth of study units offered by the Department at undergraduate and postgraduate level, respectively, this year the Department introduced 13 ECTS worth of study units offered to the new pre-tertiary Certificate for Engineering Science; the Department took an active role in this new Programme not only through its teaching contribution but also by having two members of the Department in the roles of Programme Coordinator and Subject Coordinator for the Mathematics study units.

The Department has continued to strengthen its academic areas: the research and teaching portfolio in robotics and control engineering is strengthened with a variety of intra- and extramural research projects, and with the creation of new teaching units, which will be offered in academic year 2020-2021, some to the Faculty of Engineering and others to other Faculties; the Department's activity in intelligent transport systems is broadened and new equipment for the TRAKE complex aimed for this area is already arriving and being put to effective use in teaching and research; the Department has a growing number of computer vision research projects and international collaborations in this area, bringing on board experienced postdoc researchers; the Department has also strengthened its biomedical engineering activity with a number of research projects and with new postgraduate teaching offers. This strong portfolio is greatly supported by a competent and hard working complement of technical staff who ably keep the laboratories running and help in the procurement of new equipment. I congratulate all the members of the Department for this personal and collective success.

The Department has maintained a research funding level close to a quarter of a million euros which permits the purchase of specialised equipment and publications, and supports the five research support officers and several of the postgraduate and doctoral students working on these projects.

Once again, the Department has remained very active in public outreach, with several Department members delivering physical and on-line talks, writing media articles and giving radio and television interviews, visiting schools and participating in student events, and coordinating the Faculty's Engineering Technology Clubs, which attracted 650 secondary school students, until this programme had to stop due to the COVID-19 pandemic.

As I close the 8th and last year of my Headship for Alexandra to take the helm, I express my gratitude to all the academic, technical and administrative members of the Department who never stop imagining and creating new initiatives, and for being such a good team, working together to grow and excel. Thank you and let's keep it up!

Prof Ing. Kenneth P. Camilleri
Head of Department
30th September 2020

2. Staff Members

2.1 Staff Members List

Full Professors

Prof. Ing. Kenneth P. Camilleri, *B.Elec.Eng.(Hons.) (Melit.), M.Sc. (Sur.), Ph.D. (Sur.), MIEE, SMIEEE* — ***Head of Department***
Prof. Ing. Simon G. Fabri, *B.Elec. Eng. (Hons.) (Melit.), M.Sc. (Sheff.), Ph.D. (Sheff.), SMIEEE*

Senior Lecturers

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

Lecturers

Dr Alexandra Bonnici, *B.Eng. (Hons.) (Melit.), M.Phil. (Melit.), Ph.D. (Melit.), LLCM(TD), MIEEE*
Dr Ing. Stefania Cristina, *B.Eng.(Hons) (Melit.), M.Sc. (Melit.), Ph.D. (Melit.), MIEEE, MIET*
Dr Ing. Luana Chetcuti Zammit, *B.Eng. (Hons.) (Melit.), M.Sc.(Eng.), Ph.D. (Melit.), MIEEE*

Visiting Academics

Ing. Andre Sant, *B.Eng.(Hons.) (Melit.), M.Sc.(Eng.), MIEEE*
Mr David Debono, *B.Eng. (Hons.) (Melit.), M.Sc.(Eng.)*
Dr Brian Azzopardi, *B.Eng. (Hons.) (Melit.), Ph.D. (Manchester), PGCHE (Oxford Brookes)*

Research Support Officer IV

Dr Peter Ashley Clifford Varley, *M.A.,M.Sc.,Ph.D.,C.En (from May 2020)*

Research Support Officer II

Ing. Rosanne Zerafa, *B.Eng. (Hons.) (Melit.), M.Sc.(Eng.)*
Mr Daniel Bonanno, *B.Sc. (Hons.) (Melit.), M.Sc. ICT (Melit.) (until August 2020)*

Research Support Officer I

Mr Andre Tabone, *B.Eng. (Hons.) (Melit.)*

Research Support Assistant

Mr Matthew Mifsud, *B.Eng. (Hons.) (Melit.)* (*from July 2020*)

Systems Engineers

Ing. Lucianne Gauci, *B.Eng. (Hons.) (Melit.), M.Sc.(Eng.)*
Ing. Rachael Duca, *B.Eng. (Hons.) (Melit.), M.Sc.(Eng.), MIEEE*

Senior Laboratory Officer

Mr Noel Agius

Administrators

Ms Sanchia Cilia Lentini
Ms Allison Sultana *(from July 2020)*

2.2 Academic Staff Scholarly and Administrative Activities

Prof. Ing. Kenneth P. Camilleri

Administrative

Prof. Camilleri is the the Head of the Department of Systems and Control Engineering and member of the Board of Studies of the Electrical & Electronic Engineering undergraduate programme, the Board of Studies of the M.Sc. by Research in Engineering, the Board of the Faculty of Engineering and the University Promotions Board, and chairs the Board of Studies of the taught M.Sc. in Signals, Systems and Control. He is also Director of the Centre for Biomedical Cybernetics and chairs the Centre's Doctoral Committee and its Board of Studies for the M.Sc. by Research programme, and he represents the Centre on the Board of the Malta Neuroscience Network of the University of Malta. Prof. Camilleri assists the European Union's Research Executive Agency in its evaluations of proposals submitted to various Horizon 2020 calls, and assists various international research agencies in their research proposal evaluations.

Scholarly

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" as well as project co-ordinator for the Horizon 2020 project '4NSEEK'. He is the principal investigator for the MCST National R&I FUSION-TDP funded project R&I-2016-010-T 'WildEye' and the RIDT Malta Neuroscience Network Brain Fund Award 'DeepMotionBCI'. Prof. Camilleri is also co-investigator for the MCST National R&I FUSION-TDP funded projects R&I-2015-032-T 'BrainApp', R&I-2015-048-T 'FIHI', R&I-2017-002-T 'Deep-FIR', R&I-2017-028-T 'MAProHand', R&I-2018-012-T 'EyeCon', and R&I-2018-004-T 'NIVS', and for the MCST National R&I FUSION-CVP funded projects R&I-2018-024-V 'ESC', R&I-2019-007-V 'Leggiero', R&I-2019-012-V 'ACOTHERM', R&I-2019-024-V 'PointACT', and R&I-2019-025-V 'VRSurge', as well as co-investigator in the TRAKE projects 'CAMVISM' and 'EyeDesign', and in the RIDT Cancer Research Grant 2018 project entitled 'Combined Thermal and Visual Imaging for Early Detection of Skin Cancer'. Prof. Camilleri is a participant and member of the Management Committee of the COST Action CA19121 'GoodBrother' which is concerned with vision-based applications for Active and Asssistive Living. Prof. Camilleri is a member on the Editorial Board of the Journal of Neuroscience Methods (Elsevier) and regular reviewer for several journals, including: IEEE Transactions on Image Processing; IEEE Access; SPIE Journal of Electronic Imaging; Elsevier Expert Systems with Applications; and Taylor & Francis Brain Computing Interfacing Journal, among others. He is also a reviewer and/or member of International Programme Committees of several international conferences, including: the International Conference on Intelligent Environments (IE 2020), the International Conference on Pattern Recognition (ICPR2020), the International Conference on Applications of Intelligent Systems (APPIS 2020), the ACM Symposium on Document Engineering (DocEng2020), the Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC 2020), and the International Conference on Informatics in Control, Automation and Robotics (ICINCO 2020). Prof. Camilleri is a Guest Editor in the Research Topic 'Music and AI' in the journal Frontiers in Artificial Intelligence, Machine Learning and Artificial Intelligence section.

Prof. Ing. Simon G. Fabri

Administrative

Prof. Fabri is a member on several University boards and committees including the Academic Resources Funds Committee, the Board of the Centre for Biomedical Cybernetics, the Board of the Institute for Climate Change and Sustainable Development, the Quality Assurance Committee, the Doctoral Academic Committee, the SEA-EU Quality and Ethics sub-committee, the Board of Studies of the M.Sc. in Signals, Systems and Control, and the M.Sc. Board of Studies and Doctoral Committee of the Centre for Biomedical Cybernetics. Prof. Fabri is coordinator of the department's Internal Research Workshop Series and the M.Sc. course on Signals, Systems

and Control. He is a member of the Malta Government Engineering Profession Board and the Executive Board of the Mediterranean Control Association.

Scholarly

Prof. Fabri is a member on the Editorial Board of the International Journal on Advances in Intelligent Systems and Associate Editor of the Taylor and Francis publication International Journal of Systems Science. Prof. Fabri is main investigator on the MCST National R&I funded project (FUSION) R&I-2019-025-V 'VRSurge' and co-investigator in projects R&I-2019-003-T 'SMART-CLAP', R&I-2016-035T 'HDMS' and R&I-2017-003T 'Ride+Safe'. He is a reviewer for several journal submissions, including, among others, the International Journal on Advances in Intelligent Systems, the International Journal of Control, the IEEE Transactions on Neural Networks and Learning Systems and IEEE Transactions on Aerospace & Electronic Systems. He is also a reviewer committee member or associate editor for several international conferences.

Dr Kenneth Scerri

Administrative

Dr Scerri chairs of the Faculty of Engineering International Affairs Committee, which during this academic year has establish three new Erasmus agreements and has both sent and welcomed numerous students and academics on various placements, internships and visits. He is currently finalising the establishment of the Intelligent Transportation Research Laboratory at the Faculty of Engineering. He has also finalised the MCST Commercialisation Voucher Programme (CVP), for the project entitled "An Internet of Things Solution for Urban Traffic Control" (IOT4UTC). Together with colleagues at the Faculty for the Build Environment and the Centre for Entrepreneurship and Business Incubation, he was successfully applied as local partners in the H2020 project "A vision for human-centred future cities" (VARCITIES). During this academic year, Dr Scerri has participated in the EU COST action CA18232 - Mathematical models for interacting dynamics on networks and collaborated on the proposal of a second COST action entitled "Environmental implications of sunscreens on the Mediterranean Sea". He has also worked to maintain the Data Science Research Platform at the University of Malta and establish research collaborations with local IT companies and start-ups.

Scholarly

Dr Scerri is a reviewer for the International Journal of Systems Science and various international scientific conferences. He is also a member of the Data Science research platform at the University of Malta.

Dr Ing. Marvin K. Bugeja

Administrative

Dr Bugeja is the national representative on the general assembly of the European Control Association (EUCA). He is also the Faculty's representative on Senate (until July 2019) and a member of the University of Malta Scholarship Selection Board; a member of the Board of Studies of the M.Sc. in Language and Computation offered by the Institute of Linguistics and Language Technology; a member of the Board of Studies of the M.Sc. in Signals, Systems and Control offered by the Faculty of Engineering; and a member of the Faculty of Engineering IT affairs committee.

Scholarly

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 among others. In addition Dr Bugeja is a member of the Astrionics research group (Astrea), and a member of the Particle Detector and Accelerator research group, both of the University of Malta, as well as a regular

invited lecturer at the ISMMB, Dept. of Mechatronics, Faculty of Mechanical Engineering, Brno University of Technology, Brno, Czech Republic. He is also the engineering specialist in the iFoot research project, which this year won the TAKEOFF Seed Fund Award (TOSFA) in the Proof of Concept category.

Dr Tracey Camilleri

Administrative

Dr Camilleri acts as the Department's representative on Faculty board, is a member of the Faculty's M.Sc. by Research Board of Studies, the Faculty's representative in the Malta Neuroscience Network, the academic advisor for first year electrical engineering students, the counsellor of the IEEE Malta student branch, the secretary of the IEEE Women in Engineering and a member of the IEEE Malta Section committee.

Scholarly

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. Dr Camilleri is the principal Investigator of the National R&I Fund Award R&I-2015-132-T 'BrainApp' and the National R&I Fund Award R&I-2018-012V 'EyeCon', and co-investigator of the RIDT Malta Neuroscience Network Brain Fund Award 'DeepMotionBCI'.

Dr Alexandra Bonnici

Administrative

Dr Bonnici is a member on the Faculty's Board of Studies (B.Eng. electrical stream) as well as the Doctoral Board of Studies for the Centre of Biomedical Cybernetics. Dr. Bonnici coordinates the Faculty of Engineering Technology Clubs, the Job Shadowing Week, and is the coordinator of the Carousel Week. Dr Bonnici is also the Program Coordinator of the new Certificate in Engineering Sciences being offered by the Faculty of Engineering.

Scholarly

Dr Bonnici is a reviewer or committee member for international conferences and journals, including: The Eurographics Workshop on Sketch Based Interfaces and Modelling, Computer and Graphics Journal, The International Symposium on Document Engineering and The Eurographics Conference on Visualization. Dr Bonnici is also a member of the Steering Committee of the ACM International Symposium on Document Engineering, a topic editor for the research topic Music and AI for Frontiers, and is an associate editor on Xjenza, the journal of the Malta Chamber of Scientists. Dr Bonnici is a co-investigator on the '4NSEEK' project co-financed through the H2020 ISFP-2017-AG-CYBER call and the TRAKE 'EyeDesign' project. Alexandra is also a member of the National STEM Engagement Working Group and a member of the MATSEC Board.

Dr Ing. Stefania Cristina

Administrative

Dr Cristina is a member of the Faculty's PR committee. She forms part of the Executive Team of the IET Vision & Imaging Technical Network, and serves as Hon. Secretary of the Malta Group of Professional Engineering Institutions (MGPEI). She also serves as a project proposal evaluator for Horizon 2020 project proposals.

Scholarly

Dr Cristina is a reviewer for several conferences and journal submissions, including the International Workshop on Assistive Computer Vision and Robotics (ACVR), the ACM Symposium on Eye Tracking Research and Applications (ETRA), the ACM Symposium on Document Engineering (DocEng) and the ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM). Dr Cristina is the principal investigator of the National R&I Fund Award

R&I-2019-024V 'POINTact' and part of the Project Management team of the National R&I Fund Award R&I-2016-010T 'WildEye'. She is also a principal investigator of the TRAKE 'EyeDesign' project, and a co-investigator of the '4NSEEK' project co-financed through the H2020 ISFP-2017-AG-CYBER call.

Dr Ing. Luana Chetcuti Zammit

Administrative

Dr Ing. Chetcuti Zammit is an IEEE member. She is currently helping in the establishment of the Intelligent Transportation Research Laboratory at the Faculty of Engineering.

Scholarly

Dr Ing. Chetcuti Zammit is a reviewer for several international conferences such as the Australian Control Conference.

3. Academic Activities

3.1 Research Activities

Research Projects

Coordination and Control of Multi-Robot Systems

MAIN INVESTIGATORS: Dr Ing. Marvin Bugeja
RESEARCH STUDENTS: Ing. Rachael Duca

For several decades, the robotics community has focused its research on the design of optimal and robust algorithms that enable a mobile robot to individually and autonomously perform a specific task. However there are times when it is very difficult, if not impossible, for a single robot to execute the given task on its own. For instance, the task at hand can be too complex for a single agent, or it might involve a large physical space. Moreover, a system of multiple robots working together to achieve some common goal, often leads to a quicker, more robust and more efficient solution. However such systems can only be designed if the task at hand is split and distributed in a manner that maximizes efficiency and enhances robustness, based on the capabilities of the individual robots in the team. Such systems have several real-life applications such as in: persistent surveillance, disposal of hazardous waste, warehouse management, and autonomous exploration. To this end, this doctoral research programme (started Oct 2016) is investigating how the coordination and cooperation between autonomous agents in a multi-robot system can be made more efficient, robust, and reconfigurable. This work aims to contribute an optimal framework that allows for task division, allocation and execution for multi-robot systems. This framework shall then be applied to address a real-life relevant problem. The results of the reviewing stage of this project has been published in a review paper[1] at an international peer-reviewed conference in July 2017. More recently, a novel solution to the energy-restricted coverage problem, where a team of robots with energy restrictions is required to optimally cover an environment with time-varying importance regions, has been published in one of the major conferences in the field [2]. Due to the COVID-19 pandemic, this conference was held virtually.

[1] R. N. Darmanin, M. K. Bugeja, "A review on multi-robot systems categorised by application domain," in Proc. of the 25th Mediterranean Conference on Control and Automation (MED), Valletta, Malta, July 2017, pp. 701-706.

[2] R. N. Duca, M. K. Bugeja, "Multi-robot energy-aware coverage control in the presence of time-varying importance regions," in 21st IFAC World Congress, Berlin, Germany, July 2020

Control, Robotics and Automated Systems

Main investigators: Prof. Ing. Simon G. Fabri, Dr Ing. Marvin Bugeja
Research Students: Various

Funding Body: University of Malta Research Grants
Funding Amount: €4,400
Awardee: Prof. Ing. Simon G. Fabri, Dr Ing. Marvin Bugeja

Projects in this area study various aspects of control systems engineering, robot control on different platforms, including mobile robots, and other automation systems. Examples include the implementation of a real-time computer control system for a ball-and-beam apparatus as shown in Figure 3.1, considering different types of control algorithms such as LQR and LQG.

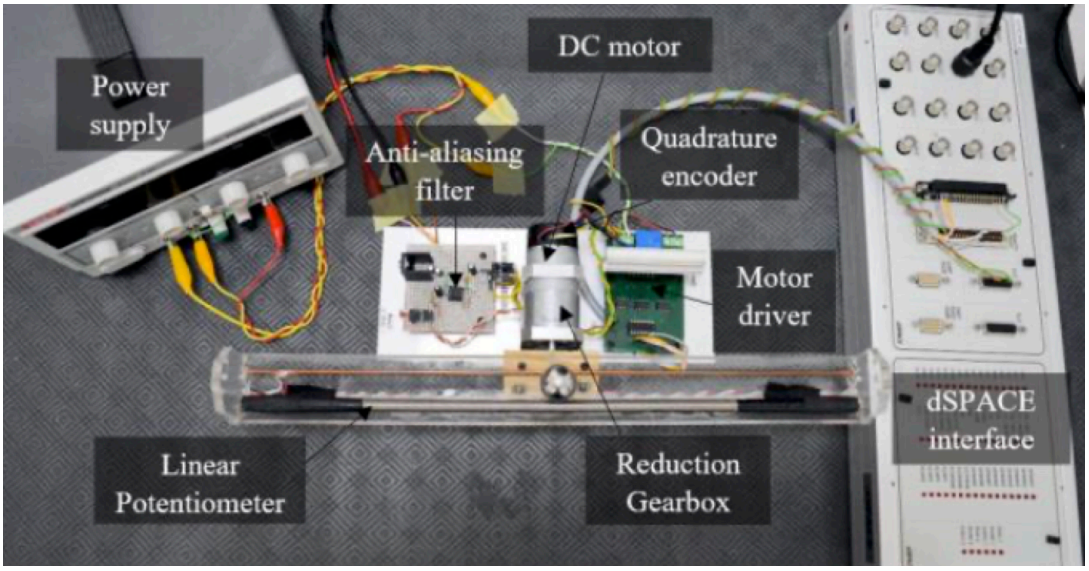


Figure 3.1: The ball-and-beam hardware setup.

Another project under this theme is the design and construction of an autonomous mobile vehicle that can be used as a robotic training partner for track runners (depicted in Figure 3.2). In summary, the project aims to convert an electric remote controlled racing model car into an autonomous mobile robot that can follow the lane lines on a running track with high precision at high specified speeds. The runner would therefore have a moving reference while running on the track. This will help him/her run at the desired paces and therefore train more effectively. The project is organised in phases, spanning the areas of mechanical design, electrical and electronic interfacing, as well as algorithm design and programming.

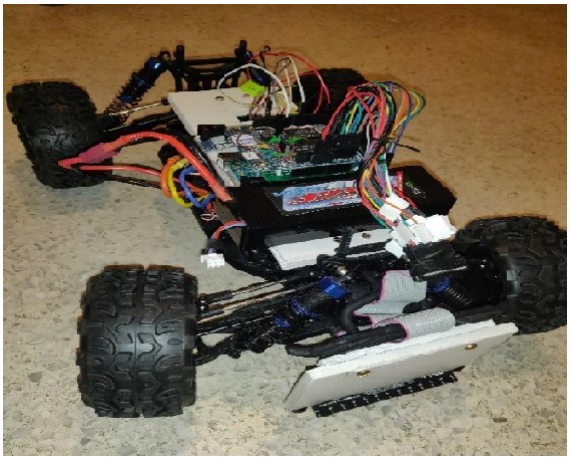


Figure 3.2: The robotic pacer under construction.

Design and Implementation of the Control System for a Physical Motorcycle Simulator

MAIN INVESTIGATOR: Prof. Ing. Simon G. Fabri
FUNDING BODY: MCST FUSION R&I TDP
FUNDING AMOUNT: €6,000 research scholarship
RESEARCH STUDENT AND INVESTIGATOR: Daniel Cassar

This project forms part of a larger MCST-funded research programme called *Ride+Safe*, led by the Department of Industrial and Manufacturing Engineering. This project involves the design and implementation of a control system for a Stewart Platform (hexapod) that will carry a mock-up motorcycle along with a user. A virtual reality headset worn by the user will display the motorcycle ride from a commercial software simulator, and the platform will manoeuvre the user in such a way as to emulate the physical dynamics of this simulation. The rider's physical movements, control of the motorcycle and vestibular effects are used to manipulate the platform with the effect of realistically emulating the feel of a motorcycle ride, including acceleration, banking and so on, through motion cueing algorithms.

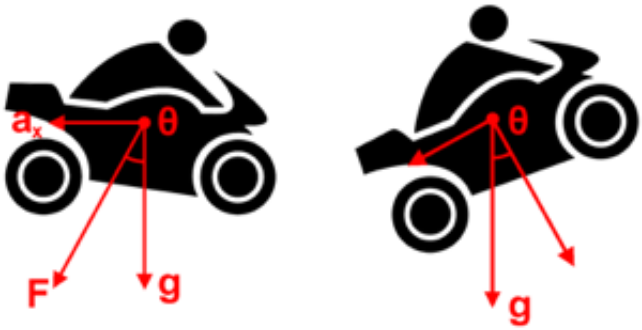


Figure 3.3: Motion cueing to physically emulate the motorcycle ride

Attitude Control of a Pico Satellite

MAIN INVESTIGATORS: Prof. Ing. Simon G. Fabri, Dr Ing. Marvin K. Bugeja, Dr Ing. Marc Anthony Azzopardi[3]
RESEARCH STUDENT: Mr Darren Debattista [4]

This project is part of the Faculty-wide Astrea collaborative project led by the Department of Electronic Systems Engineering, aimed at launching a pico-satellite designed and developed at the University of Malta. During the past year, this subproject focused on data fusion techniques for reliable simulation of the satellite attitude and position through various sensors, and the design of 3-axis attitude control systems using reaction wheels and magnetorquers.

The design of a complete model of the kinematics and dynamics of the satellite in orbit of the Earth was developed and simulated. This was followed by a physical mock-up of the satellite to test the attitude determination and control systems as a proof of concept. This work has resulted in an article published in the IEEE Journal on Miniaturization for Air and Space Systems.

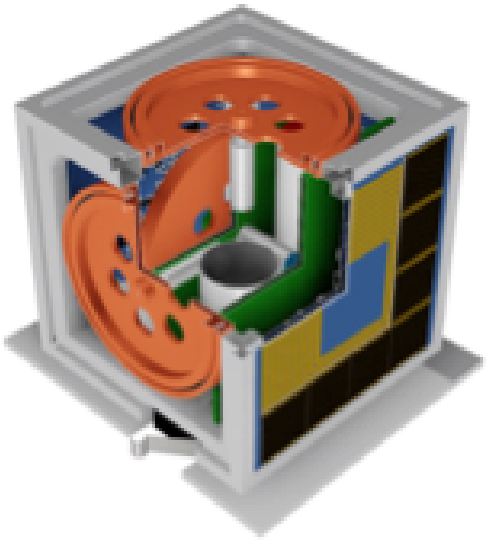


Figure 3.4: Cutaway drawing of the UoMBSat-1 pico-satellite

VRSurge - Virtual Reality Surgical Training Simulator

MAIN INVESTIGATORS: Prof. Ing. Simon G. Fabri
FUNDING BODY: FUSION R&I Commercialisation Voucher Programme 2019
FUNDING AMOUNT: €17,000
AWARDEE: Prof. Ing. Simon G. Fabri

VRSurge proposes the use of 3D Virtual Reality and immersive technologies to develop a simulator for training of medical surgeons and assistants. Trainees are able to visualize realistic 3D images of human organs and surgical instruments while manipulating physical mock-up instruments to perform actions such as dissection, suturing and knotting on a virtual patient. The mock-up instruments transmit back tactile feedback of the forces and sense of touch as

[3]Department of Electronic Systems Engineering
[4]Department of Electronic Systems Engineering

felt by surgeons during real interventions. The use of such techniques makes the simulator very realistic and enhances skills acquisition for the trainees. This project has completed all three stage of the FUSION CVC. Thus, a TDP research proposal is planned to be formulated and submitted.

Vision-based Eye-Gaze Tracking

Main investigators: Dr Ing. Stefania Cristina
Funding Body: University of Malta Research Grant
Funding Amount: €2,200
Awardee: Dr Ing. Stefania Cristina

This project builds upon our long-standing track record on eye-gaze tracking, whereby the eye movements are tracked from image frames captured by a webcam and used to control the mouse cursor on a monitor screen. The aim of this project is to investigate eye-gaze tracking methods that reduce further the constraints imposed on the user, such as on the head and face movements, in order to allow for more natural user interaction. It is also envisaged that the interaction space is expanded to encompass the user's living environment, hence allowing interaction by means of the eye-gaze with objects of interest within a smart environment, based on image information captured by suitably placed cameras within the environment.

WildEye - Eye-Gaze Tracking in the Wild

Main investigators: Prof. Ing. Kenneth P. Camilleri and Dr Ing. Stefania Cristina
Research Support Officer: Mr Daniel Bonanno

Funding Body: FUSION R&I Technology Development Programme 2017
Funding Amount: €141,313 (out of the total project funding €193,943 for the consortium)
Awardee: Prof. Ing. Kenneth Camilleri

Eye movements have long been recognised to provide an alternative channel for communication with, or control of, a machine such as a computer, substituting traditional peripheral devices. The ample information inherent to the eye movements has attracted increasing interest through the years, leading to a host of eye-gaze tracking applications in several fields, including assistive communication, automotive engineering, and marketing and advertising research.

This project has been awarded funding under the FUSION R&I Technology Development Programme 2017, and had commenced on the 31st of July 2017 with the collaboration of Seasus Ltd as the commercial partner. The project proposes a passive eye-gaze tracking platform aimed to provide an alternative communication channel for persons with physical disabilities, permitting them to perform mundane activities such as to operate a computer, hence improving their quality of life and independence, or for normal individuals as an additional access method, permitting an auxiliary control input for computer applications, such as games.

In the proposed platform, eye and head movements will be captured in a stream of image frames acquired by a webcam, and subsequently processed by a computer (and possibly mobile devices) in order to estimate the gaze direction according to the eye and head pose

components. Mapping the eye-gaze to a computer screen will permit commands to be issued by the selection of icons on a suitably designed user interface. This project will be addressing challenges associated with eye-gaze tracking under uncontrolled daily life conditions, including handling of head and non-rigid face movements, and reduction or elimination of user calibration for more natural user interaction.

The research work carried out during the past year has finalised the development of a method for the estimation of head pose under non-rigid face movement, and developed a method for mapping the 3D gaze information onto a 2D point-of-regard on the monitor screen. A testing protocol has also been designed, and an initial set of trials has been carried out on a group of participants. The collected test data has enabled us to identify a good compromise between the number of calibration markers to use and the attainable mapping accuracy. The project work has now progressed towards incorporating our research work into a Graphical User Interface (GUI) designed by the commercial partner, Seasus Ltd.

POINTact - Natural Interaction for Smart Environments

Main investigators: Dr Ing. Stefania Cristina and Prof. Ing. Kenneth P. Camilleri
Funding Body: FUSION R&I Commercialisation Voucher Programme 2019
Funding Amount: €17,000
Awardee: Dr Ing. Stefania Cristina

The ability to interact in a natural manner with objects in one's environment is especially beneficial to enhance the personal autonomy of persons with impaired mobility or speech. The POINTact project proposes to address the challenge of interacting with objects within a smart environment unobtrusively, based on image information captured by suitably placed cameras within the environment. The image-based detection of different interaction modalities by means of finger, head and possibly eye pointing, will be investigated for more natural interaction that does not rely on obtrusive wearable devices. The project has successfully completed all stages of the FUSION CVC, namely Stage 1: IP Check, Stage 2: Market Research and Product Development Costings, and Stage 3: Economic Impact and Risk Assessment. A research proposal is planned to be submitted to the next call of the FUSION TDP Programme.

EyeDesign

Main investigators: Dr Ing. Stefania Cristina, Dr Alexandra Bonnici and Prof. Ing. Kenneth P. Camilleri
Research Support Officer: Dr Peter Ashley Clifford Varley
Funding Body: TRAKE 2019 (First Call)
Funding Amount: RSO IV Salary for two and half years + €15,000 research funds (estimated total of €120,000)
Awardee: Dr Ing. Stefania Cristina

In the collaborative design process, where multiple users interact with a single object, gaze visualisations are designed to help collaborators understand where others are looking at in a shared visual space. Such visualisations are key to effective communication and collaboration between entities, particularly when the collaborators are not co-located and first-hand obser-

vation of the attentiveness of the collaborators is not possible. However, eye-gaze trackers require lengthy user calibration which is not conducive to quick and easy collaborative design. As a result, eye-gaze tracking techniques have not been adopted in the field, despite the advantages that they bring into the field. This project will use computer vision techniques to reduce user calibration, hence increasing the usability of eye-gaze tracking and visualisation in the collaborative design process.

The project has been kicked-off remotely, on the 4th May 2020, due to travel restrictions arising from the Covid-19 situation. The ongoing research work is currently exploring methods for the detection of facial features from images taken at a distance of 2m-10m, as typically captured in a conference room setting. The detected facial features will be used for the computation of the head pose, as a major contributor to the computation of the gaze angles.

Visual object recognition based on textual descriptions

MAIN INVESTIGATORS: Dr Albert Gatt[5] and Prof. Ing. Kenneth P. Camilleri
RESEARCH STUDENTS: Mr Marc Tanti [6]

This research project, undertaken in collaboration with the Institute of Linguistics and Language Technology, combines the computer vision expertise of the Department with linguistic description of images expertise provided by the Institute. Specifically, the aim of the project is to generate linguistic captions for images and seek methods that can generate descriptions of objects by recognition of its parts. This research has led us to study the use of deep neural networks to this problem. In this context, typically, a convolutional neural network (CNN) extracts image features and a recurrent neural network (RNN) encodes linguistic information. The most common architectural model "injects" the CNN-extracted visual features directly as an input to the RNN, thus making it part of the linguistic encoding process, as shown in Figure 3.5b. An alternative architecture that we have investigated encodes the visual and linguistic features separately, with these being "merged" at a subsequent feed-forward stage, as shown in Figure 3.5a. Our work suggests that the "merge' architecture is superior to the "inject" approach, leading not only to architectures that are more suitable for this task but also to an insightful interpretation on the role of the RNN and CNN processes. Recent work investigated the sensitivity of the various architectures of neural image caption generators to the visual input. This work showed that the extent to which image captioning architectures retain and are sensitive to the visual information depends on the type of word being generated and its position in the caption.

On the basis of this work, the investigators applied for MCST FUSION funding under the Commercialisation Voucher Programme with the project called Electronic Sighted Companion (ESC). The ESC project seeks to provide an assistive technology for vision-impaired people proposing to integrate visual input from a phone camera with intelligent processing to supply visually-impaired persons with spoken information about relevant aspect of their surroundings, as they navigate complex environments.

[5] Institute of Linguistics and Language Technology
[6] Institute of Linguistics and Language Technology

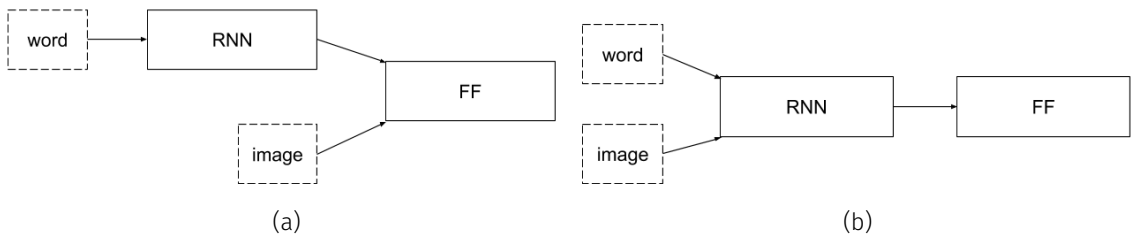


Figure 3.5: Two deep neural network architectures. (a) shows a 'merge' architecture and (b) shows an 'inject' architecture.

Musical Score Analysis

MAIN INVESTIGATORS: Dr Alexandra Bonnici, Dr Ing. Stefania Cristina, Prof. Ing. Kenneth Camilleri

Printed musical scores have, for centuries, given musicians the necessary instructions to reproduce musical pieces according to the composer's intent. The musical score presents information related to the melodic and rhythmic nature of the notes as well as other information related to the expressive nature of the note, such as its articulation, loudness and any ornamental embellishments that may be added to the notes. In addition, the musical score, presents the music player with the sequence with which the music is to be played since, unlike the reading of text, the reading and playing of music is not bound by reading in a forward direction only.

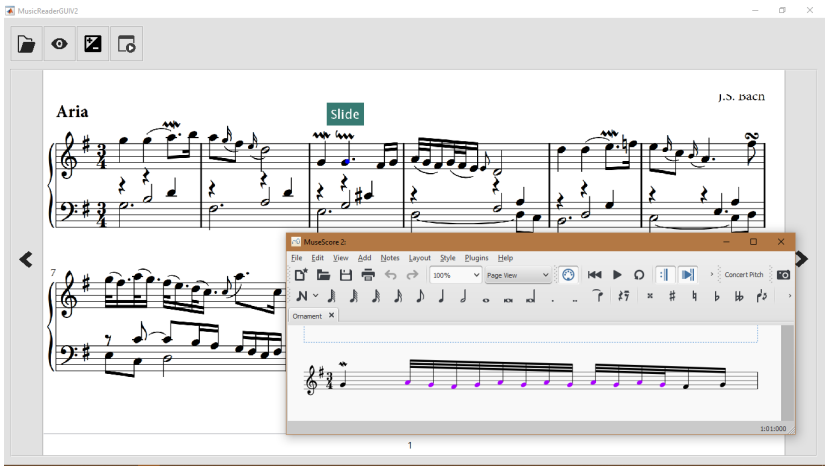


Figure 3.6: A user-interface which allows the pianist to select an ornamented noted and display this as a fully expressed ornament.

While musical notation has developed to suite the needs of printed publications, advances and widespread availability of technology no longer restricts music to the printed score. By performing optical musical recognition (OMR) we can identify the contents of the musical score and re-write this into digital formats, notably in MusicXML format which can be displayed on music readers such as MuseScore among others, and in the MIDI format which can be played by digital instruments. In the former case, we use musical knowledge on the interpretation of ornaments to fully express ornamented notes, creating a user interface which allows the piano student to switch between the notated ornament and the fully expressed ornament as illustrated in Figure 6.1. The MIDI file format allows us to interpret the musical notation and introduce expressiveness to the notes. Here, machine learning techniques such as Kalman

filters are used to introduce expressions which are implied by the music but not necessarily notated in the score.

Leggiero: A piano students' companion

Main investigators: Dr Alexandra Bonnici and Prof. Ing. Kenneth P. Camilleri
Funding Body: FUSION R&I Commercialisation Voucher Programme 2019
Funding Amount: €17,000
Awardee: Dr Alexandra Bonnici

Music students who follow music lessons as private, after-school activity spend longer periods of unsupervised practice than students who attend specialised music schools. This, in turn, leads to a greater chance that the teacher's instruction and hence facilitate the learning of an instrument.

The Leggiero application requires four main algorithms, namely

- Interpreting the score using optical music recognition and re-writing it in MusicXML format
- Creating computational expressive models to play back the score expressively
- Transcribing the notes played by the user to compare with the written score for feedback
- Creating suitable ornament interpretations

The first algorithm will be based on machine learning approaches whereby different note instances are used to train machine learning algorithms such that these may be detected each time they occur in the musical score. A second algorithm will use samples of expressive playing from recorded music and use these samples to build models for expressions. The music will then be analysed to determine the rise and fall patterns of the melody line and the models of expressive playing will be applied to these patterns. Computational intelligence algorithms will be used to create the expressive models, to locate the rise and fall patterns of the music and to apply the models to these patterns. A third algorithm will be used to transcribe the music played by the user. This will involve obtaining the Fourier transform of the musical signal and applying unmixing techniques such as non-negative matrix factorisation to determine the notes being played from the frequency signal. Finally, the last algorithm will consider various factors including speed, duration of the note as well as the musical context of the piece to suggest suitable ornament interpretations based on musical theory. The suggestions will be ordered according to their suitability for the piece being studied. This project has completed the FUSION CVC and a research proposal will be submitted in the next call of the FUSION TDP program.

4NSEEK - Forensic Analysis for Child Sexual Abuse

Main investigators: Prof. Ing. Kenneth P. Camilleri, Dr Alexandra Bonnici, Dr Ing. Stefania Cristina, and Dr Ing. Reuben Farrugia
Research Support Officers: Mr. Andre Tabone, Dr Mark Borg
Funding Body: EU
Funding Amount: €76,674

Funding Body: University of Malta Research Grant

Funding Amount: €4,000
Awardees: Prof. Ing. Kenneth Camilleri, Dr Alexandra Bonnici

Thousands of images and video data pertaining to child pornography is made available on the Internet every month. Tracking such data to curtail the sharing of pornography, protect the children involved and prosecute the perpetrators is, therefore, a critical aspect of cybercrime activities. Software capable of fast detection of pornographic content is essential to law enforcement agencies (LEAs). Such needs have driven researchers to propose algorithms which aid LEAs in their fight against cybercrime. Thus, tools that detect pornographic content, perform age estimation, and search for specific keywords in file names, amongst others, exist to aid LEAs. The aim of the 4NSEEK project is to investigate new, faster and more accurate deep-learning algorithms to create a single tool which allows LEAs to investigate new cases of potential child abuse more efficiently.

The role of the Maltese research team in this project is the detection and labelling of private body parts within pornographic images. Algorithms which analyse images specifically to determine whether these contain private body parts would provide LEAs with essential descriptors of the image content, providing for a better understanding of why images were considered pornographic without the need for manual inspection of the images. To this extent, we have created a two-step approach, in which the first step is a pornographic image detector, and the second step uses a windowing approach to detect private body parts within the image.

We are in the process of creating a labelled dataset in which pornographic images are being manually labelled with the location and label of the exposed private body part. This labelled data-set is being used to train the deep-learning architectures being investigated.

We are investigating the use of different deep learning classifiers, using transfer learning and fine-tuning techniques based on pre trained (on Imagenet data set) models of VGG-19, Inception-V3 and MobileNet architectures, using the TensorFlow GPU module. Through our investigations we have been able to implement a VGG classifier that reached a validation accuracy of 80.15% on the labelled data currently available, and a MobileNet classifier which achieved an accuracy of 80.72%, but at a fraction of the computational time used by the VGG.

BrainApp - Brain Controlled Applications

Main investigators: Dr Tracey Camilleri, Prof. Ing. Kenneth P. Camilleri and Dr Owen Falzon
Research Support Officer: Ing. Rosanne Zerafa
Funding Body: FUSION R&I Technology Development Programme
Funding Amount: €136,335 (out of the total project funding €181,793 for the consortium)
Awardee: Dr Tracey Camilleri

A Brain Computer Interface (BCI) gives a person the ability to communicate with and control machines using brain signals instead of peripheral muscles. BCIs allow people with severely restricted mobility to control devices around them, increasing level of independence and improving quality of life. BCIs may also be used by healthy individuals, e.g. in gaming, and are expected to become a ubiquitous alternative means of communication and control.

The project is now in its last stage and should be completed by end of November 2020, how-

ever due to some delays, primarily from the new partner's side, we will be asking for another 6 month extension.

The work carried out in this past year included the following:

1. The publication of a conference paper entitled "An autoregressive multiple model probabilistic framework for the detection of SSVEPs in brain-computer interfaces" which was presented at Biosignals 2020 and the submission of a journal article to the Communications in Computer and Information Science (CCIS) Series book published by Springer, which is still under review.
2. The featuring of BrainApp on the ReThink podcast aired on 27th January 2020.
3. The publication of various articles including i) an article on Newspoint, published on 18th March 2020, entitled 'UM engineers build brain-controlled devices', and ii) an article entitled 'Sodod motorizzati li jahdmu bis-sinjali li jintbaghtu mill-mohh' and its English version 'A motorised bed that responds to mental instructions', published on TVM news on the 20th March 2020.
4. An interview with Dr Tracey Camilleri on TVM news, aired on Sunday 22nd March 2020 at 8pm, to talk about the project's aims, current and future work. A prototype of BrainApp was also shown during the interview.
5. The drafting of a patent with Potter Clarkson which was filed on 14th May 2020 at the UK Patent Office.
6. Online training by Wearable Sensing on a newly purchased EEG headset.

Work is currently being done to get the blocks of the brain controlled motorised bed together so that the system can be tested on a number of subjects and fine tuned as necessary. The industrial partner is porting the algorithms developed on the commercial BrainApp platform.

Figure 3.7: Brain controlled motorised bed

EyeCon - Eye based Control

Main investigators: Dr Tracey Camilleri, Prof. Ing. Kenneth Camilleri, Mr Nathaniel Barbara
Research Support Officer: Mr Matthew Mifsud Funding Body: FUSION R&I Technology Development Programme
Funding Amount: €122,772 (out of the total project funding €194,910 for the consortium)
Awardee: Dr Tracey Camilleri

EyeCon aims to use a particular eye movement recording technique known as electrooculography (EOG), whereby the electrical activity of the human eyes is captured using electrodes attached to the face in close proximity of the eyes, to develop a practical human-computer interface (HCI) system. This project aims to address practical issues related to the usage of EOG-based systems, particularly to fuse head pose information and develop head movement compensation algorithms, to allow the user to interact with an eye movement-based assistive application naturally and without restrictions.

This project started in mid February 2020 and in July 2020 Mr Matthew Mifsud was employed as a Research Support Officer 1 on the project. A research ethics application form has been submitted and is currently waiting UREC approval. This will allow us to carry out surveys with occupational and speech therapists familiar with vision based eye gaze trackers, as well as system users, so as to identify current limitations with such commercially available eye gaze trackers, typically used for communication. This information will help us define the features for the EOG based eye gaze tracking system that is being developed.

In the mean time work is being carried out to develop robust point of gaze estimation algorithms which will be tested on grid interface menus typically found in such eye gaze tracking systems. The project has also subcontracted the development of a wireless EOG glasses which would allow us to record EOG signals from 9 electrodes in real time. A prototype is expected to be made available towards the beginning of next year.

Gaze Angle Estimation using a Dense Multi-Channel EOG Electrode Configuration with Varying Head Pose Compensation

Main investigators: Dr Tracey Camilleri, Prof. Ing. Kenneth Camilleri
Research Student: Mr Nathaniel Barbara

Electrooculography (EOG) is an eye movement recording technique which is typically used in eye-gaze tracking applications, particularly to develop human-computer interface (HCI) systems, targeted mainly at the mobile impaired. Specifically, EOG captures the electrical activity that is generated by the human eye, which could be regarded to behave like an electric dipole, having the positive and negative poles at the cornea and retina respectively. In fact, the eye creates an electrical field and the electrical signal generated by this field is recorded through EOG via a number of electrodes which are attached to the subject's face, in peri-orbital positions around the eyes.

This doctoral research program has started in June 2018 and the student sat for his MSc to

PhD transfer at the beginning of November 2019. Since then the work focussed on developing an accurate, real-time, point of gaze estimation technique that takes into consideration the effect of baseline drift on the EOG signals. Two publications that have been published in this past year include:

- N. Barbara, T. Camilleri, K. P. Camilleri, "A comparison of EOG baseline drift mitigation techniques", Biomedical Signal Processing and Control, 1;57:101738, Mar 2020.
- N. Barbara, T. A. Camilleri, and K. P. Camilleri, "EOG-based ocular and gaze angle estimation using an extended Kalman filter," in Symposium on Eye Tracking Research and Applications (ETRA), Association for Computing Machinery, June 2020.

Developing a practical human machine interface

MAIN INVESTIGATORS: Dr Tracey Camilleri, Prof. Ing. Kenneth Camilleri, Dr. Owen Falzon
FUNDING BODY: University of Malta Research Grant
FUNDING AMOUNT: €2,200
AWARDEE: Dr Tracey Camilleri

This project aims to develop a practical human machine interface that allows a person to control computer applications using biosignals rather than the standard keyboard, mouse or touch screen interface. Particularly, brain signals and eye movements can be used to allow a person with limited mobility to communicate and control applications that will provide him/her with a better quality of life.

This research grant is being used to support two PhD students, Ing. Rosanne Zerafa and Mr. Nathaniel Barbara, as well as MSc student Mr. Jeanluc Mangion. In different ways, all three students are working on improving the practicality of the difference human machine interface systems they are working on. Specifically, Ing. Zerafa is working on the use of switching autoregressive models for SSVEP based brain computer interface systems, Mr Barbara is focussing on modelling of eye movements captured through EOG (electrooculography), for improved point of gaze estimation, while Mr. Mangion is considering an SSVEP based system which also exploits eye movement information captured in real time from EEG electrodes. The latter has successfully shown that eye movements in four directions can be reliably captured through frontal EEG electrodes and this information can be incorporated within a hybrid brain computer interface which also exploits steady state visual evoked potentials. Mr Mangion is expected to submit his MSc dissertation by end of October 2020.

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

MAIN INVESTIGATORS: Prof. Ing. Simon G. Fabri, Dr Francis Zarb[7], Prof. Mark McEntee[8]
RESEARCH STUDENT: Mr Idris Garba [9]

Computed Tomography (CT) procedures are considered as high radiation dose examinations.

[7]Department of Radiography, Faculty of Health Sciences
[8]Brain and Mind Research Institute, University College Cork, Ireland
[9]Department of Radiography, Faculty of Health Sciences

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.

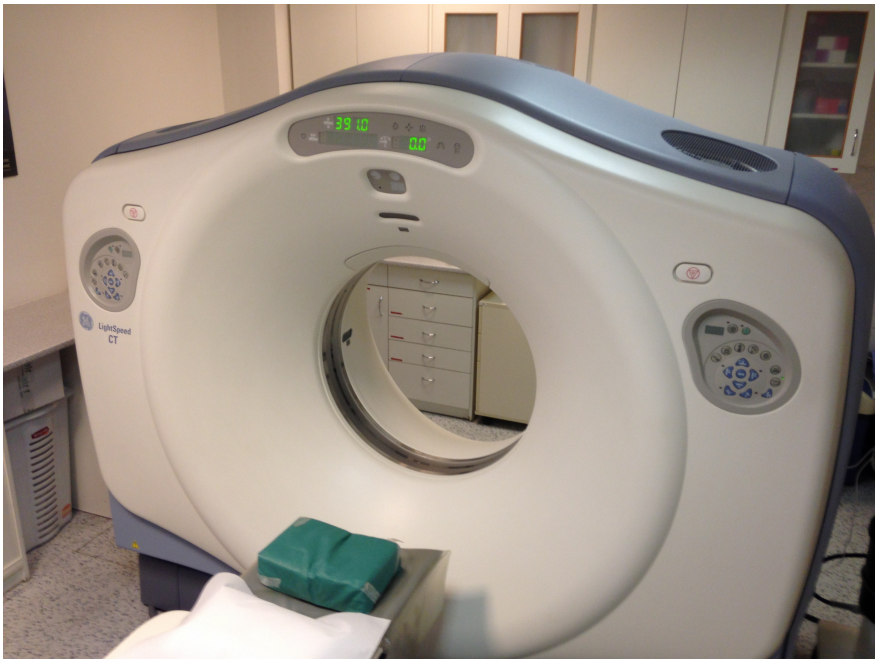


Figure 3.8: Typical CT scanning equipment

The study has applied quantitative methodologies with a cross sectional research design to identify radiation dose in terms of Computed Tomography Dose Index (CTDI) and Dose Length Product (DLP) for CT examinations. Both retrospective and prospective approaches were adopted. Retrospective dose data for the initial radiation dose assessment was collected for adults and paediatrics. This data was used to identify those centres where high or possibly unnecessary radiation exposure is used. A novel optimisation procedure was developed and executed whereby, through systematic adjustment of the CT scan parameters (kV, mAs, slice thickness, pitch), radiation dose is minimised while maintaining acceptable image quality for diagnostic purposes. Data was once again collected for the re-evaluation of the radiation dose after optimisation in centres where there is unnecessary high radiation dose value with respect to other CT centres or countries.

DeepMotionBMI - Intracranial stereo-EEG analysis during grasping movement and intent: a neuroscientific and brain-machine interface study

Main Investigators: Prof. Kenneth P. Camilleri, Dr Tracey Camilleri, Prof. Giuseppe De Giovanni[10], Dr Fausto Caruana [11]

Funding Body: RIDT Brain Research Fund of the Malta Neuroscience Network

Funding Amount: €5,000

Awardees: Prof. Kenneth P. Camilleri, Dr Tracey Camilleri, Prof. Giuseppe De Giovanni, Dr Fausto

[10] University of Parma, Italy
[11] University of Parma, Italy

Caruana

This proposal, in collaboration with the University of Parma, concerns the signal analysis of intracranial stereo-EEG collected from 14 patients during voluntary opening and closing of a set of normal and reverse-action pliers while the position of the pliers was also being measured. This work seeks to build on earlier single neuron recordings, obtained from macaque monkey by the Parma group, to throw light on the human neural basis of the opening and closing motor actions and on the higher level intentional grasping action which can be differentiated from the data obtained when subjects used the normal versus the reverse-action pliers.

It is planned that through spectral analysis and bandlimited ERP analysis of the motor system activity insight into the neural basis of grasping action in humans may be obtained and related to the earlier single neuron recording work. Furthermore, this work intends to investigate single trial classification of the open-close event and of the actual plier opening in the context of the further development of brain-machine interfaces, building on the University of Malta's track record of work on scalp EEG brain-computer interfacing, which in turn may be used to control external devices without muscle control or drive neural prostheses.

After the work carried out in 2018-2019 by Ms Giovanna Stella, an Erasmus+ M.Sc. student from the University of Catania, who had carried out signal preprocessing and a preliminary analysis of the stereo EEG signals provided for this project by our collaborators at the CNR Institute of Neuroscience, Parma, Italy, during this academic year, Ms Ella Miceli-Farrugia, a B.Eng. final year project student, investigated single trial classification of the open-close event. In this work, Ms Miceli-Farrugia investigated various signal feature extraction and selection methods which permitted the extraction of suitable features for plier movement classification.

A prospective longitudinal study investigating underlying mechanisms of upper limb somatosensory impairments of people with stroke

Main Investigators: Dr Lisa Tabone, Prof. Kenneth P. Camilleri, Dr Tracey Camilleri, Prof. Dr Geert Verheyden [12]

Funding Body: Reach High Scholars Programme

Funding Amount: €198,000 [13] (in collaboration with the University of Malta, Centre for Biomedical Cybernetics, and Katholieke Universiteit Leuven)

Awardees: Dr Lisa Tabone, Professor Kenneth P. Camilleri, Prof. Dr Geert Verheyden

Somatosensation includes exteroception (e.g. touch and pain), proprioception (e.g. position sense) and higher cognitive somatosensation (e.g. stereognosis). In a prospective longitudinal study involving 70 people with stroke which were assessed on admission to an acute ward and at two, four and six months' post-stroke, Upper Limb (UL) stereognosis (which was associated with UL motor performance) and proprioception were more frequently impaired than tactile sensations. In the aforementioned and other, but smaller longitudinal studies on somatosensory dysfunction, only clinical measures were used. Clinical measures do not allow the investigation of underlying mechanisms of brain dysfunction. One safe, non-invasive and portable method that can be used to monitor brain activation is electroencephalography

[12] Katholieke Universiteit Leuven

[13] Since this project is on an extension, these funds are not accounted for in the Department's external funding for this year.

(EEG) which records the electrical activity of the brain at the scalp. It has been suggested that oscillatory EEG rhythms between sensorimotor cortices might have an important function post stroke. Furthermore, a relationship was found between severity of UL motor impairment and event-related desynch7 ronization in the unaffected hemisphere. Thus, further longitudinal studies exploring changes in brain activation in relation to the clinical manifestation of somatosensory impairments from the early to the chronic stage are warranted. Such studies can provide a more thorough understanding of whether over-activity in the unaffected cortex is a contributor to sensorimotor impairments and subsequently, when being an independent predictor for motor outcome, provide a rationale for novel treatment options.

This project aims to investigate the changes in brain activation of UL somatosensory impairments post stroke, and specifically to:

1. Pilot EEG measurements of brain activation for UL somatosensory impairments in people with stroke and present a standardised protocol;
2. Identify the longitudinal recovery pattern of clinical somatosensory measurements and corresponding changes in cortical EEG activity for UL somatosensory impairments in the early, sub-acute and chronic stage of stroke;
3. Investigate the longitudinal relationship of changes in cortical EEG activity for UL somatosensory impairments and clinical somatosensory measurements with UL motor impairment and function, spasticity and stroke impact in the early, sub-acute and chronic stage of stroke.

Towards Autonomic Control of Urban Traffic Junctions

Main investigators: Ing. Luana Chetcuti Zammit
Funding Body: University of Malta Research Grant
Funding Amount: €2,200
Awardee: Ing. Luana Chetcuti Zammit

As increasing traffic demands are reaching critical levels worldwide, advanced traffic signal management is becoming a fundamental requirement. Despite recent advances in ITS, current systems can become suboptimal when networks are subject to major unanticipated irregularities, such as roadworks, accidents and extreme weather conditions, or to drastically changing and unpredictable traffic demand, say during rush hour. Autonomous-based systems are required to self-handle these complexities by modelling the network behaviour and adapting to the changes as required, in order to control traffic signals so as to optimize the flow of vehicles. This research work is directed towards the design of autonomous-based systems for signalized traffic junctions.

Cloud-Based Intelligent Traffic Light Control

Main investigators: Dr Kenneth Scerri
Research Students: Various
Funding Body: University of Malta Research Grants
Funding Amount: €2,200
Awardee: Dr Kenneth Scerri

This research projects aims to develop the infrastructure and software for a cloud connected intelligent solution for traffic light control in urban environments. Developed over multiple years with the efforts of both undergraduate and postgraduate students, this project has developed and validated the hardware required to measure vehicle queues at the urban intersections. The cloud architecture required for the implementation of the machine learning algorithms have also been extensively investigated and a working solution is being tested. This project is now entering its final phase of testing the complete solution on a local traffic light junction.

IoT4UTC - An Internet of Things Solution for Urban Traffic Control

Main investigators: Dr. Kenneth Scerri
Funding Body: FUSION R&I Commercialisation Voucher Programme 2019
Funding Amount: €17,000
Awardee: Dr. Kenneth Scerri

Modern urban life is significantly shaped and often scarred by our need for transportation. Traffic on our urban network can be managed by various means. In this project, we propose to optimize traffic flow in urban regions through the use of Artificial Intelligence (AI), while leveraging on the connectivity and processing power of Internet of Things (IoT) solutions. The big players in the field of transport control have been slow in adopting these novel technologies; creating the vacuum to be exploited by this project.

3.2 Student Projects and Supervision

3.2.1 B.Eng. Students

Project Title: Behind the ear EEG for SSVEP based BCIs
Student: Mandy Abela
Supervisor: Dr Tracey Camilleri
Co-Supervisor: Prof. Ing. Kenneth Camilleri

Project Title: Detecting movement thoughts from electrodes in the brain
Student: Ella Miceli Farrugia
Supervisor: Prof. Ing. Kenneth Camilleri
Co-Supervisor: Dr Tracey Camilleri

Project Title: Analysis of EOG data recorded while reading
Student: Matthew Mifsud
Supervisor: Dr Tracey Camilleri Co-Supervisor: Prof. Ing. Kenneth Camilleri

Project Title: Vision-based Human Pose Estimation for Sports Biomechanics
Student: Yasmin Albaili
Supervisor: Dr Ing. Stefania Cristina

PROJECT TITLE: Vision-based telemanipulation of a kinetic surface
STUDENT: Michaela Spiteri
SUPERVISOR: Dr Ing. Stefania Cristina

PROJECT TITLE: Player Tracking and Heatmap Generation from broadcasted football games
STUDENT: Gilbert Vassallo
SUPERVISOR: Dr Ing. Stefania Cristina

PROJECT TITLE: An Autonomous Robotic Pacer for Track Runner
STUDENT: Mohamed Attir
SUPERVISOR: Dr Ing. Marvin Bugeja

PROJECT TITLE: Control of a ball and beam apparatus
STUDENT: Simon Sultana
SUPERVISOR: Prof. Ing. Simon Fabri

PROJECT TITLE: Control of Connected and Autonomous Vehicles
STUDENT: Leon Gatt
SUPERVISOR: Dr Kenneth Scerri

PROJECT TITLE: Nonlinear Optimization for Itinerary Planning
STUDENT: Amy Spiteri
SUPERVISOR: Dr Kenneth Scerri

3.2.2 M.Sc. by Research Students

PROJECT TITLE: EEG based control of a home automation system
STUDENT: Mr Jeanluc Mangion
SUPERVISOR: Prof. Ing. Kenneth P. Camilleri
CO-SUPERVISOR: Dr Tracey Camilleri

PROJECT TITLE: SSVEP-Based BCI Technology for Web Browsing
STUDENT: Ms Alison Camilleri
SUPERVISOR: Dr Chris Porter
CO-SUPERVISOR: Dr Tracey Camilleri

PROJECT TITLE: Development of the Control Framework for a Minimal Anthropomorphic Prosthetic Hand
STUDENT: Ms Rachel Cauchi
SUPERVISOR: Prof. Ing. Kenneth P. Camilleri
CO-SUPERVISOR: Prof. Ing. Michael A. Saliba[14]

[14] Dept. of Industrial and Manufacturing Engineering

PROJECT TITLE: Principal Component Analysis for Vision-Based Non-Contact Heart Rate Monitoring
STUDENT: Ing. Lucianne Gauci
SUPERVISOR: Dr Owen Falzon [15]
CO-SUPERVISOR: Prof. Ing. Kenneth Camilleri

PROJECT TITLE: An EEG-Based Biometric System
STUDENT: Ms Elysia Calleja[16]
SUPERVISOR: Dr Owen Falzon
CO-SUPERVISOR: Prof. Ing. Kenneth P. Camilleri

PROJECT TITLE: Enhancing the Common Spatial Patterns Method for BCI Classification by Integrating Temporal Information
STUDENT: Mr Edward Zammit[17]
SUPERVISOR: Dr Owen Falzon
CO-SUPERVISOR: Prof. Ing. Kenneth P. Camilleri

PROJECT TITLE: Anomaly Detection on Smart Meter Data
STUDENT: Mr Michael Farrugia
SUPERVISOR: Dr Kenneth Scerri
CO-SUPERVISOR: Dr Andrew Sammut

PROJECT TITLE: Design and Implementation of the Control System for a Physical Motorcycle Simulator
STUDENT: Mr. Daniel Cassar
SUPERVISOR: Prof. Ing. Simon Fabri

PROJECT TITLE: Stability and Optimisation of a High Dynamic Motor Starter Prototype's Current Control Algorithm
STUDENT: Mr Daniel Lendi[18]
SUPERVISOR: Dr. Daniel Reiko[19]
CO-SUPERVISOR: Prof. Ing. Simon Fabri

PROJECT TITLE: Design of an Attitude Control and Determination System for the UoMBSat1 Pico-Satellite
STUDENT: Mr Darren DeBattista[20]
SUPERVISOR: Dr Ing. Marc A. Azzopardi[21]
CO-SUPERVISOR: Dr Ing. Marvin Bugeja
ADVISOR: Prof. Ing. Simon Fabri

[15] Centre for Biomedical Cybernetics
[16] Centre of Biomedical Cybernetics
[17] Centre of Biomedical Cybernetics
[18] Dept. of Industrial and Electrical Power Conversion
[19] Dept. of Industrial and Electrical Power Conversion
[20] Electronic Systems Engineering
[21] Electronic Systems Engineering

PROJECT TITLE: Identification of Pigments Using Multispectral Image Analysis
STUDENT: Mr Nathan Magro
SUPERVISOR: Dr Alexandra Bonnici
CO-SUPERVISOR: Dr Ing. Stefania Cristina

PROJECT TITLE: Detection of Sexually Explicit Content in Images Using Deep Learning
STUDENT: Mr Andre Tabone
SUPERVISOR: Dr Alexandra Bonnici
CO-SUPERVISOR: Dr Ing. Stefania Cristina

3.2.3 M.Phil. / Ph.D. Students

PROJECT TITLE: Trajectory Space Factorisation for Vision-Based Automated Sign Language Recognition
STUDENT: Mr Mark Borg
SUPERVISOR: Prof. Ing. Kenneth P. Camilleri
ADVISOR: Dr Marie Alexander[22]

PROJECT TITLE: Electrode Modelling for Applications of Functional Electrical Stimulation
STUDENT: Ms Mary Grace Cassar [23]
SUPERVISOR: Prof. Cristiana Sebu, [24]
CO-SUPERVISOR: Prof. Ing. Kenneth Camilleri

PROJECT TITLE: Switching Multiple Models for SSVEP-Based Brain-Computer Interfaces
STUDENT: Ing. Rosanne Zerafa
SUPERVISOR: Dr Tracey Camilleri
CO-SUPERVISORS: Dr Owen Falzon, Prof. Ing. Kenneth Camilleri

PROJECT TITLE: Gaze Angle Estimation using a Dense Multi-Channel EOG Electrode Configuration with Varying Head Pose Compensation
STUDENT: Mr Nathaniel Barbara
SUPERVISOR: Dr Tracey Camilleri
CO-SUPERVISOR: Prof. Ing. Kenneth Camilleri

PROJECT TITLE: Analysis of temperature transient patterns using dynamic infrared thermography
STUDENT: Mr Jean Gauci[25]
SUPERVISOR: Dr Owen Falzon[26]
CO-SUPERVISOR: Prof. Ing. Kenneth Camilleri

[22] Institute of Linguistics and Language Technology, University of Malta
[23] Department of Mathematics
[24] Department of Mathematics
[25] Centre for Biomedical Cybernetics, University of Malta
[26] Centre for Biomedical Cybernetics, University of Malta

PROJECT TITLE: An Enhanced Wearable System for Kinematic and Kinetic Gait Analysis
STUDENT: Mr Nikiforos Okkalidis[27]
SUPERVISOR: Dr Owen Falzon
CO-SUPERVISORS: Dr Ing. Marvin Bugeja, Dr Alfred Gatt[28]
ADVISOR: Prof. Ing. Kenneth P. Camilleri

PROJECT TITLE: Quantifying Atherosclerosis using Freehand 3D Ultrasound Imaging
STUDENT: Mr Carl Azzopardi[29]
SUPERVISOR: Dr Yulia Hicks[30]
ADVISOR: Prof. Kevin Cassar [31], Prof. Ing. Kenneth P. Camilleri

PROJECT TITLE: Coordination and Control of Multi-Robot Systems
STUDENT: Ing. Rachael Duca
SUPERVISOR: Dr Ing. Marvin Bugeja

PROJECT TITLE: CT Radiation Doses in Nigeria: Establishment of Diagnostic Reference Levels and Radiation Dose Optimisation
STUDENT: Mr Idris Garba[32]
SUPERVISOR: Prof. Ing. Simon G. Fabri
CO-SUPERVISOR: Dr Francis Zarb[33]
ADVISOR: Prof. Mark McEntee[34]

PROJECT TITLE: Towards More Compact Chip to Chip Communication Methods
STUDENT: Mr Andre Micallef[35]
SUPERVISOR: Dr. Ing. Marc Anthony Azzopardi [36]
CO-SUPERVISOR: Prof. Ing. Simon G. Fabri

PROJECT TITLE: Visual Object Recognition based on Textual Descriptions
STUDENT: Mr Marc Tanti[37]
SUPERVISOR: Dr Albert Gatt [38]
CO-SUPERVISOR: Prof. Ing. Kenneth P. Camilleri

[27] Centre for Biomedical Cybernetics
[28] Department of Podiatry, Facuty of Health Sciences, University of Malta
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[36] Department of Electronic Systems Engineering
[37] Institute of Linguistics and Language Technology
[38] Institute of Linguistics and Language Technology

3.3 Staff Publications

Journal Publications

1. D. De Battista, S.G. Fabri, M.K. Bugeja, M.A. Azzopardi, "PocketQube pico-satellite attitude control: Implementation and testing", IEEE Journal on Miniaturization for Air and Space Systems, Vol.1, No. 2, pp. 90-102, September 2020.
2. I. Garba, F. Zarb, M.F. McEntee, S.G. Fabri, "Computed tomography diagnostic reference levels for adult brain, chest and abdominal examinations: A systematic review", Radiography, September 2020.
3. A. Tabone, A. Bonnici, S. Cristina, "Automated Page Turner for Musicians" Frontiers in Artificial Intelligence, section Machine Learning and Artificial Intelligence Journal, August 2020.
4. N. Okkalidis, K. P. Camilleri, A. Gatt, M. K. Bugeja, O. Falzon, "A review of foot pose and trajectory estimation methods using inertial and auxiliary sensors for kinematic gait analysis" Biomed Tech (Berl)., June 2020.
5. S. Griffin, O. Falzon, K. P. Camilleri, and V. Valdramidis, "Bacterial and fungal contaminants in caprine and ovine cheese: a Meta-analysis assessment," vol. 137 Food Research International June 2020.
6. J. Gauci, K. P. Camilleri, O. Falzon, "Principal component analysis for dynamic thermal video analysis," Infrared Physics and Technology, vol. 109, May 2020.
7. N. Barbara, T. Camilleri, K. P. Camilleri, "A comparison of EOG baseline drift mitigation techniques", Biomedical Signal Processing and Control, 1;57:101738, March 2020.
8. C. Azzopardi, K. P. Camilleri, Y. A. Hicks, "Bimodal Automated Carotid Ultrasound Segmentation Using Geometrically Constrained Deep Neural Networks", IEEE Journal of Biomedical and Health Informatics, vol. 24, issue 4, pp. 1004-1015, January 2020.
9. N. Okkalidis, G. Marinakis, A. Gatt, M. K. Bugeja, K. P. Camilleri, O. Falzon, "A multi-segment modelling approach for foot trajectory estimation using inertial sensors", Gait & Posture vol. 75, pp. 22-27 January 2020.
10. A. Bezrouka, T. Hosszú, O. Falzon, P. Vodaa, M. Vachek, J. Záhora, V. Mašín, K. P. Camilleri, J. Kremláček, "Digital orbitoplethysmograph: a new device to study the regional cerebral circulation using extraorbital plethysmography", Journal of Neuroscience Methods, 1; 329:108459, January 2020.
11. L. Chetcuti Zammit, S.G. Fabri, K. Scerri, "Real-time parametric modeling and estimation of urban traffic junctions", IEEE Transactions on Intelligent Transportation Systems, Vol. 20, No. 12 , pp. 4579-4589, December 2019.
12. A. Bonnici, A. Akman, G. Calleja, K. P. Camilleri, P. Canturk, P. Fehling, A. Ferreira, F. Hermuth, J. H. Israel, T. Landwehr, J. Liu, N. M. J. Padfield, T. M. Sezgin, P. L. Rosin, "Sketch-based Interaction and Modelling: Where do we stand?", in Artificial Intelligence for Engineering Design, Analysis and Manufacturing, vol. 33, issue 4, pp. 370-388, November 2019.

Conferences Publications (Peer Reviewed)

1. D. Fürst, M. Miller, D. A. Keim, A. Bonnici, H. Schafer M. El-Assady, "Augmenting Sheet Music with Rhythmic Fingerprints", 5th Workshop on Visualization for the Digital Humanities, October 2020.
2. L. Chetcuti Zammit, S.G. Fabri, K.Scerri "Real-time multiple model joint estimation for an

urban traffic junction subject to jump dynamics", IFAC-V World Congress, 21st IFAC World Congress, July 2020.
3. R. N. Duca, M. K. Bugeja, "Multi-robot energy-aware coverage control in the presence of time-varying importance regions," IFAC-V World Congress, 21st IFAC World Congress, July 2020.
4. M. Cauchi, K. Scerri, "An Improved Variable Neighbourhood Search Algorithm for Selective Dial-a-Ride Problems," IEEE 20th Mediterranean Electrotechnical Conference (MELECON), June 2020.
5. N. Barbara, T. A. Camilleri, and K. P. Camilleri, "EOG-based ocular and gaze angle estimation using an extended Kalman filter," in Symposium on Eye Tracking Research and Applications (ETRA), Association for Computing Machinery, June 2020.
6. R. Zerafa, T. Camilleri, O. Falzon, and K. P. Camilleri, "An autoregressive multiple model probabilistic framework for the detection of SSVEPs in brain-computer interfaces", 13th International Joint Conference on Biomedical Engineering Systems and Technologies (BIOSTEC), Volume 4: BIOSIGNALS, February 2020.
7. A. Tabone, A. Bonnici, S. Cristina, R. Farrugia, K. P. Camilleri, "Private Body Part Detection using Deep Learning", 9th International Conference on Pattern Recognition Applications and Methods 2020, February 2020.
8. M. Borg and K. P. Camilleri, "Phonologically-meaningful Subunits for Deep Learning-based Sign Language Recognition", In Proceedings of the European Conference on Computer Vision (ECCV), Sign Language Recognition, Translation and Production (SLRTP) Workshop 2020 (Vol. 4), February 2020.
9. Y. Aquilina, M.A. Saliba and S.G. Fabri, "Mobile Assistive Robot in an Inclusive Space: the MARIS Project", In: Salichs M. et al. (eds) Social Robotics. International Conference on Social Robotics ICSR 2019. Lecture Notes in Computer Science, vol 11876. Springer, Cham, pp. 538-547, Madrid, Spain, November 2019.

3.4 Participation in Courses, Meetings and Overseas Visits

Participation in the EUCA General Assembly meeting

As the Maltese representative on the European Control Association (EUCA) Dr. Ing. Marvin Bugeja attended the EUCA General Assembly meeting, held online on the 16th July 2020. Among several items, the agenda included the election of new members of the assembly, and the consideration and selection of proposals for the organisation of the European Control Conferences (ECC) of 2023 and 2024.

Participation in UESA Electives Webinar

On Friday 15th May 2020, Dr. Bonnici participated in the UESA Electives Webinar where she outlined the different electives offered by the Department, including the three new electives which were introduced to the Program of Studies.

Participation in the Management Committee Meeting and Working Group Meeting for the EU COST action CA18232

Between the 24th and the 27th of February 2020, Dr Kenneth Scerri attended the Management Committee Meeting and Working Group Meeting for the EU COST action CA18232 - Mathematical

models for interacting dynamics on networks, where he presented some on his resent work related to this topic.

Participation in the ICPRAM conference

Between the 22nd and the 24th of February 2020, Prof Kenneth Camilleri and Dr Alexandra Bonnici attended the ICPRAM conference which was held in Valletta, Malta. During this conference, Dr Bonnici presented the paper "Private Body Part Detection using Deep Learning".

Participation in BMVA Technical Meeting

On Wednesday 29th January 2020, Dr Alexandra Bonnici participated in the BMVA Technical Meeting on 3D worlds from 2D images in humans and machines which was held in London.

Participation in IET Vision & Imaging Technical Network Meeting

On Tuesday 21st January 2020, Dr Stefania Cristina was invited to attend a meeting of the V&I Technical Network in London, following her interest in joining the executive committee. During this meeting, she also delivered a short presentation on the relevant research activities of the Department.

Presentation to MSc in AI students, University of Malta

Dr Tracey Camilleri gave a presentation to students following the MSc in AI with the Faculty of ICT on Human Machine Interface systems. This presentation was held on 6th November 2019.

Participation in the kick-off Management Committee Meeting of the EU COST Action CA19121 - GoodBrother

Prof. Kenneth P. Camilleri and Dr Stefania Cristina participated in the kick-off Management Committee meeting of the COST Action CA19121 - Good Brother which is an action that seeks to build a pan-European network concerning privacy issues in the use of technologies, such as computer vision, in Active and Assistive Living.

3.5 External Lectures and Visitors

Invited Lectures by Prof. Steven J. Simske

On the 2nd and 3rd March 2020, Prof. Steven Simske delivered guest lectures on low-level and intermediary image processing techniques as a guest lecturer in the study unit SCE3204 Image Analysis and Computer Vision. Prof. Simske also delivered a lecture on Image Profligacy.

Prof. Steven Simske is a Professor with the Department of Systems, Mechanical, and Biomedical Engineering at the Colorado State University, Colorado, US.

Due to the COVID-19 situation, these lectures were delivered online.

Visit by 4NSEEK research team

On the 25th and 26th February 2020, the Department hosted Prof Enrique Alegre, Dr Eduardo Fidalgo from the University of Leon, Dr George Azzopardi and Mr Guru Bennabhaktula from Gronignen University, as well as Inspector Timothy Zammit from the Malta Police Force for the

mid-term meeting of the 4NSEEK project. During this meeting, the researchers involved in the project discussed the project achievements and directions to take for the following months.

Visit by the President of Malta

On 6 February 2020, H.E. Dr George Vella, President of Malta, visited a number of research facilities at the University of Malta. Among these research facilities, H.E. Dr Vella visited the Department's laboratories, namely the Control Systems Engineering Laboratory and the Biomedical Engineering Laboratory.

During this visit, Prof. Ing. Kenneth P. Camilleri, showed the President some examples of biomedical signal processing and biomedical image processing applications. Later on, Dr Ing. Marvin Bugeja and Prof. Ing. Simon Fabri demonstrated the smart wheelchair prototype to H.E. Dr Vella in the Control Systems Engineering Lab. This device could potentially enable its target users to automate certain processes which are otherwise taken forgranted, ultimately allowing for more autonomy.

3.6 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. Additionally, the Department also delivers a taught M.Sc. in Signals, Systems and Control programme on full-time and part-time basis. 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. These study units are listed and summarized in Table 3.2.

The department also offers training to its final year students to assist them in the presentation of the dissertation work. This training consists of a tutorial on the use of LaTeX to write their dissertations and two seminars during which students deliver a 10-minute presentation on their work.

Table 3.1: A selection of undergraduate study units offered by the Department in 2019/2020

Unit code	Unit Name	ECTS Credits
SCE Undergraduate Study Units		
SCE1201	Dynamic Systems and Signals 1	5
SCE2111	Automatic Control Systems 1	5
SCE2112	Control Systems 1	5
SCE2201	Numerical Methods for Engineers	5
SCE2213	Automatic Control Systems 2	5
SCE3101	Dynamic Systems and Signals 2	5
SCE3205	Dynamic Systems and Signals 3	5
SCE3204	Image Analysis and Computer Vision	5
SCE3112	Control Systems Technology and Automation	5
SCE3113	Automatic Control Systems 3	5
SCE3114	Introduction to Control Engineering	5
SCE3216	Automatic Control Systems 4	5
SCE4101	Computational Intelligence 1	5
SCE4102	Systems Theory	5
Other Undergraduate Study Units supported by SCE		
ENR3008	Team Project (unit co-ordination and supervision of two team projects)	5
ENR4200	Engineering Project (final year project supervision by several academic members of the department)	20
Pre-tertiary Study Units Supported by SCE		
ENR0002	Vectors, Matrices and Complex Numbers	5
ENR0010	Experimental Setup and Procedures	3
ENR0011	Engineering Technology	5

Table 3.2: A selection of postgraduate study units offered by the Department in 2019/2020

Unit code	Unit Name	ECTS Credits
SCE Postgraduate Study Units		
SCE5101	Linear Dynamic Systems and Signals	6
SCE5102	Estimation and System Identification	6
SCE5103	Continuous-time Control Systems	5
SCE5104	Discrete-time Control Systems	5
SCE5105	Advanced Signal Processing	5
SCE5106	Research Methods for Systems and Control Engineering	4
SCE5201	Machine Learning and Pattern Recognition	10
SCE5202	Nonlinear Systems and Control	5
SCE5203	System Optimisation and Control	4
SCE5204	Adaptive and Intelligent Control	5
SCE5205	Computer Vision	5
SCE5301	Research Project in Systems and Control Engineering	30
Other Postgraduate Study Units supported by SCE		
LIN5508	Language and Embodied Agents (part of)	10
IES5009	Introduction to System Dynamics	6
OMS5004	Data Resources in Operational Oceanography (part of)	10
ENR5006	Research Methods (part of)	5
ENR5007	Engineering Seminar	5
MEC5014	Data Analysis Techniques in Condition Monitoring	5
ENR5026	Science Communication in Engineering (part of)	5
SCE5021	Introduction to Biomedical Signal and Image Processing	5

4. Prizes, Awards and Appointments

Awards

- In June 2020, Ing. Lucianne Gauci was awarded the Masters by Research in Engineering from the University of Malta for successfully defending her Masters thesis entitled "Principal Component Analysis for Vision-Based Non-Contact Heart Rate Monitoring."
- Mr Mark Cauchi, supervised by Dr Kenneth Scerri, has been awarded third place in the IEEE R8 Student Paper Contest, at the 20th IEEE Mediterranean Electrotechnical Conference (MELECON), in June 2020.
- In February 2020, Andre Tabone and Caroline Debattista participated in the MGPEI Final Year Project Presentations Electrical Engineering & ICT Students with their dissertations entitled Automated Page Turner for Musicians (supervised by Dr. Bonnici and Dr. Cristina) and Automation Enforcement on Priority Lanes (supervised by Dr. Scerri and Dr. Bonnici). Mr Tabone was awarded first place, while Ms Debattista was awarded second place.
- In December 2019, Ing. Rachael Duca was awarded the Engineering Warrant.
- In December 2019, Prof. Simon Fabri, together with the rest of the SPEECHIE project team, was awarded the "Premju Propjeta' Intelletwali Għall-Inizjattiva Teknoloġika" from the Ministry of the Economy, Investment and Small Business.
- In October 2019, Ing Luana Chetcuti Zammit was awarded the Ph.D. degree from the University of Malta for successfully defending her doctoral thesis entitled "Toward Autonomic Control of Urban Traffic Junctions."

Appointments

- In January 2020, Dr Ing. Stefania Cristina was appointed to the Executive Team for the Vision & Imaging Technical Network of the Institution of Engineering and Technology (IET).
- Dr Ing. Luana Chetcuti Zammit was promoted to Lecturer with the Department.
- In November 2019, Dr Alexandra Bonnici was appointed as a member of the Matsec Board.
- In November 2019, Dr Alexandra Bonnici was appointed as a member of the National STEM Engagement Working Group.

5. Collaboration with Third Parties

Loan of thermal cameras to assist checkpoints during the COVID-19 pandemic

Department of National Public Health

Four thermal cameras, one of which belongs to the Department of Systems and Control Engineering, and three of which are owned by the Centre for Biomedical Cybernetics, have been loaned to the Office of the Superintendent of Public Health to assist with body temperature detection.

As it is now commonly known, one of the symptoms of COVID-19 is fever, and although they cannot diagnose the virus per se, these thermal cameras provide a fast way of detecting elevated body temperatures without requiring physical contact as in other conventional close-range thermometers.

Certificate in Engineering Sciences

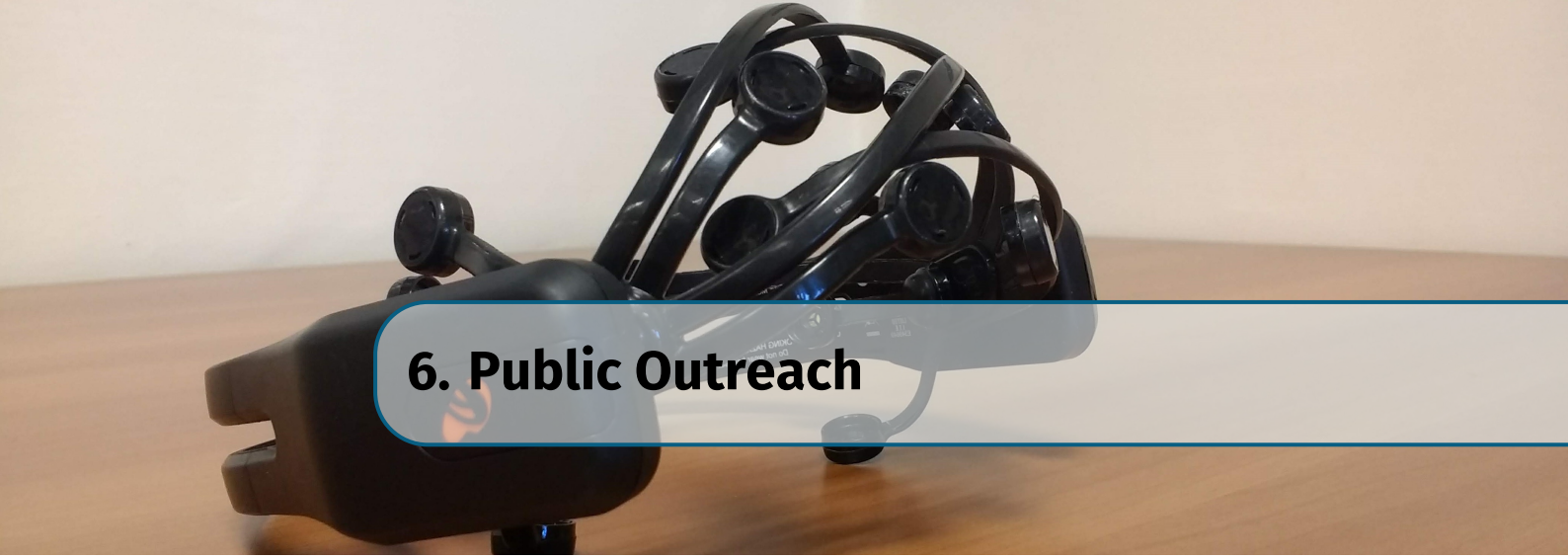
Faculty of Engineering

During the last academic year 2019 - 2020, on behalf of the Faculty of Engineering, Dr Alexandra Bonnici coordinated the first run of the new Certificate in Engineering Sciences course. The Faculty of Engineering launched the Certificate to provide students with an alternative entry route to the Bachelor degree courses offered by the Faculty.

During this course, students study Mathematics and Physics required to be able to follow the Engineering degree courses with success. The course also introduces the student to computer programming and experimental procedures in Engineering.

In addition to the academic content, students also follow practical engineering workshops in the fields of electronics, electrical power, control and robotics, mechanical, materials and manufacturing engineering. The Certificate course helps individuals who need to top-up their Maths and Physics Advanced Levels, who want to redirect their studies to the Engineering field, or who are entering back into academic education after working in the industry.

Nine students have successfully completed this Certificate programme, eight of whom have now enrolled in the undergraduate courses offered by the Faculty of Engineering, while another student enrolled in the undergraduate courses offered by the Faculty of ICT.



6. Public Outreach

6.1 Participation in career fairs

6.1.1 iChoose

On the 31st July 2020, Alexandra Bonnici attended the iChoose Career Fair which was held at the Hotel Excelsior between 17:00 and 19:00. During this event, Alexandra spoke to several students seeking career advice as well as demonstrating several student projects.

6.1.2 Teen Science Cafe - Girls' Festival

On the 7th November 2019, Dr. Bonnici participated in the Teen Science Cafe Girls' Festival organised by the Directorate for Learning and Assessment Programmes. This festival, offered students the opportunity to encounter a number of professionals from different STEM related careers through the means of interactive informal exchanges between the students and the professional.

6.2 Organisation and Participation in the Faculty of Engineering Technology Clubs

Dr. Bonnici led the Engineering Technology Clubs for the 2019/2020 academic year. These workshops, which are held every Wednesday, provide an opportunity for secondary school students to discover the different aspects of the Engineering Profession. During these workshops, students participate in two practical workshops in various disciplines, after which Dr. Bonnici delivers a talk highlighting different pathways to becoming an engineer at the University of Malta as well as answer student questions regarding options choices.

With the support of Mr Noel Agius, Dr. Bonnici also delivers workshops in robotics and image and signal processing as part of these Clubs.

This year, 650 students attended the Technology Clubs from different church and state schools. Unfortunately, the workshops had to end prematurely due to the COVID-19 pandemic.

6.3 Zoom Meetings and Talks

6.3.1 Coding Music Online Workshop

On the 14th June 2020, Dr Alexandra Bonnici virtually connected with students from St Monica to deliver an online workshop on coding music as part of the STEM fair organised by the school.During this workshop, Dr Bonnici showed students how we can communicate with digital instruments using MIDI. She then connected her digital piano to her laptop and gave control

over her laptop to the students. By using the programming software SonicPi, the students could play Dr Bonnici's piano from the comforts of their own home.

6.3.2 Talk to students from the Archbishop's Seminary

On Monday 27th April 2020, Dr Alexandra Bonnici delivered a talk on the Engineering profession to a group of nine Form 4 students from The Malta Seminary. During the talk, Dr Bonnici highlighted how engineers with different areas of expertise can come together to create a complex system such as an aircraft. Dr Bonnici also highlighted the different pathways to becoming an engineer at the University of Malta.

6.3.3 Business Coffee Chats Online

On the 23rd April 2020, Dr Kenneth Scerri delivered a talk entitled "Sustainable Mobility Opportunities – moving from A to B in the times of teleworking!" The talk dealt on the traffic flow improvements and associated environmental benefits of a transition from traditional toward connected and autonomous vehicles in urban environments.

6.3.4 Career Talk at St Monica School (B'Kara)

On the 17th April 2020, Dr Alexandra Bonnici held a Zoom meeting with 30 Form 2 students attending St Monica B'kara. During this meeting, Dr Bonnici talked about the Engineering profession and what option choices will lead to a career in Engineering. Dr Bonnici kick-started the meeting by asking students to list words or phrases that come to mind when one thinks of an Engineer.

6.4 School Visits

6.4.1 Zabbar Primary School Visit

On the 28th February 2020, Dr Alexandra Bonnici visited the Zabbar Primary School to deliver a demonstration on how mobile phones work. This initiative formed part of the Freedom to Learn Project co-funded by the Erasmus+ Programme of the European Union.

Figure 6.1: Dr Alexandra Bonnici demonstrating how a mobile phone works.

6.4.2 Visits to Sixth-Forms

In order to spread awareness about the Certificate in Engineering Sciences, Dr Bonnici visited two sixth forms, namely:

- St Martin's College Sixth form on Friday 31st January 2020
- Junior College on Friday 7th February 2020

During these visits, Dr Bonnici had informal chats with sixt-formers following one of Physics, Pure-Maths and Computing A'levels to discuss the possibility of the Certificate as an entry route into the Engineering degree courses.

6.4.3 St Monica (Gzira) Career Talks

On Tuesday, 17th December 2019, Dr Bonnici participated in a career event organised by the St Monica School in Gzira. Around 30, Form 5 students participated in Dr Bonnici's talk during which questions related to subject choices and pathways leading to an Engineering degree were discussed with the students.

6.4.4 St Thomas More College Zejtun Secondary

On the 29th October 2019, Dr Alexandra Bonnici participated in the post-secondary schools talk organised by the guidance team at the St Thomas More College in Zejtun.

6.5 Participation in National Events

6.5.1 STEM Expo 2020 at Esplora

Between the 21st and 26th January 2020, Dr Alexandra Bonnici, Ing. Rachael Duca, Ing. Rosanne Zerafa, Mr Jeanluc Mangion, Mr Jean Gauci, Mr Daniel Bonanno and Mr Nathaniel Barbara, participated in the first instance of the STEM Expo 2020 held at Esplora. During this event,students, school children and the general public could participate in the interactive exhibits exhibited by our staff. Among several projects and setups found in our Department, the smart wheelchair, the electronic piano, a thermal camera, the eye-gaze tracking SMI system, EOG glasses and the LeapMotion system formed part of the interactive exhibition. The general public responded well to these interactive demonstrations.

6.6 Media Exposure

6.6.1 Non-peer reviewed articles

1. "Less page-turning, more music-playing", UM Newspoint, 16th September 2020. This article outlines the work undertaken by Mr Andre Tabone, Dr Stefania Cristina and Dr Alexandra Bonnici on eye-gaze based page-turning for musical sheets.
2. "UM team develops head pose tracker under non-rigid face expression for eye-gaze tracking", UM Newspoint, 26th August 2020. This article features the work done through the project WildEye.
3. "Lecturer makes waves at the Institution of Engineering and Technology", UM Newspoint, 15th July 2020. This article features Dr Stefania Cristina's appointment to the Executive Team for the Vision and Imaging Technical Network, of the Institution of Engineering and Technology (IET).

4. “First run of new Certificate in Engineering Sciences successfully completed,” UM Newspoint, 13th July 2020. This article outlines the first successful run of the new Certificate in Engineering Sciences which started during the academic year 2019-2020. The coordinator of this course is Dr Alexandra Bonnici.
5. “Inspiring younger students by bringing the engineering world to them,” UM Newspoint,3rd June 2020. This article discusses the work done by Dr Alexandra Bonnici in designing and delivering the Engineering Technology Clubs to secondary students on a yearly basis.
6. An article entitled ’Sodod motorizzati li jahdmu bis-sinjali li jintbaghtu mill-mohh’ and its English version ’A motorised bed that responds to mental instructions’ has been published on TVM news on the 20th March 2020.
7. “UM engineers build brain-controlled devices,” UM Newspoint, 18th March 2020. This article showcases the work done on the project BrainApp by Dr Tracey Camilleri, Prof.Ing. Kenneth Camilleri, Dr Owen Falzon and Ing. Rosanne Zerafa in collaboration with the industrial partner 88.eu.

6.6.2 Television Appearances and Interviews

1. On the 25th April 2020, Dr Alexandra Bonnici and Dr Ing. Stefania Cristina participated in an interview held by Radio Mocha broadcast on Radju Malta. During this interview Dr Bonnici and Dr Ing. Cristina discussed the topic of computer vision.
2. On the 20th March 2020, TVM news featured a Skype interview with Dr Tracey Camilleri, who talked about the project BrainApp.
3. On the 12th February 2020, TVM news featured a demonstration given by Dr Ing. Marvin Bugeja and Prof. Ing. Simon Fabri, featuring a working prototype of the smart wheelchair.
4. On the 28th January 2020, Dr Tracey Camilleri and Ing. Rosanne Zerafa participated in the new radio show and podcast called ReThink. During this podcast, Dr Camilleri and Ing. Zerafa talked about their research and work done on the project BrainApp.

7. Contact Us

For further information, we invite you to visit:

- our **Facebook** page: www.facebook.com/um.scedepartment/
- our **University webpage**: www.um.edu.mt/eng/sce

Furthermore, you may wish to contact us through one of the following means:

- on our **e-mail** address: sce.eng@um.edu.mt
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