L-Università ta' Malta
Faculty of Engineering | Department of Systems & Control Engineering

ANNUAL
REPORT
2023-2024

Presented By
Department of Systems and Control Engineering

Contents

Key Descriptors

Members of Staff

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

Externally Funded Members of Staff

Research Support Officer III	1
Research Support Officer II	1
Research Support Officer I	3

Research Projects

Externally Funded	3
Internally Funded	8
In Collaboration	12

Research Funds Disbursed During 2023/24

International Funds	€26,667
National Funds	€148,154
Internal Funds	€8,800

Student Supervision

Supervision/Co-supervision of B.Eng. Final Year Students	5
Supervision/Co-supervision of M.Sc. by Research Students	12
Supervision/Co-supervision of M.Phil./Ph.D. Students	8
Supervision of Internships	1

Peer-reviewed Publications

Journal papers	8
Conference papers	2
Abstracts	3
Non-peer reviewed articles	26

Teaching Activities

Postgraduate study units	1 (9.5 ECTS)
Undergraduate study units	22 (111 ECTS)
Pre-tertiary study units	4 (9.2 ECTS)

Outreach Events

Project-related dissemination	3
Student outreach events	26 (≈ 86 contact hours)

1. Foreword

To give real service you must add something which cannot be bought or measured with money, and that is sincerity and integrity.

Douglas Adams

As I reflect on the past year, I am filled with immense pride and gratitude for the incredible work done by all members of the Department of Systems and Control Engineering. It has been a year of growth, perseverance, and collaboration, where every member has played a part in ensuring a positive and enriching experience for our students. I am especially proud of the positive feedback we have received from students, not only through the formal university channels but also through their personal acknowledgment that, as a department, we are not only open to feedback, but are willing to act upon it. This responsiveness to the needs of our students is one of the qualities that makes me most proud to be a member of this department.

This year has been marked by many joys, including new academic achievements, the excitement of new projects, and the welcoming of new family members. However, we have also faced moments of worry, as we navigated challenges and uncertainties, and of sorrow as we mourned the loss of cherished loved ones within our department's community. Through it all, the strength and unity displayed by our team have been a testament to the spirit and resilience of this department.

On a personal note, this year marks the end of my first term as Head of Department. When I started this journey, I was in awe of the responsibilities that come with this role. Undoubtedly, I have made mistakes along the way and I deeply appreciate the patience, understanding, and support you have all shown. I am in sincere gratitude (and some incredulity) that you have trusted me with the headship for a second term. I promise to take the lessons learned to heart and, like Anne of Green Gables, 'I never make the same mistake twice.' Hopefully, unlike Anne, I will not make many new ones.

As we look ahead, we have an exciting year in store, especially as we follow the progress of our new online MSc program — a pioneering step that the department has taken. I look forward to see what we can achieve together in the coming year.

Thank you once again for your hard work, passion and dedication. It has been a privilege to work alongside each of you.

Dr Alexandra Bᴏɴɴɪᴄɪ
Head of Department
16th October 2024

2. Staff Members

2.1 Staff Members List

Head of Department

Dr Alexandra Bonnici, *B.Eng. (Hons.) (Melit.), M.Phil. (Melit.), Ph.D. (Melit.), LLCM(TD), SMIEEE, MIET, SMACM*

Full Professors

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

Associate Professors

Prof. Ing. Marvin K. Bugeja, *B.Eng. (Hons.) (Melit.), Ph.D. (Melit.), SMIEEE, MIET*
Prof. Ing. Tracey Camilleri, *B.Eng. (Hons.) (Melit.), Ph.D. (Melit.), SMIEEE*

Senior Lecturers

Dr Kenneth Scerri, *B.Eng. (Hons.) (Melit.), M.S. (Oakland), Ph.D. (Sheff.), MIEEE*
Dr Ing. Stefania De Battista Cristina, *B.Eng.(Hons) (Melit.), M.Sc. (Melit.), Ph.D. (Melit.), MIEEE, MIET*

Lecturers

Dr Ing. Luana Chetcuti Zammit, *B.Eng. (Hons.) (Melit.), M.Sc.(Eng.), Ph.D. (Melit.), MIEEE*

Visiting Academics

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

Research Support Officer III

Dr Hani Hazza Ali Ahmed, *(from February 2024)*

Research Support Officer I

Mr Nipun Sandamal Ranasekara Pathiranage, *B.Sc. Computer Science (NSBM Green University)*
Mr Salah Ad-Din Ahmed Youbi, *B.Eng. (Hons.) (Melit.)*
Ms Dina Owens, *(from September 2024)*

Systems Engineers

Dr Ing. Rachael Duca, *B.Eng. (Hons.) (Melit.), M.Sc.(Eng.), Ph.D. (Melit.)*
Mr Matthew Mifsud, *B.Eng. (Hons.) (Melit.), M.Sc.(Eng.)*

Assistant Laboratory Manager

Mr Noel Agius

Administrators

Ms Sanchia Cilia Lentini

3. Administrative Contributions

3.1 Administrative Contributions of Department Members

Department members contribute to the administration of the Department, Faculty and the University through memberships in various committees. The list below, indicates the administrative contribution of various department members throughout this academic year.

Prof. Ing. Simon G. Fabri

- University Pro-Rector for Research and Knowledge Transfer
- A member of the following University Boards and Committees:
    - Academic Resources Funds Committee
    - Board of the Centre for Biomedical Cybernetics (Chair)
    - Board of the Institute for Climate Change and Sustainable Development
    - Board of the Institute of Physical Education and Sport (Chair)
    - Doctoral Academic Committee
    - SEA-EU Quality and Ethics sub-committee
    - Board of Studies of the M.Sc. in Signals, Systems and Control,
    - University Assessment Appellate Board (co-Chair)
    - Doctoral School Board
    - PhD and Research Master Degrees Scholarship Board (co-Chair)
    - IT Services Committee (Chair)
    - Malta University Publishing Board
    - Professional Development Committee (Chair)
    - Professional Doctorate Sub-committee
    - Research Engagement Committee (Chair)
    - Research Funds Committee (Chair)
    - Staff Affairs Committee
    - Staff Scholarships and Bursaries Committee
    - Board of Directors of MUIP
    - Steering Committee on Infrastructural Projects
    - University Senate
    - University Council (observer)
- UM representative on the European University Association (EUA) Expert Group on Innovation (EGInno)
- Member of the Executive Board of the Mediterranean Control Association
- Lead manager of the Control Systems Engineering Laboratory within the Department

Prof. Ing. Kenneth P. Camilleri
- Member of the University Promotions Board for Associate Professors and Professors
- Director of the Centre for Biomedical Cybernetics (CBC)
- Chair of the CBC's Doctoral Committee
- Chair of the CBC's Board of Studies for the M.Sc. by Research programme
- Member of the Board of Studies of the M.Sc. in Signals, Systems and Control
- Member of the Board of the University of Malta Magnetic Resonance Imaging (UMRI) Platform
- CBC representative on the Board of the Malta Neuroscience Network (University of Malta)
- Assists the European Union's Research Executive Agency in its evaluations of proposals submitted to various Horizon 2020 and Horizon Europe calls
- Assists various international research agencies in their research proposal evaluations
- Lead manager of the Biomedical Engineering Laboratory within the Department
- Lead manager of the TRAKE CBC Laboratory

Dr Kenneth Scerri
- Chair of the Faculty of Engineering International Affairs Committee
- Coordinator of Data Science Platform (DSP)
- Member of the Board of Studies for MSc by Research in Engineering
- Member of the Board of Studies of the M.Sc. in Signals, Systems and Control

Prof. Ing. Marvin K. Bugeja
- A member of the:
  - University of Malta PhD and Master Degrees (Research) Scholarship Selection Board
  - Board of Studies of the M.Sc. in Language and Computation offered by the Institute of Linguistics and Language Technology
  - Board of Studies of the M.Sc. in Signals, Systems and Control
  - Board of Studies of the B.Eng. Electrical and Electronics course
  - B.Eng. Electrical and Electronics Course Accreditation Committee

Prof. Ing. Tracey Camilleri
- Member of the Faculty of Engineering Doctoral Committee
- Member of the Board of Studies of the M.Sc. in Signals, Systems and Control
- Scholar of Repute on the Board of the Centre for Biomedical Cybernetics (CBC)
- Member of the CBC's Board of Studies for the M.Sc. by Research Programme

Dr Alexandra Bonnici
- Department head
- A member of the:
  - Faculty Board of the Faculty of Engineering
  - Faculty's Board of Studies (B.Eng. Electrical and Electronics area of study)
  - Board of Studies of the MSc by Research in Engineering
  - Board of Studies of the MSc in Signals Systems and Control
  - Board of Studies of the Certificate in Engineering Sciences
  - TRAKE steering committee
  - Doctoral Board of Studies for the Centre of Biomedical Cybernetics
  - National STEM Engagement Working Group
  - MATSEC Board
  - SEAC Engineering Technology syllabus panel

- University representative for the SEA-EU Society Hub Working Group.
- Coordinator of the Faculty of Engineering Technology Clubs
- Program Coordinator of the Certificate in Engineering Sciences
- Secretary and Treasurer of the ACM SIGWEB Executive Committee

Dr Ing. Stefania Cristina

- Member of the Faculty's PR Committee
- Member of the University's Visiting Lecturers and External Examiners Committee
- Member of the Board of Studies of the MSc in Signals Systems and Control
- Coordinator of the Department's Learning Thursdays
- Chair of the Executive Team of the IET Vision & Imaging Technical Network
- Committee member of the Malta Group of Professional Engineering Institutions (MGPEI)
- Assists in the evaluations of project proposals submitted to various Horizon Europe calls

Dr Ing. Luana Chetcuti Zammit

- A member of the SEC Engineering Technology syllabus panel
- Coordinator of the MSc in Signals Sytems and Control
- Board of Studies of the MSc in Signals Systems and Control
- A member of the FREC
- A member of the Faculty Sustainable Committee
- Member of the European Control Association

Ms Sanchia Cilia Lentini

- Administrative assistance with the Engineering Technology Clubs

4. Academic Activities

Department members are active members of the research community, providing scholarly service to the community in addition to supervising students at various undergraduate and postgraduate levels and seeking funds to support the research community within the Faculty and the University. This section gives an overview of these activities, detailing scholarly activities, supervised projects, publications and other academic activities undertaken by the department members.

4.1 Overview of Scholarly Activities of Academic Staff Members

Prof. Ing. Simon G. Fabri

Prof. Fabri's academic work focuses on Automatic Control Engineering, particularly adaptive and intelligent control; computational intelligence and AI methodologies for control, modelling of dynamic systems and signals; nonlinear and stochastic control; systems theory; robotics and robot control systems; and applications of control systems. Specific scholarly contributions carried out during this academic year are listed below.

Contributions to research projects
- Main investigator on the ongoing TRAKE project "CONAI"
- Co-investigator in the ongoing project "BRAINCON", funded by TRAKE
- Co-investigator in the ongoing MCST-funded projects:
  - R&I-2019-003-T "SMARTCLAP"
  - SCP-2022-007 "SALTT-CITY"
  - R&I-2019-003A "CuraCLAP"

Contributions to local and international networks
Prof. Fabri is a member of the Mediterranean Control Association & the EUA Expert Group on Innovation.

Contributions to peer review
Prof. Fabri is a reviewer on academic journals and is a review committee member or associate editor on international conferences. Prof. Fabri is also the Associate Editor of the International Journal of Systems Science published by Taylor and Francis.

Prof. Ing. Kenneth P. Camilleri

Prof. Camilleri's academic work is concerned with signal and image processing, computer vision and machine learning, with a particular focus on the application of these areas to health and medicine. Specific scholarly contributions carried out during this academic year are listed below.

Contributions to research projects
- Principal investigator for the:

- – RIDT Malta Neuroscience Network Brain Fund Award "DeepMotionBMI"
- – TRAKE project "BrainCon"
- – Sino-Malta-2023-18 "SIDec"

- Co-investigator for the MCST-funded projects:
  - – R&I-2018-012-T "EyeCon"
  - – SCP-2022-010 "SmartGaze"
  - – REP-2023-022 "EyeTrack"
  - – R&I-2018-012-A "EyeCon+"

- Co-investigator for the TRAKE projects:
  - – "CAMVISM"
  - – "CONAI"

- Co-investigator for the RIDT Cancer Research Grant 2018 project "Combined Thermal and Visual Imaging for Early Detection of Skin Cancer"
- Co-investigator for the UM Research Excellence Fund project "BrainWeb"

Contributions to local and international networks

Prof. Camilleri is a participant and management committee member of the COST Action CA19121 "Good-Brother"

Contributions to peer review

Prof. Camilleri is a member of the Editorial Board of the Journal of Neuroscience Methods (Elsevier) and a regular reviewer for journals such as the:

- IEEE Transactions in Image Processing,
- IEEE Access, the SPIE Journal of Electronic Imaging
- Elsevier Expert Systems with Applications
- Taylor & Francis Brain Computing Interfacing Journal

He is also a reviewer and/or member of international programme committees of international conferences, including the:

- ACM Symposium of Document Engineering,
- Annual International Conference of the IEEE Engineering in Medicine and Biology Society
- International Conference on Pattern Recognition
- International Conference on Informatics in Control, Automation and Robotics

Dr Kenneth Scerri

Dr Scerri's academic work is concerned with system modelling and data engineering with applications in transportation, air quality, and biomedical signal processing. Specific scholarly contributions carried out during this academic year are listed below.

Contributions to research projects

Dr Scerri is a co-investigator on the following research projects:
- H2020 project "Activation of NATURE-based solutions for a JUST low carbon transition" (JustNature).
- Internal seed fund project Be-BoB (Beyond Boundaries of the Brain).
- FUSION: R&I Research Excellence Programme project MARC (Measuring the ARchitecture of Consciousness).
- Space Upstream Thematic Programme 2023 project Operation Tom.
- Sino-Malta Fund MCST 2021 programme project BIMA (Dual fuel engine technology and dynamic behavior Improvement for MArine Application).

- RIDT research grant 2023 project Brian (Brain Research through Imaging Analysis for Neuro-oncology).

Contributions to local and international networks

Dr Scerri is a member of the EU COST action "CA18232 - Mathematical models for interacting dynamics on networks"

Contributions to peer review

Dr Scerri is a reviewer for international scientific conferences and the International Journal of Systems Science.

Prof. Ing. Marvin K. Bugeja

Prof. Bugeja's academic work is concerned with robotics and automatic control systems. Specific research areas of interest in robotics include: autonomous mobile robots, mobile manipulators, multi-robot systems and robot control; while focus areas in general control systems include: nonlinear, adaptive, intelligent, stochastic and neuro control, as well as mechatronic and process control systems, among others. Specific scholarly contributions carried out during this academic year are listed below.

Contributions to research projects

- Principle applicant of the successful MCST funded CVP application R&I-2022-009 "REALISM"
- Co-applicant of the successful MCST funded CVP application R&I-2022 "RIV"
- Co-investigator in project "CONAI", funded by TRAKE
- Co-investigator in project "BRAINCON", funded by TRAKE
- Co-investigator in the ongoing MCST funded TDP projects:
  - R&I-2019-005-T "SIT-DIAB"
  - R&I-2021-005-T "SMARTSPACK"

Contributions to peer review

Prof. Bugeja is an associate editor on the EUCA Conference Editorial Board, and is a reviewer and programme committee member for international conferences and journals, such as: the European Control Conference (ECC), the International Conference on Robotics and Automation (ICRA), the International Journal of Systems Science (Taylor & Francis), and the IFAC Journal of Systems and Control. This year he also served as program chair for the 10th International Conference on Control, Decision and Information Technologies (CoDiT 2024).

Contributions to local and international networks

Prof. Bugeja is a member of the Astrionics research group (Astrea), University of Malta, the Particle Detector and Accelerator research group, University of Malta. He is also a research committee member of the Centre Innovation Drones de Normandie (CIDN) and a member of the General Assembly of the European Control Association (EUCA). In addition, he is a regular invited lecturer at the ISMMB, Department of Mechatronics, Faculty of Mechanical Engineering, Brno University of Technology, Brno, Czech Republic and is a technical advisor and team mentor for the IEEE R8 Robot Championships.

Prof. Ing. Tracey Camilleri

Prof. Camilleri's academic work is concerned with the signal processing of biomedical data and development of human machine interface systems, particularly using electroencephalography (EEG) and electrooculography (EOG). Prof. Camilleri has been on sabbatical leave from October 2022 until February 2023. Specific scholarly contributions carried out during this academic year are listed below.

Contributions to research projects

- Principal investigator for the:

- MCST FUSION Smart Cities Thematic Funding Programme project SCP-2022-010 "SmartGaze"
- MCST FUSION Go-to-Market project R&I-2018-012-A "EyeCon+"
- Co-investigator on the projects:
  - RIDT Malta Neuroscience Network Brain Fund Award "DeepMotionBCI"
  - "BRAINCON", funded by TRAKE
  - Sino-Malta-2023-18 "SIDec"
  - REP-2023-022 "EyeTrack"
  - University of Malta Research Excellence Programme 2023 "BrainWeb"

Contributions to peer review

Prof. Camilleri is a reviewer for journal submissions including, the Journal of Selected Topics in Signal Processing, the Journal of Biomedical Engineering and Control and the IEEE Transactions on Biomedical Engineering, among others.

Dr Alexandra Bonnici

Dr Bonnici's academic work is concerned with image processing and computer vision, applying these disciplines to document engineering, specifically focusing on sketched documents and musical documents. Specific scholarly contributions carried out during this academic year are listed below.

Contributions to research projects

- Principal investigator on the MCST Research Excellence Programme funded project REP-2022-006 "Doc2Speech"

Contributions to peer review

Dr Bonnici is a reviewer or programme committee member for journals and conferences including:
- IEEE Transactions on Multimedia
- Springer Journal on Multimedia Tools and Applications
- Elsevier Computer and Graphics Journal
- ACM International Symposium on Document Engineering
- Eurographics Conference on Visualization.

Dr Bonnici is also an associate editor on Xjenza the journal of the Malta Chamber of Scientists and an editorial board member for ST-OPEN, the journal of the University of Split. She is also an evaluator for the MCST STEM Community Fund, and a reviewer for the European Science Foundation through which she reviews applications for postdoctoral fellowships under the Research Foundation Flanders' (FWO) framework.

Contributions to local and international networks

Dr Bonnici is a member of the steering committee of the ACM International Symposium on Document Engineering. In August 2024, following the resignation of the current chair, Dr Bonnici was elected as the Chair of this Steering Committee.

Dr Bonnici is also the President of the Malta Chamber of Scientists.

Dr Ing. Stefania Cristina

Dr Cristina's academic work is concerned with image processing and computer vision, with particular focus on their application to assisted living technologies. Specific scholarly contributions carried out during this academic year are listed below.

Contributions to research projects

- Principal investigator for the:

- – MCST Research Excellence Programme funded project REP-2022-002 "LuminEye"
    - – RIDT Cancer Research Grant 2018 project entitled "Combined Thermal and Visual Imaging for Early Detection of Skin Cancer"
  - Co-investigator of the MCST Research Excellence Programme project REP-2022-006 "Doc2Speech"

Contributions to peer review

Dr Cristina is a reviewer for several conferences and journal submissions, including:
- International Workshop on Assistive Computer Vision and Robotics (ACVR)
- ACM Symposium on Eye Tracking Research and Applications (ETRA)
- ACM Symposium on Document Engineering (DocEng)
- ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM).

Contributions to local and international networks

Dr Cristina is a participant and management committee member of the COST Action CA19121 "Good-Brother". She also contributes, as a senior writer, to one of the largest websites covering machine learning topics, `machinelearningmastery.com`.

Dr Ing. Luana Chetcuti Zammit

Dr Chetcuti Zammit's academic work is concerned with machine learning and control with applications in transportation. Specific scholarly contributions carried out during this academic year are listed below.

Contributions to peer review

Dr Chetcuti Zammit is a reviewer for international conferences such as the Australian Control Conference and the IEEE Intelligent Transportation Systems Conference.

Contributions to local and international networks

Dr Chetcuti Zammit is a member of the EU COST Action PROCLIAS (CA19139)

4.2 Student Projects and Supervision

4.2.1 B.Eng. (Hons) Students

PROJECT TITLE: Investigating the feeling of space motion sickness in AR/VR
STUDENT: Alexander Anthony Zerafa
SUPERVISOR: Dr Alexandra Bonnici
CO-SUPERVISOR: Prof. Ing. Kenneth P. Camilleri

PROJECT TITLE: A Mobile Robot for Home Security Surveillance
STUDENT: Carsten Karl Grech
SUPERVISOR: Prof. Ing. Marvin K. Bugeja

PROJECT TITLE: Electrooculography (EOG) Signal Analysis for Fatigue Detection
STUDENT: Michelle Emma Desira
SUPERVISOR: Dr Ing. Nathaniel Barbara
CO-SUPERVISOR: Prof. Ing. Kenneth P. Camilleri

PROJECT TITLE: Identifying Optimal Investment Strategies with Artificial Intelligence
STUDENT: Kain Gauci
SUPERVISOR: Dr Kenneth Scerri

PROJECT TITLE: Long Distance Eye-Gaze Tracking
STUDENT: Erik Micallef
SUPERVISOR: Dr Ing. Stefania Cristina
CO-SUPERVISOR: Prof. Ing. Kenneth P. Camilleri

4.2.2 M.Sc. by Research Students

PROJECT TITLE: Controlling a Smart Wheelchair using Steady-State Visually Evoked Potentials
STUDENT: Mr Shawn Darmanin
SUPERVISOR: Prof. Ing. Kenneth P. Camilleri
CO-SUPERVISOR: Prof. Ing. Tracey Camilleri

PROJECT TITLE: Localisation of Brain-activity for SSVEP-based BCIs: An fMRI and EEG Study
STUDENT: Ms Cheryl Gilford
SUPERVISOR: Prof. Ing. Kenneth P. Camilleri
CO-SUPERVISOR: Prof. Ing. Tracey Camilleri

PROJECT TITLE: Automatic Error Detection for an SSVEP-Based BCI System
STUDENT: Mr Fabian Camilleri
SUPERVISOR: Prof. Ing. Tracey Camilleri
CO-SUPERVISOR: Prof. Ing. Kenneth P. Camilleri

PROJECT TITLE: A Real Time Hand-movement Motion Capture System for Rehabilitation of Children with Cerebral Palsy
STUDENT: Mr Mario Farrugia
SUPERVISOR: Prof. Ing. Simon Fabri
CO-SUPERVISOR: Dr Ing. Owen Casha [1]

PROJECT TITLE: Occluded Pedestrian Detection by Pre-Detecting Potentially Dangerous Regions
STUDENT: Mr Luke Scicluna
SUPERVISOR: Dr Ing. Stefania Cristina

PROJECT TITLE: Investigating the Neural Changes Underlying Sexual Arousal in Bisexual Women
STUDENT: Ms Antonella Bugeja
SUPERVISOR: Dr Claude Bajada [2]
CO-SUPERVISOR: Dr Kenneth Scerri

PROJECT TITLE: Anomaly Detection in Visual Road Traffic Data
STUDENT: Ms Nicole Bonnici
SUPERVISOR: Prof. Adrian Muscat [3]
CO-SUPERVISOR: Dr Kenneth Scerri

PROJECT TITLE: Multi-Camera Tracking of Road Vehicles
STUDENT: Mr Pierre Zahra
SUPERVISOR: Prof. Adrian Muscat [3]
CO-SUPERVISOR: Dr Kenneth Scerri

PROJECT TITLE: Investigation of Boosting and Knock on Dual Fuel, LPG-Diesel Engines

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[1]Department of Microelectronics and Nanoelectronics
[2]Department of Physiology & Biochemistry
[3]Department of Computer and Communications Engineering

STUDENT: Mr Aidan James Azzopardi
SUPERVISOR: Prof. Mario A. Farrugia [4]
CO-SUPERVISOR: Dr Kenneth Scerri

PROJECT TITLE: Investigating AdBlue as both an emissions reductant and combustion stabiliser in dual-fuel C.I. Engines
STUDENT: Mr Thor Scicluna
SUPERVISOR: Prof. Mario Farrugia [4]
CO-SUPERVISOR: Dr Kenneth Scerri

PROJECT TITLE: Control of Traffic Junction through Markov Decision Processes
STUDENT: Mr Leonard Farrugia
SUPERVISOR: Dr David Suda [5]
CO-SUPERVISOR: Dr Kenneth Scerri

PROJECT TITLE: A Novel Approach to Early Skin Cancer Detection Using Dynamic Thermography and Deep Learning
STUDENT: Mr Nipun Sandamal Ranasekara Pathiranage
SUPERVISOR: Dr Ing. Stefania Cristina
CO-SUPERVISOR: Prof. Ing. Kenneth P. Camilleri

4.2.3 M.Phil. / Ph.D. Students

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

PROJECT TITLE: Electrode Modelling for Applications of Functional Electrical Stimulation
STUDENT: Ms Mary Grace Cassar [6]
SUPERVISOR: Prof. Cristiana Sebu [6]
CO-SUPERVISOR: Prof. Ing. Kenneth Camilleri

PROJECT TITLE: Analysis of Temperature Transient Patterns using Dynamic Infrared Thermography
STUDENT: Mr Jean Gauci [7]
SUPERVISOR: Dr Owen Falzon [7]
CO-SUPERVISOR: Prof. Ing. Kenneth Camilleri

PROJECT TITLE: Towards More Compact Chip to Chip Communication Methods
STUDENT: Mr Andre Micallef [8]
SUPERVISOR: Dr. Ing. Marc Anthony Azzopardi [8]
CO-SUPERVISOR: Prof. Ing. Simon G. Fabri

PROJECT TITLE: Application of Computer Vision for Collaborative Robotics
STUDENT: Mr Steve Zerafa
SUPERVISOR: Dr Kenneth Scerri
CO-SUPERVISOR: Dr Brian Azzopardi

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[4]Department of Mechanical Engineering
[5]Department of Statistics and Operations Research
[6]Department of Mathematics
[7]Centre for Biomedical Cybernetics
[8]Department of Electronic Systems Engineering

PROJECT TITLE: Development of a Framework for the Conversion of a Home to a Robot-Inclusive Space, and for the Design of a Compatible Autonomous Domestic Robot
STUDENT: Mr Prabhu Rayudu Naraharisetti [9]
SUPERVISOR: Prof. Michael Saliba [9]
CO-SUPERVISOR: Prof. Ing. Simon G. Fabri

PROJECT TITLE: Dual Fuel Engine Dynamic Behaviour Improvement Through Control Techniques
STUDENT: Mr Anthony Theodore Saliba [9]
SUPERVISOR: Prof. Mario Farrugia [9]
CO-SUPERVISOR: Dr Kenneth Scerri

PROJECT TITLE: Analysis on the use of EOG data during long-term use
STUDENT: Mr Matthew Mifsud
SUPERVISOR: Prof. Ing. Tracey Camilleri
CO-SUPERVISOR: Prof. Ing. Kenneth P. Camilleri

4.2.4 Internships

PROJECT TITLE: Fault diagnosis of pneumatic production machines
STUDENT: Barnabas Dobossy
SENDING INSTITUTION: Brno University of Technology (BUT), Czech Republic
DURATION: 4 Jan 2024 - 5 Apr 2024
SUPERVISOR: Prof. Ing. Marvin Bugeja
BRIEF: Theoretical work on doctoral research on fault diagnosis of pneumatic production machines. Side-work on exercises in ROS for mobile robot navigation.

4.3 Teaching Activities

The Department is responsible for teaching several study-units at both undergraduate and postgraduate levels, offering its teaching services with the following degree courses:

- B.Eng.(Hons) in Electrical and Electronic Engineering (Faculty of Engineering)
- B.Eng.(Hons) in Mechanical Engineering (Faculty of Engineering)
- Certificate in Engineering Sciences (Faculty of Engineering)
- B.Sc.(Hons) in Technical Design and Technology (Faculty of Education)
- B.Sc.(Hons) in Communications and Computer Engineering (Faculty of ICT)
- B.Sc.(Hons) in Physics, Medical Physics and Radiation Protection (Faculty of Health Sciences)
- M.Sc. in Language and Computation (Institute of Linguistics)
- M.Sc. in Medical Physics (Faculty of Health Sciences)
- M.Sc. in Environmental Management and Sustainability (Institute of Earth Systems)
- M.Sc. in Artificial Intelligence (Faculty of ICT)
- M.Sc. in Applied Oceanography (Faculty of Science)
- M.Sc. in Orthotics and Prosthetics (Faculty of Health Sciences)

In addition, the Department also coordinates and delivers a taught M.Sc. in Signals, Systems and Control, offering this course on both a full-time and part-time basis. The study units offered by the Department at undergraduate and postgraduate levels are listed in Tables 4.1 and 4.2 respectively.

Besides these teaching duties, the department also offers additional training to its final year students to assist them in the presentation of the dissertation work. This training consists of a tutorial on the

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[9]Department of Mechanical Engineering

Table 4.1: Undergraduate study units offered by the Department in 2023 - 2024

Code	Name	ECTS
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
SCE3115	Introduction to Robotics	5
SCE3216	Automatic Control Systems 4	5
SCE4101	Computational Intelligence 1	5
SCE4102	Systems Theory	5
SCE4103	An Introduction to Biomedical Signal Analysis	5
SCE4104	Practical Applications in Computer Vision	5
Other Undergraduate Study Units supported by SCE		
ENR3008	Team Project (unit co-ordination and project supervision)	5
ENR4200	Engineering Project (project supervision & assessment)	20
Pre-tertiary Study Units Supported by SCE		
ENR0012	Trigonometry and Vectors (part of)	6
ENR0013	Matrices, Numerical Methods and Probability (part of)	6
ENR0010	Experimental Setup and Procedures	3
ENR0011	Engineering Technology (coordination & part of)	5
Study units offered to other undergraduate degrees		
SCE2112	Control Systems 1 (ICT)	5
SCE3114	Introduction to Control Engineering (Mechanical Engineering)	5
SCE3206	Control Systems Fundamentals (Technical Design and Technology)	5
SCE3021	Biomedical Signal & Image Processing for Medical Physics (Health Sciences)	6

use of LaTeX to write their dissertations and two seminars during which students deliver a 10-minute presentation on their work.

4.4 Other Academic Activities

In addition to teaching study units to service degree programs, department members engage in other academic activities examples of which described hereunder.

4.4.1 Engineering Exhibition

From the 21st June until the 23rd June 2024, the department's final-year students together with Dr Natasha Padfield, Mr Matthew Mifsud, and Ms Cheryl Gilford presented their work during the Engineering Exhibition organised by the Faculty of Engineering. During this exhibition, Dr Bonnici together with other

Table 4.2: Postgraduate study units offered by the Department in 2020/2021

Code	Name	ECTS
SCE Postgraduate Study Units		
SCE5101	Linear Dynamic Systems and Signals	6
SCE5102	Estimation and System Identification	5
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	5
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		
ENR5026	Science Communication in Engineering	5
GSC5504	Instrumentation and Ocean Data Systems (part of)	10
ARI5321	Automation and Applied Robotics (part of)	5
POD5050	Foundations of Design in Orthotics and Prosthetics 1 (part of)	5

female engineers participated in an open Q&A session to celebrate the International Day for Women in Engineering.

4.4.2　Engineering Students Summer Training Course

Between the 1st of July and the 9th of August 2024, Mr Noel Agius delivered a three-day summer training course as part of Faculty's summer training program. The training was repeated over a six-week period to accommodate all the second-year students following the Electrical & Electronic and Mechanical Engineering degree courses. Mr Noel Agius started the training by giving the students a demonstration of a direct-on-line and forward and reverse starter by controlling a single-phase capacitor start induction motor and a 3-phase star-connected induction motor. During the demonstration, measuring instruments were used to measure direct current (24V DC) and alternating current (230/400v AC); to detect a 3-phase rotation sequence; and to measure the motor shaft speed. Devices such as the contractor, auxiliary contacts, thermal overload relay, 4-pole RCBO (3P+N), 2-pole MCB, single phase RCD, power supply (230V AC to 24V DC), single-phase over-voltage/under-voltage relay, under-voltage/over-voltage protector phase sequence/phase loss protector and power display, were shown and explained to the students. Moreover, students were shown how to interpret the information listed on each motor name plate; how to connect the terminals of a 3-phase motor in both star and delta configurations; and how to use bootlace terminals. Students were then assigned two practical tasks:

Task 1: The students used an electric circuit diagram to wire a direct-on-line starter, controlling a 12V DC motor. The contactor hold-on coil operates by a 24V DC supply.

Task 2: The students used an electric circuit diagram to wire a forward and reverse starter, controlling a 24V DC motor. The contactor hold-on coil operates by a 24V DC supply.

In both tasks the students used wax lacing to keep the wires neatly and tightly bundled together. For both tasks, before switching on the students carried out a visual inspection and continuity test. After

switching the students measured DC voltages across the terminals of the electrical circuit.

4.4.3 Certificate in Engineering Sciences

Dr Alexandra Bonnici once again coordinated the Certificate of Engineering Sciences on behalf of the Faculty of Engineering. This course provides an alternative entry route to the Bachelor degree courses offered by the Faculty, helping students 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. This past year, 20 students successfully completed the programme and these are now enrolled in the undergraduate courses offered by the Faculty of Engineering, and the Faculty of ICT.

4.4.4 University of Malta Research Expo (UMRE) 2024

Department members participated in the second edition of the University of Malta Research Expo 2024 held on Wednesday 29th May 2024 and which was organised under the pro-rectorate's office of Prof. Ing. Simon Fabri. During this expo, Prof. Tracey Camilleri, Prof. Kenneth Camilleri, Dr Nathaniel Barbara, Mr Matthew Mifsud and Mr Salah Ad-Din Ahmed Youbi presented a poster showcasing their work on the project "SMARTGAZE: Control of devices using EOG-based eye gaze tracking for a smart home environment".

4.4.5 Participation in GoodBrother COST Action Meetings and Short-Term Scientific Missions

The GoodBrother COST Action is concerned with increasing the awareness of ethical, legal and privacy issues related to audio- and video-based solutions for active and assisted living.

On the 11th and 12th of April 2024, Dr Stefania Cristina and Prof. Kenneth Camilleri hosted a two-day Working Group meeting for the GoodBrother COST Action, to discuss the technological, ethical, legal and social aspects of smart mirrors.

On the 19th and 20th of June 2024, Dr Stefania Cristina and Mr Nipun Sandamal attended the Joint visuAAL-GoodBrother Conference on trustworthy video- and audio-based assistive technologies, which was held at the University of Alicante in Spain. During this conference, they delivered a presentation on their latest work that deals with robust iris centre localisation for eye-gaze tracking, which was carried out as part of the MSCT-funded project, LuminEye (which also included the involvement of Prof. Kenneth Camilleri). The conference was then followed by the last Management Committee meeting for the GoodBrother COST Action.

On the 5th and 6th of September 2024, Dr Stefania Cristina and Mr Nipun Sandamal were hosted by Prof. Anton Fedosov at the Institute of Interactive Technologies FHNW in Windisch, Switzerland (Figure 4.1), as part of their COST Short-Term Scientific Mission (STSM), where they presented their eye-gaze tracking research and engaged in many interesting discussions with the Institute's academics and researchers.

4.5 Publications

Journal Publications

1. N. Grech, J. Calleja-Agius, S. Sciberras, N. Micallef, **K. P. Camilleri** and O. Falzon, "Non-contact Vital Signs Monitoring in Paediatric Anaesthesia–Current Challenges and Future Direction." ACTA MEDICA, Volume 66, November 2023.

2. N. Barbara, **T. A. Camilleri**, **K. P. Camilleri**, "Real-time continuous EOG-based gaze angle estimation with baseline drift compensation under non-stationary head conditions," Biomedical Signal Processing and Control, Volume 90, December 2023.
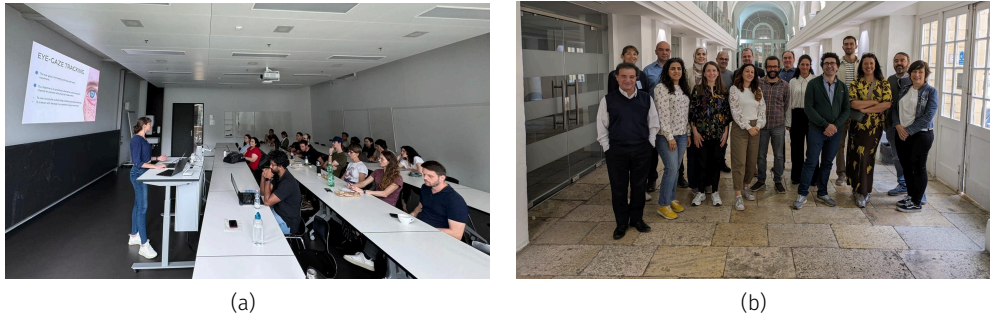
Figure 4.1: (a) Dr Cristina presenting at the Institute of Interactive Technologies FHNW and (b) Participants of the working group meeting of the GoodBrother COST action

3. **M. Mifsud**, **T. A. Camilleri**, **K. P. Camilleri**, "A distance robust EOG-based feature for gaze trajectory inference", Biomedical Signal Processing and Control, Volume 90, December 2023.

4. **S. Cristina**, V. Despotovic, R. Pérez-Rodríguez and S. Aleksic, "Audio- and video-based human activity recognition systems in healthcare," IEEE Access, vol. 12, pp. 8230-8245, January 2024.

5. C. Farrugia, P. Galdi, I. A. Irazu, **K. Scerri** and C.J. Bajada, "Local gradient analysis of human brain function using the Vogt-Bailey Index. Brain Structure and Function", 229(2), pp.497-512, January 2024.

6. N. Padfield, **T. A. Camilleri**, **S. G. Fabri**, **M. Bugeja**, & **K. P. Camilleri**, "A combined EEG motor and speech imagery paradigm with automated successive halving for customizable command selection", Brain-Computer Interfaces, 1-18, July 2024.

7. Y. Ding, M. Farrugia, Y. Peng, L. Xiang and **K. Scerri**, "Combustion performance optimization of marine diesel-natural gas dual-fuel engines under low operation loads", In Journal of Physics (Vol. 2823, No. 1, p. 012013). IOP Publishing, August 2024.

8. C. Gilford, **T. A. Camilleri**, & **K. P. Camilleri**, "User discomfort in SSVEP-based BCIs - can modulation depth offer a solution?", Brain-Computer Interfaces, September 2024.

Conferences Publications (Peer Reviewed)

1. P. R Naraharisetti, M. A. Saliba, **S. G. Fabri**, "Mapping, localization and navigation for an assistive mobile robot in a robot-inclusive space", in Proceedings of the 20th International Conference on Informatics in Control, Automation and Robotics (ICINCO 2023), Vol.1, pp. 172-179, November 2023.

2. T. Camilleri, P. Farrugia, P. Refalo, **M. Bugeja**, "Towards a multi-user experience data-driven design framework for sustainable smart take-away food packaging", in Proceedings of the ASME 2024 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference IDETC-CIE 2024, pp. 172-179, November 2023. pp. 1-10, August 2024.

Peer-reviewed Abstracts

1. N. Barbara, **T. A. Camilleri**, and **K. P. Camilleri**, "Optimal bipolar channel selection for EOG-based gaze displacement estimation," in 22nd European Conference on Eye Movements (ECEM), August 2024.

2. N. Barbara, **T. A. Camilleri**, and **K. P. Camilleri**, "EOG-based ocular angle estimation without assuming equal vertical ocular angles," in 22nd European Conference on Eye Movements (ECEM), August

2024.

3. **T. A. Camilleri**, N. Barbara, **M. Mifsud**, **S. Youbi** and **K. P. Camilleri**, "GUI-free EOG-based control of smart devices," in 22nd European Conference on Eye Movements (ECEM), August 2024.

4.5.1 Non-peer reviewed articles

Blog posts and tutorials

1. Stefania Cristina How to Calculate Eigenvalues and Eigenvectors with NumPy, September 2024
2. Natasha Padfield, Decoding your internal speech, August 2024.
3. Fabian Camilleri, Did you really want to that?, July 2024.
4. Stefania Cristina How to Perform Matrix Operations with NumPy July 2024
5. Alexandra Bonnici, AI and the environment: a balancing act?, June 2024.
6. Simon Sultana, Mastering balance: a self-balancing unicycle robot, May 2024.
7. Stefania Cristina, A Gentle Introduction to OpenCV: An Open Source Library for Computer Vision and Machine Learning, January 2024
8. Stefania Cristina, How to Read, Write, Display Images in OpenCV & Converting Color Spaces, January 2024
9. Stefania Cristina, How to Read and Display Videos Using OpenCV, Janary 2024
10. Stefania Cristina, K-Means Clustering for Image Classification Using OpenCV, January 2024
11. Stefania Cristina K-Nearest Neighbors Classification Using OpenCV, January 2024
12. Stefania Cristina Image Datasets for Practising Machine Learning in OpenCV, January 2024
13. Stefania Cristina Support Vector Machines in OpenCV, January 2024
14. Stefania Cristina SVMs for Image Classification and Detection Using OpenCV, January 2024
15. Stefania Cristina Normal Bayes Classifier for Image Segmentation Using OpenCV, January 2024
16. Stefania Cristina Random Forest for Image Classification Using OpenCV, January 2024
17. Stefania Cristina K-Means Clustering in OpenCV & Application for Color Quantization, January 2024
18. Stefania Cristina Image Vector Representation for Machine Learning Using OpenCV, January 2024
19. Stefania Cristina Logistic Regression in OpenCV, January 2024
20. Stefania Cristina Logistic Regression for Image Classification Using OpenCV, January 2024
21. Aiden Bezzina, Are you looking at this?, December 2023.
22. Alexandra Bonnici, Reviewer 2 must be stopped!, October 2023.

Magazines and newspapers

1. BrainCon's non-invasive approach to thought-controlled wheelchairs, THINK magazine, Issue 43
2. LuminEye: Gazing into the future, THINK magazine, Issue 43
3. Say it out loud, THINK magazine, Issue 43
4. A Robot to Protect Your Home, THINK magazine, Issue 44

5. Professional Development

The Department members make efforts to keep abreast with new administrative, pedagogical and technological practices by following lectures, talks or courses as organised by the University of Malta and other relevant entities. The Department also maintains its commitment to offer its members the opportunity to share knowledge and experiences through the Learning Thursdays. These sessions provide a platform for academic and technical staff members, research support staff and post-graduate students of the Department, the Centre for Biomedical Cybernetics, as well as close research collaborators from other departments or institutes to discuss academic matters of common interest as well as providing final year and postgraduate students the opportunity to communicate their research work. The following summarises all the professional development activities carried out by department members during this year.

5.1 Learning Sessions

5.1.1 7th February 2024: Dr Roberta Attard

This session was delivered by Dr Roberta Attard, a chartered Clinical Psychologist with training in Social Work, Applied Systemic Theory and many other therapeutic modalities. She has been active for many years in supporting children and young persons with issues related to attachment, abuse, developmental trauma, gender identity, depression, neurodiversity, substance misuse and addictions, post-traumatic stress, anxiety, loss and bereavement amongst others and in assisting in the development of therapeutic services to provide trans-disciplinary intervention. Roberta is a full-time lecturer, supervisor, practicum coordinator, practitioner-researcher and Head of the Department of Counselling at the University of Malta and is a consultant for various young person focused Boards and State services.

The session titled 'The Weight of the Glass - otherwise known as This Thing Called Stress' looked at what stress really is from a somatic and psychological point of view, and how it affects us and those around us, with the ultimate goal of identifying and practicing ways of making it work for us rather than against us.

5.1.2 28th February 2024: Dr Ing. Rachael Duca

This session was delivered by Dr Ing. Rachael Duca regarding the research of her Ph.D studies.
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 maximises 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. This research focuses on coverage control performed by a multi-robot system when constraints are present in the system itself and in the environment. Such constraints include having a time-varying environment, where certain important regions in the environment are varying with time, battery level limitations since the energy of the robots is not unlimited, and also constraints posed by the sensory capabilities of the robots. During the past year, a modular framework for such a system was developed. Particularly, a novel region-allocation algorithm has been designed and implemented such that robots in the team are optimally allocated to the different important regions in the environment according to the requirements of each region and the capabilities of each robot.

5.1.3 20th March 2024: Final year projects

This learning session was delivered by the 4th year students who are currently carrying out their final year project with the Department. During this session, students presented their ongoing research work in a formal manner and also prepare for their upcoming viva examinations.

5.2 Courses and Training Followed by Staff Members

- While on maternity leave, in March 2024, Dr Luana Chetcuti Zammit completed the course "Creativity and Gamification Training for STEM Academics". The course is designed to support UM academics in expanding their knowledge on creativity and gamification, which can be used as part of the teaching .

- Over the past year, while on sabbatical leave, Dr Tracey Camilleri followed the courses: "The Python Bible™ | Everything You Need to Program in Python", "Learn Python Programming Masterclass", "Signal processing problems, solved in MATLAB and in Python", and "Complete neural signal processing and analysis: Zero to hero" offered by Udemy.

- In November 2023, Dr Kenneth Scerri attended the training session on "Research Ethics and Data Protection: Principles and Procedures" held at the Msida Campus.

5.2.1 Erasmus+ Staff Mobility Training Visits

- Between April 8th and 16th, 2024, Prof. Ing. Marvin Bugeja delivered a set of lectures and practical sessions at the Institute of Solid Mechanics, Mechatronics and Biomechanics of Brno University of Technology in the Czech Republic.

- Between August 12th and 17th, 2024, Dr Alexandra Bonnici visited the Department of Systems Engineering at the Colorado State University, in Fort Collins, Colorado, USA. During this visit, Dr Bonnici had the opportunity to follow a department and curriculum meeting, as well as talk with different researchers working in the fields of AR and VR, as well as document engineering.

- Between September 12th and 16th, 2024, Mr. Noel Agius visited Brno University of Technology in the Czech Republic. During his visit, he met with academics and researchers from the Institutes of

Figure 5.1: Prof. Bugeja delivering a lecture at Brno University of Technology

Solid Mechanics, Mechatronics and Biomechanics, Energy, Aerospace, and Machine and Industrial Design. The training he received was designed to deepen his knowledge in areas relevant to his professional work, provide opportunities for professional development and collaboration, and facilitate the exchange and adoption of best practices in laboratory management.

6. Research Activities and Collaborations

The Department has an active research track-record with its members actively involved in seeking research funds to support postgraduate and post-doctoral students. This section describes the work carried out through these projects.

6.1 Transdisciplinary Research and Knowledge Exchange Projects

The following two projects are financed by the University of Malta through the second call for projects issued by the Transdisciplinary Research and Knowledge Exchange (TRAKE) project ERDF.01.124.

CONAI - Artificial Intelligence for Control of Complex Systems

MAIN INVESTIGATORS: Simon G. Fabri, Kenneth P. Camilleri, and Marvin Bugeja
RESEARCH SUPPORT OFFICER: Hani Ahmed Hazza
FUNDING AMOUNT: €120,000
PROJECT LEADER: Simon G. Fabri

This project is on the design of intelligent control methodologies for complex systems that are able to operate under conditions of complexity and uncertainty, using the latest developments in Artificial Intelligence such as deep and reinforcement learning. Intelligent control offers potential for automation of equipment in, for example, control of pollution or wastewater treatment, the development of smart and reliable systems for control of active prosthetic devices, automation and control of industrial manufacturing facilities and robotic assembly infrastructures, and the development of autopilot systems and driverless/autonomous navigation. This widespread use of applications is testimony to the fact that control systems are ubiquitous in many technological areas, and that modern systems exhibit complex challenges that demand smarter controllers than traditional techniques that make use of Artificial Intelligence.

BrainCon - User-intuitive Continuous Brain Control of a Smart Wheelchair

MAIN INVESTIGATORS: Kenneth P. Camilleri, Tracey Camilleri, Simon G. Fabri and Marvin Bugeja
RESEARCH SUPPORT OFFICER: Natasha Padfield[1]
PROJECT LEADER: Kenneth Camilleri [2]

The project seeks to: (a) integrate a BCI signal to the dynamic model of a smart wheelchair; (b) develop new methods permitting multi-dimensional control signal integration to include, e.g., speed control and direction control; (c) estimate signal integration parameters by reinforcement learning to be tuned by practice; and (d) explore more intuitive mental states, such as thought speech. Combining an intuitive

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[1]Centre for Biomedical Cybernetics
[2] Prof. Ing. Kenneth Camilleri is acting in his capacity as Director of the Centre of Biomedical Cybernetics

mental state command with a paradigm of continuous BCI control would lead to a more natural brain-machine interaction resembling embodied control, making this technology more viable for people with motor impairment. The BCI experts involved in this project, two of whom are members of the Department, will contribute to the development of a BCI platform and to the investigation of alternative BCI mental states; the robot and control experts, members of the Department, will contribute to the development of the physical wheelchair model and the integration models; and a medical doctor specialising in rehabilitation medicine will contribute end-user advice and recruitment. The project is being carried out with the collaboration of the Rehabilitation Specialist-in-Training, Dr Andrei Agius Anastasi.

6.1.1   National Funding

SmartGaze - Control of devices using EOG-based eye-gaze tracking for a smart home environment

MAIN INVESTIGATORS: Tracey Camilleri, Kenneth Camilleri, Nathaniel Barbara
RESEARCH SUPPORT OFFICERS: Salah Ad-Din Ahmed Youbi, Matthew Mifsud
FUNDING BODY: MCST FUSION Smart Cities Programme
FUNDING AMOUNT: €149,982
AWARDEE: Tracey Camilleri

Being immersed in a technological environment has made it important to be able to communicate and control technological devices in a seamless, effortless manner. The standard interfaces include remote controls, applications on smartphones or tablets, or touch screens made available on the device itself. This communication modality, however, is not always suitable for individuals with limited fine motor skills who find it difficult to press small buttons on a remote control or icons on a touch screen.

SmartGaze aims to address this issue by exploiting the natural gaze interaction of human beings with devices in their environment to allow individuals with mobility impairments to control devices, such as an air conditioner or television set, using eye gaze tracking. Specifically, electrooculography (EOG) is used as the eye gaze tracking modality, together with head orientation and localisation of the individual within a smart home, to determine the device that the subject wants to control. Once locked with a device, the individual selects device specific control functions through simple eye gestures. The proposed system makes use of a wearable, wireless EOG glasses and does not require a computer screen for device function selection, making the system more practical to use.

SmartGaze thus provides a novel communication interface for individuals who lack the necessary fine motor skills to control standard interfaces, bringing forth more independence and a better quality of life as it reduces the continuous dependence on carers or family members.

EyeCon+ - Validation of Electrooculography-based Eye Tracking

MAIN INVESTIGATORS: Tracey Camilleri, Kenneth Camilleri, Nathaniel Barbara
RESEARCH SUPPORT OFFICER: Matthew Mifsud
FUNDING BODY: MCST FUSION Go-to-Market Programme
FUNDING AMOUNT: €99,970
PROJECT LEADER: Tracey Camilleri

The success of the EyeCon project, funded by the MCST Technology Development Programme, lies in controlling computer applications through electrooculography (EOG) for augmentative and alternative communication. Building upon this achievement, EyeCon+ aims to validate the software engine developed in EyeCon, which permitted continuous eye-gaze tracking using EOG while accommodating natural head movements. Comprehensive user testing will be conducted on a significant cohort of healthy participants and individuals with motor impairments, as they interact with grid-based graphical user interfaces, such as virtual keyboards and symbol-based interfaces. The quantitative results of the user testing, together with qualitative feedback obtained from these participants and collaborating occu-

pational therapists, will play a pivotal role in refining and tailoring the current engine, enhancing its applicability, and advancing it towards commercialization.

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

MAIN INVESTIGATORS: Kenneth P. Camilleri, Tracey Camilleri, Giuseppe De Giovanni [3], Fausto Caruana [3]
FUNDING BODY: RIDT Brain Research Fund of the Malta Neuroscience Network
Funding Amount: €5,000
PROJECT LEADER: Kenneth P. Camilleri

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.

   This work seeks to investigate the neural basis of grasping action in humans using spectral analysis and bandlimited ERP analysis of the motor system activity. 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.

Combined Thermal and Visual Imaging for Early Detection of Skin Cancer

MAIN INVESTIGATORS: Stefania Cristina, Kenneth P. Camilleri
RESEARCH SUPPORT OFFICER: Nipun Sandamal Ranasekara Pathiranage
FUNDING BODY: RIDT ALIVE Cancer Research Grant 2018
FUNDING AMOUNT: €60,000
PROJECT LEADER: Stefania Cristina

Early detection of malignant skin lesions is crucial for increasing the effectiveness of skin cancer treatment. Current methods for the differentiation between benign and malignant skin lesions are invasive, because they involve the removal of the skin lesion onto which a hispathology is then performed. This project, alternatively, aims for a non-invasive differentiation between benign and malignant skin lesions by exploiting a combination of dynamic thermography with visual dermoscopy using deep learning techniques. The aim is to study the thermal and visual characteristics of the human skin, in order to automatically distinguish between healthy and pathological skin regions. The use of deep learning techniques has already shown promise in improving detection rates when applied to dermoscopic images, and hence such techniques will be investigated for the purpose of this study.

6.2 Internal Research Grants

The following projects were awarded through the University of Malta Internal Research Grant funding scheme. During this academic year, all projects awarded under this scheme were allocated a grant of €1,100. A total of eight grants were awarded under this scheme.

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[3] University of Parma, Italy

Smart Control of Dynamic Systems

MAIN INVESTIGATORS: Simon Fabri
GRANT: SCERP01-24

Modern engineering systems are becoming evermore complex and thus require a certain degree of self-autonomy for appropriate operation, with as little human intervention as possible. In this context, such systems exhibit a degree of 'smartness' by making use of modern control theory for reliability and stability, coupled with adaptive techniques and artificial intelligence so as to augment the 'smartness' factor. This project aims to address such issues by designing, exploring and developing techniques that augment the degree of smartness and autonomy in systems such as robots, mechatronic devices and process plant. Theoretical and practical aspects will be considered, together with simulation studies and implementation/evaluation on laboratory-scale pilot equipment.

Investigating the feeling of space motion sickness in AR/VR

MAIN INVESTIGATORS: Alexandra Bonnici
GRANT: SCERP02-24

As augmented and virtual reality (AR/VR) headsets become more accessible, their use across gaming and educational applications has expanded, offering immersive experiences. However, prolonged exposure to AR/VR can lead to motion sickness, triggered by sensory conflicts, eye movements, or postural instability, with symptoms ranging from sweating to nausea. Since users often become engrossed in the virtual environment, they may not notice symptoms until motion sickness sets in. This project aims to detect the early onset of motion sickness to alert users before it becomes severe. Participants played two VR games known to induce motion sickness, with their movements monitored using a Vicon motion tracking system. Results showed that as game intensity increased, participants' sway patterns shifted from elliptical to circular, suggesting that contrary to existing literature, positioning vision cameras frontally and laterally may better capture sway changes linked to cybersickness.

Intelligent Traffic Junctions

MAIN INVESTIGATORS: Kenneth Scerri
GRANT: SCERP01-234

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.

Advancements in Multi-Robot Systems Control: Towards Collaborative Autonomy

MAIN INVESTIGATORS: Marvin Bugeja
GRANT: SCERP04-24

Projects in this field explore diverse aspects of control systems engineering, focusing on robot control across various platforms, such as mobile robots, and other automation systems. This year, an undergraduate project titled "A Mobile Robot for Home Security Surveillance" was undertaken. This project aims to tackle the limitations of traditional home surveillance systems, particularly blind spots caused by the fixed positions of cameras. The proposed security solution features a mobile robot equipped with
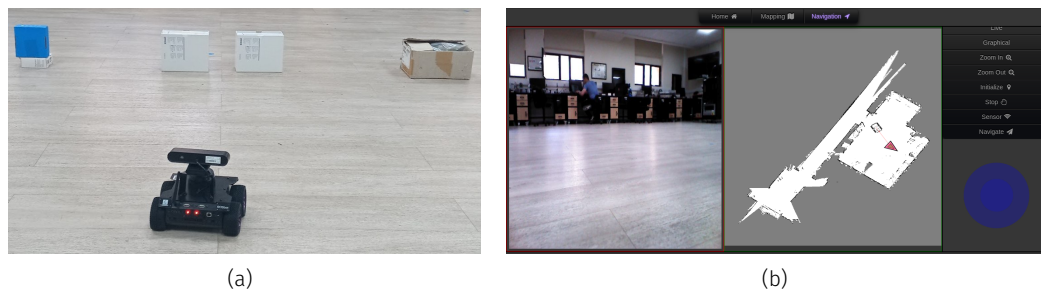
Figure 6.1: (a) Mobile robot with autonomous capabilities (b) environment map created

a camera and an array of autonomous capabilities. Additionally, it includes custom sensor modules designed to detect environmental abnormalities, such as motion, gas, and noise, all managed through a web-based user interface. The system deploys these sensors strategically within the monitored area. Upon triggering one of the sensors, the robot is wirelessly directed to navigate to the area of interest, enabling real-time monitoring without requiring human intervention. Simultaneously, the user receives an email alert, prompting him/her to access the web interface. Accessible from the internet, this interface provides a live video feed from the robot's camera and allows for manual remote control of the robot, enhancing security and responsiveness (Figure 6.1).

Vision-based eye-gaze tracking: System development and deep net gaze estimation

Main Investigators: Kenneth P. Camilleri, Stefania Cristina
Grant: SCERP05-24

Our ongoing work on vision-based eye-gaze tracking is based on classical computer vision with hand-crafted feature extraction, geometric modelling and point-of-gaze mapping. Through FUSION projects and industrial collaboration, we have developed a server-based software for eye-gaze tracking. Deep neural networks have recently been applied to eye-gaze tracking tasks, namely, iris segmentation, pupil centre localisation, head pose and gaze estimation, and point-of-regard estimation. Through this project we continue to develop the server-based system, investigate state of the art of deep network eye-gaze tracking, and integrate our existing algorithmic architecture with state of the art deep network eye-gaze tracking architectures.

Developing a practical human machine interface system

Main investigators: Tracey Camilleri
Grant: SCERP13-24

This study focuses primarily on EOG-driven human-machine interfaces, aiming to mitigate decay in gaze estimation over time. New EOG baseline wander modelling techniques are explored as a solution to enhance long-term gaze estimation. Integration of passive VOG data is also hypothesised to enrich EOG-based gaze tracking and this is investigated and validated through human subject recordings. Concurrently, research continues on brain signal-based wheelchair control using phenomena like steady-state visual evoked potentials, motor, and speech imagery. Testing these approaches on subjects during data recording sessions ensures their efficacy for practical implementation.

Intelligent Transportation Systems

Main investigators: Luana Chetcuti Zammit
Grant: SCERP14-24

The management of road congestion is of utmost importance to attain sustainable economic activity

and development. With the availability of inexpensive big traffic flow data, data mining applications can be developed which can help in reducing traffic congestion in many cities. For example, traffic events such as accidents, road closures etc. can be detected from big traffic flow data. The objectives in this research include: the investigation of the challenges involved in utilizing massive data and the investigation of emerging technologies such as blockchain to transportation.

Less Constrained Eye-Gaze Tracking for More Natural User Interaction

MAIN INVESTIGATORS: Stefania Cristina, Kenneth P. Camilleri
GRANT: SCERP15-24

This project aims to support our continued research work in developing deep learning-based methods for eye-gaze tracking, which permit the user to interact in a more natural manner under less constrained conditions. Our long-standing work on eye-gaze tracking has focused mainly on human-computer interaction, where the user sits at a distance of 60-70cm from the camera (mounted on a monitor screen) and their point-of-regard is mapped onto the monitor screen following the estimation of gaze. More recent work has been looking at applying deep learning techniques to permit eye-gaze tracking in less constrained conditions, such as to track the eye movements under shadow and occlusion, and at a lengthier distance from the camera. Hence, this project aims to continue this ongoing work, by developing deep learning-based methods for less constrained eye-gaze tracking.

6.3   Non-funded PhD Projects

Analysis on the use of EOG data during long-term use

MAIN INVESTIGATORS: Tracey Camilleri, Kenneth P. Camilleri
RESEARCH STUDENTS: Matthew Mifsud

In this technological era, the internet has become an accessible medium through which individuals connect from any point in the world through a simple click. In order to carry out different tasks on the internet, users are constantly required to operate different control input devices which range from keyboards to touchscreen devices. Operating these systems requires little to no effort from the user's end, however, such systems are not a viable option for individuals with severe mobility impairments, such as individuals suffering from Amyotrophic Lateral Sclerosis (ALS) or who are completely locked in. In such situations, users typically resort to eye gaze tracking as a suitable alternative, which enables users to communicate efficiently and lead a more independent way of life. Recent developments in electrooculography (EOG)-based eye gaze-tracking research has shown that such systems can achieve improved eye gaze-tracking accuracies, however, the tracking quality in EOG-based systems deteriorates over time. This is a primary stumbling block towards making EOG-based eye gaze tracking a viable option for users who make use of Augmentative and Alternative Communication (AAC) applications on a daily basis. To this end, this doctoral research programme (started Feb 2024 on a part-time basis) is investigating the long-term usability issues of EOG-based eye gaze tracking, in an effort to preserve the gaze tracking quality and make it a possible alternative to current videooculography (VOG)-based eye gaze tracking solutions.

6.4 Projects with Department Members as Collaborators

JUSTNature - Activation of NATURE-based solutions for a JUST low carbon transition

LOCAL INVESTIGATORS: Edward Duca [4], Kenneth Scerri and Daniel Micallef [5]
FUNDING BODY: EU H2020 LC-CLA-11-2020

Cities are major energy consumers and significantly contribute to greenhouse gas (GHG) emissions. They have a high density of socio-economic activities and a built environment design that enhance these issues. In this regard, especially developed cities can be exemplars in leading the way towards a low-carbon society, and turning it into an opportunity as recently iterated by the European Green Deal. Such advances can address several other challenges arising from urbanisation and structural socio-economic changes. Cities represent a complex setting, where low income populations are more exposed to environmental ills, environmental and climate impacts are not distributed evenly, environmental qualities are becoming increasingly exclusive to high-income households, and wealthier neighbourhoods are more biologically diverse than others. In this regard, the overall objective of JUSTNature is the activation of nature-based solutions (NbS) by ensuring a just transition to low-carbon cities, based on the principle of the right to ecological space. This in particular refers to the right to clean air and indoor/outdoor thermal comfort for human health and well-being, as well as thriving biodiversity and ecosystems. It also refers to the duty of not constraining the ecological space of others, in particular in relation to the mitigation of climate change and measures required for reducing GHG emissions. JUSTNature will contribute to this vision of shaping low-carbon cities by developing a set of typical Low carbon | High air quality NbS in seven European city practice labs. By activating their just implementation, it will drive the co-design, co-creation and co-decision of supporting interventions with regard to four innovation dimensions: 1) enabling effective governance, 2) enabling NbS system maintenance and operation, 3) enabling innovative business models and market design, and 4) enabling efficient technologies and applications.

Sit_Diab - Smart Insole Technology for the Salvage of the Diabetic Foot

MAIN INVESTIGATORS: Alfred Gatt [6], Cynthia Formosa [6] and Marvin Bugeja
FUNDING BODY: MCST FUSION R&I Technology Development Programme

This project aims to develop and validate a device in an attempt to reduce the incidence of diabetic foot complications. The technology being developed assesses the patient's risk of getting a diabetic ulcer by monitoring foot plantar pressure and temperature during walking. The technology uses Artificial Intelligence to process the pressure and temperature signals to determine areas which have a high risk of ulceration during daily activities. The proposed solution is envisaged to eventually replace traditional offloading techniques, which have been shown to be ineffective in reducing amputation rates in practice.

SALTT-CITY - A User-Experiences Based Approach for Designing Connected Speech and Language Therapeutic Toys in a Smart City

MAIN INVESTIGATORS: Philip Farrugia[7] and Simon G. Fabri
FUNDING BODY: MCST Smart Cities Thematic Programme
RESEARCHER: Mario Farrugia

The SALTT-CITY project is a multidisciplinary collaboration led by Prof. Philip Farrugia from the Department of Industrial and Manufacturing Engineering and includes members from the Department of Speech and Language Pathology and the Department of Microelectronics and Nanoelectronics. It aims to

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[4] Faculty of Education
[5] Faculty for the Built Environment
[6] Department of Podiatry
[7] Department of Industrial and Manufacturing Engineering

develop a platform which supports connected Speech and Language Therapeutic Toys (SALTTs) in a smart city environment, enabling the elicitation of user-experiences and integrating them in computer-based design support tools. This project builds upon the SPEECHIE project which took place over a period of three years during which an innovative product service system (PSS) was developed. The product in this PSS enhances the engagement of children with 'Developmental Language Disorder' during speech and language intervention, whereas the service aspect assists speech and language pathologists in monitoring children's progress during therapy in clinical and home settings. Based on evaluations carried out with Olly Speaks (the product developed in SPEECHIE), the SALTT-CITY project aims to improve this device.

Smartclap: A Real Time Hand-movement Motion Capture System for Rehabilitation of Children with Cerebral Palsy

MAIN INVESTIGATORS: Philip Farrugia [8], Simon G. Fabri and Owen Casha[9]
FUNDING BODY: MCST FUSION R&I Technology Development Programme
RESEARCHER: Mario Farrugia

This project forms part of a larger MCST-funded research programme called *SmartClap*, led by Prof. Philip Farrugia from the Department of Industrial and Manufacturing Engineering. This project is concerned with the design, implementation and testing of a Motion Capture System to track finger, wrist and arm movements of children with Cerebral Palsy (CP) while playing a Virtual Reality (VR) game purposely designed to help with their rehabilitation therapy. In addition to designing and implementing a Motion Capture Algorithm (MCA), the design, fabrication and testing of the back-end hardware and electronics is also included.

CuraClap - Conformity and Usability Risk Assessment for SMARTCLAP Commercialisation

INVESTIGATORS: Philip Farrugia [8] and Simon G. Fabri
RESEARCH SUPPORT OFFICER: Mario Farrugia
FUNDING BODY: MCST: FUSION R&I: Go-To-Market Accelerator Programme

The CuraCLAP project, which is led by Prof. Ing. Philip Farrugia from the Department of Industrial and Manufacturing Engineering, aims to bring the smart wearable device, DigiClap, developed in the Smart-Clap project, closer to market. DigiClap is intended to be used by children with Cerebral Palsy during occupational therapy of the upper limb. The project is carried out with the collaboration of staff from the Department of Occupational Therapy and the Department of Microelectronics and Nanoelectronics.

SMARTSPACK - A User-Centred Smart PlatforM for Designing and MAnufactuRing Self-SaniTising and Sustainable PACKaging

INVESTIGATORS: Philip Farrugia[8], Marvin Bugeja, Margaret Camilleri Fenech[10]
FUNDING BODY: MCST FUSION R&I Technology Development Programme

SMARTSPACK aims to develop a novel sanitising solution, integrated in the packaging, such that the user is invariably bound to sanitise their hands before consuming the edible product inside the packaging. A user-centred design (UCD) approach will be employed in the design, to ensure that the consumer is satisfied with the smart packaging. Thus, contributing to the overall good user-experience of the end-user. Furthermore, design for sustainability principles will also be employed. Environmental and ethical concerns are also becoming increasingly important in consumers' product choices. Moreover, end-users would be able to input their demographics and feedback of experiences with the packaging

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[8] Department of Industrial and Manufacturing Engineering
[9] Department of Microelectronics and Nanoelectronics
[10] Institute for Climate Change and Sustainable Development

through the SMARTSPACK platform. Their experiences will be measured using metrics such as (i) Type of package, (ii) Ease of opening, (iii) Ease of application, (iv) Satisfaction with sanitiser amount, and (v) Satisfaction with sanitiser properties such as viscosity. The outcomes from the SMARTSPACK platform will be used by the intelligent cloud to infer the right amount of sanitising solution to the respective packaging being fabricated. This will be achieved with the application of big data analytics on smart packaging production.

Operation Tom - Enhancing Astronaut Neuro-Imaging Capabilities: Toolbox Optimization and Modification

INVESTIGATORS: Claude Bajada [11] and Kenneth Scerri
FUNDING BODY: MCST Space Upstream Thematic Programme 2023

While changes to brain structure resulting from spaceflight have been extensively studied, limited research has focused on brain function. To fill this void, the project aims to enhance the capabilities of the Vogt-Bailey (VB) toolbox, a software developed by the BOB Lab at the University of Malta in conjunction with external collaborators. This toolbox is specifically designed to identify patterns of homogeneity in brain activity at the scale of a few millimetres. In its current form, however, the VB toolbox's assessment of local brain function may not consistently reflect the underlying biological mechanisms due to limitations that inadvertently amplify homogeneity at a small scale. These limitations do not arise from poor construction of the toolbox, but as a natural consequence of the preprocessing of fMRI data. The scientific approach involves accurately quantifying the impact of the resulting artefacts, and subsequently developing mitigation measures by exploring adjustments to standard preprocessing methods and/or employing data reconstruction techniques. The toolbox will also be adapted to spaceflight-specific factors such as the upward shifting of the brain and the enlargement of the ventricles, as these could potentially interfere with the data analysis.

BRIAN - A User-Centred Smart PlatforM for Designing and MAnufactuRing Self-SaniTising and Sustainable PACKaging

INVESTIGATORS: Claude Bajada [11] and Kenneth Scerri
FUNDING BODY: RIDT cancer research grant 2023

The BRIAN project aims to develop predictive models for tumour failure locations. Our goal extends beyond understanding current tumour behaviour. We aim to improve the effectiveness of treatment by helping clinicians anticipate future tumour spread. This means refining surgical planning to ensure that resection margins not only cover the existing tumour but also areas likely to be involved in future propagation. By doing so, we aim to reduce instances of tumour treatment failure, which are often due to undetected tumour spread during initial treatment. By enhancing the precision of tumour resections and the effectiveness of glioblastoma treatment strategies, our project holds promise to improve life expectancy for glioblastoma patients and reduce the morbidity associated with tumour recurrence. This represents a major advancement in the field of neuro-oncology and a significant stride towards our ultimate goal: a world where high grade gliomas are no longer a death sentence, but a condition that can be effectively managed and treated.

BIMA - Dual fuel engine technology and dynamic behaviour Improvement for MArine Application

INVESTIGATORS: Mario Farrugia [4] and Kenneth Scerri
FUNDING BODY: MCST Sino-Malta Fund 2021

Dual Fuel engines enable the use of alternative fuels like Liquified Natural Gas (LNG). Using LNG as the

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[11]Department of Physiology & Biochemistry

primary energy source with a smaller amount of diesel (to initiate combustion) reduces emissions. Dual fuel use, rather than relying solely on gaseous fuel, offers flexibility in fuel supply, avoiding logistical or operational limitations. However, dual fuel operation is affected by a phenomenon known as knocking, which restricts the engine's operational range and is exacerbated during transients. Project BIMA aims to mitigate knocking through precise control of fuel delivery. Collaborators include Harbin Engineering University (HEU), China, and industrial partners Gozo Channel and Henan Diesel Engines.

SIDec - Enhancing Speech Imagery Decoding for EEG-based Brain-Computer Interface Systems

INVESTIGATORS: Kenneth P. Camilleri [12], Tracey A. Camilleri, Natasha Padfield [12]
FUNDING BODY: MCST Sino-Malta Fund

Speech imagery (SI) is a brain-computer interface (BCI) paradigm which can enable subjects to intuitively control external devices such as graphical user interfaces or robots in a hands-free manner, by using just their thoughts. However, the widespread use of the SI paradigm has been impeded by the relatively low decoding accuracies obtained when using electroencephalogram (EEG) data, which is a leading non-invasive method of reading brain signals. These low accuracies lead to poor and unrobust BCI performance. This project aims to investigate novel and innovative signal processing, machine learning, and deep learning techniques to improve the accuracy of SI decoding. It also proposes an investigation into fundamental aspects of SI, including the impact of background noise (such as music) on data quality, and how the detection rate of words varies for a vast lexicon. Finally, the findings of this project will be further explored and validated through the implementation of online SI BCIs that the user can interact with. From a technical perspective, this project aims to investigate the scalp regions and frequency bands that are most important for SI decoding. It also aims to investigate the efficacy of various classifiers for SI decoding as well as novel knowledge-based, and collaborative learning techniques to improve the decoding of SI.

EyeTrack - Robust EOG-based Eye-Gaze Tracking under Varying Illumination Conditions

INVESTIGATORS: Nathaniel Barbara [12], Tracey Camilleri, Kenneth Camilleri
FUNDING BODY: Research Excellence Programme 2023

Technological advancements have enabled various ways for people to interact with devices, such as touchscreens, voice commands, and hand gestures, but these can be difficult for those with impaired fine motor skills, like stroke or ALS patients. Since their oculomotor function is typically intact, eye movement-based human-computer interfaces (HCI) offer a viable alternative. The EyeTrack project explores electrooculography (EOG) to develop these systems by capturing bio-signals from the eyes using electrodes placed around the face. The research aims to improve gaze estimation by examining different electrode configurations and combinations, optimizing both hardware design and signal processing. Additionally, it addresses inconsistencies regarding how illumination affects EOG signals. While some studies suggest minimal impact, the Arden Ratio clinical test indicates that EOG amplitudes can vary significantly between dark and light conditions, affecting gaze accuracy. The project seeks to develop methods to counteract these variations, thereby enhancing the robustness and readiness of EOG-based technology for users needing alternative communication channels.

BrainWeb - Developing a low-cost brain-native web browser

INVESTIGATORS: Chris Porter [13], Tracey Camilleri, Kenneth Camilleri
FUNDING BODY: University of Malta Research Excellence Programme 2023

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[12]Centre for Biomedical Cybernetics
[13]Department of Information Systems

This project overarching objective is to provide people living with severely restrictive motor limitations access to the internet, and in turn all that it affords. This includes connecting and communicating with other people, learning, working, entertainment, and other activities at the core of what it means to being human. The state of the art presents little to no real opportunities for persons living in a locked-in state to act in an unbounded manner on the web, and this project aims to produce novel assistive technology, with low adoption barriers, for use outside specialised lab environments. The research questions being addressed are the following:

- How can the presentation of stimuli be optimised to afford better performance, throughput, and ergonomics?
- What architectural considerations are required to ensure the browser works efficiently at scale?
- Which EEG headsets can be used reliably for this purpose while ensuring cost-effectiveness, ease of setup and maintenance as well as comfort in long term use?
- Based on the outcomes of the above questions, what considerations are necessary to ensure the browser is ready for use by the public? This involves considerations such as usability, ease of access, security, privacy as well as performance.

7. New Facilities

The Department makes efforts to acquire new equipment to support its research activities. This equipment was funded through University's Capital Funds, Department funds, as well as individual Research funds. A list of new equipment obtained during this academic year is listed hereunder.

ARCANE VR CAVE An immersive projection-based virtual reality (VR) CAVE (Cave Automatic Virtual Environment) was installed in a VR area within the Signal, Image and Motion Analysis Laboratory within the ERIL building. The CAVE has 4 laser projectors and 4 OptiTrack cameras for motion capture and tracking of individuals within the environment (**Figure 7.1(a)**).

Laboratories inauguration The Control Systems and Robotics Laboratory, Signal, Image and Motion Analysis Laboratory, and Intelligent Transport Systems Laboratory within the ERIL building were inaugurated in February 2024 as part of the TRAKE project. This also included the arrival of a number of high-end computers which shall be used by researchers within these laboratories (**Figure 7.1(b)**).

(a)   (b)

Figure 7.1: (a) Installation and training of the VR CAVE, (b) Discussing the Department's research during the ERIL building inauguration

8. Public Outreach

The Department members continued their efforts to disseminate the research work carried out within the department to the general public as well as to share the love for all engineering with school children. This can be observed by the public engagement activities carried out by department members during the academic year, participating in annual events as well as other ad-hoc invitations by schools. These are listed below.

8.1 Organisation and Participation in the Faculty of Engineering Technology Clubs

The Department participated and led the Engineering Technology Clubs, offering 11 workshops to different middle schools, reaching over 400 students who are about to make their 'options' choices. Dr. Bonnici organised these visits, with administrative support from Ms Sanchia Cilia Lentini. Dr Bonnici also delivered a workshop on robotics and spoke to the students about career paths towards engineering degree courses during these visits.

8.2 Engineer your career

On the 8th of November 2023, Dr Stefania Cristina represented the Department in the Engineer your Career live event organised by the Chamber of Engineers at the Mediterranean Conference Centre, Valletta.

8.3 World Children's Day

On the 19th of November 2023, the Department celebrated World Children's Day by participating in the weekend events at Esplora. Dr Alexandra Bonnici showcased the Alpha Mini and Hexapod at Esplora during the event (**Figure 8.1**).

(a)   (b)

Figure 8.1: Particiaption in World Children's Day

Figure 8.2: Participation in the "She Can" campaign: (a) Dr Alexandra Bonnici talking to students at Maria Regina College with Prof. Jean Calleja Agius and Dr Danielle Farrugia, (b) Prof. Fabri at the inauguration in Parliament.

8.4 Unconventional Science Careers, #STEAM@UM

On the 30th November and the 1st December 2023 the University held its second Unconventional Science Careers day #STEAM@UM, during which around 300-500 Year 8 students coming from different schools visited labs at the Faculties of Science, Engineering, ICT, Built Environment, and Education. As part of this event, the Department opened up its Biomedical Engineering Lab, where Dr Stefania Cristina, Mr Matthew Mifsud and Mr Jean Gauci met with groups of students and explained to them the research work that the Department typically engages in.

8.5 Participation in the "She Can" Campaign

The "She Can" campaign is an initiative undertaken as part of a global initiative by the Royal Academy of Science Intentional Trust (RASIT) to advocate for equity, diversity and inclusion in all areas of science, and to place these issues at the heart of the world's attention by organising a year-long celebration. As part of this campaign, Dr Alexandra Bonnici featured in the poster exhibition that was exhibited in secondary schools, parliament, the Esplora science centre and Science in the City. Prof. Simon Fabri and Dr. Bonnici were attended the inauguration ceremony in parliament on the 15th of February. In addition, Dr Bonnici spoke at the following schools (**Figure 8.2**):

- Our Lady Immaculate, Hamrun on the 15th January, 2024
- Maria Regina College, Mosta on the 2nd February, 2024
- St Margaret College Middle School, Bormla on the 18th March, 2024
- St Benedict College Secondary School, Kirkop, on the 8th April, 2024

8.6 Guidance Teacher CPD

On the 28th February 2024, a group of 35 guidance teachers visited our labs from different schools as part of their CPD training - the theme was Engineering Education and the teachers were given an introductory talk about the engineering sector by Dr Ing. Bonnie Attard and Ing. Robert Busuttil from the Chamber of Engineers, followed by a tour around various laboratories in the Faculty of Engineering, ending the training session with a talk about the courses offered by the Faculty of Engineering.

8.7 KurzitaJiem

On the 9th and 10th of May 2024, Dr Stefania Cristina, Dr Nathaniel Barbara, and Mr Matthew Mifsud participated in the KurzitaJiem event held at Esplora and demonstrated ongoing research work on robots and the use of EOG for the development of human-computer interfaces.

(a)   (b)

Figure 8.3: Participation in Science in the City Festival

8.8 Science in the City 2024

On the 27th of September 2024, the Department participated in the annual Science in the City festival. Dr. Stefania Cristina, Prof. Tracey Camilleri, Dr. Nathaniel Barbara, Dr. Natasha Padfield, Mr. Matthew Mifsud, Mr. Nipun Sandamal Ranasekara Pathiranage, and Mr. Salah Ad-Din Ahmed Youbi presented demos to highlight the use of eye-gaze tracking and electroencephalography (EEG) to control computer applications and smart devices (**Figure 8.3**). Dr Kenneth Scerri, representing the Boundaries of the Brain (BoB) Laboratory, shared their research on studying brain activity through MRI scans. At the lab, Dr. Scerri is involved in a variety of research projects, including those that focus on analyzing tumor growth in adults and exploring how space travel affects brain activity. Prof. Marvin Bugeja was present alongside the two UM teams he is mentoring, who will be competing in the upcoming IEEE Robotics Championships 2024. Mobile robots built by students for previous competitions, as well as Niryo—a six-degree-of-freedom robotic arm, were displayed.

8.9 Additional Talks and Laboratory Visits

Department members were involved in lab visits and career talks on request from schools, and other departments as follows:

- 2nd of November, 2023: Mr Matthew Mifsud hosted a group of sixth formers from Sir M. A. Refalo Sixth Form, Gozo at the Biomedical Engineering Laboratory.

- 13th November, 2023: Dr Alexandra Bonnici participated in "Fuel Your Potential" career talk to students at St Monica, Gzira.

- 11th of December, 2023: Dr Alexandra Bonnici hosted a group of sixth form students from De La Salle College Sixth Form at the Control Systems and Biomedical Engineering Laboratories.

- 13th of March, 2024: Prof. Tracey Camilleri visited De La Salle College to talk about the role of an engineer in everyday life to a group of year 2 students.

- 22nd of January, 2024: Dr Stefania Cristina hosted a group sixth formers from St Aloysius College sixth former at the Biomedical Engineering Laboratory.

- 13th of March, 2024: Mr Matthew Mifsud hosted a group of sixth formers from the Junior College at the Biomedical Engineering Laboratory.

- 20th of March, 2024: Prof. Ing. Marvin Bugeja talked about a career in Engineering to fifth form students at the St Aloysius College careers day.

- 20th of May, 2024: Dr Alexandra Bonnici, Dr Nathaniel Barbara and Mr Matthew Mifsud hosted a group of occupational therapy students when they demonstrated the different equipment and research carried out in the labs.

(a)   (b)

Figure 8.4: Hosting students following the BSc in Occupational Therapy different technologies that can be used to assist with occupational therapy: (a) the CAVE and (b) the smart wheelchair

8.10 Discussion about Research Projects

Department members were also engaged in public talks about specfic research projects as follows:

8.10.1 Appearance on Radio Mocha

On the 25th of January 2024, Prof. Tracey Camilleri and Dr Nathaniel Barbara participated in an interview on the radio program Radio Mocha, hosted by Danielle. During this interview, they spoke about the Department's ongoing research on EOG-based eye gaze tracking and related projects, including EyeTrack project funded by the MCST under the Research Excellence Programme, the SmartGaze project funded by the MCST under the Smart Cities Programme, and the EyeCon+ project funded by the MCST under the Go-To-Market Accelerator Programme.

8.10.2 THINK Soapbox: Cyberspace

On Monday 18th March 2024, Dr Alexandra Bonnici and Dr Stefania Cristina presented a talk on the Doc2Speech and LuminEye projects at the THINK Soapbox: Cyberspace.

8.10.3 Julian's Tech Talk

On the 25th April, 2024, Dr Natasha Padfield spoke about her research during a Julian's Tech Talk session "Brain-Computer Interfaces: Controlling Computers Using Just Your Mind".

9. Prizes, Awards and Appointments

9.1 Elections and Appointments

- On the 19th of February 2024, Dr Alexandra Bonnici was elected as the new president of the Malta Chamber of Scientists.

- On the 27th of April 2024, Dr Alexandra Bonnici was elected as a Senior Member of the ACM.

- On the 24th of August 2024 , Dr Alexandra Bonnici was nominated as the Chair of the Steering Committee of the ACM Symposium on Document Engineering (DocEng).

9.2 Staff Promotions

- In October 2023, Dr Stefania Cristina was promoted to Senior Lecturer.

- In January 2024, Ms Sanchia Cilia Lentini was promoted to Administration Specialist within the Department of Systems and Control Engineering.

- In July 2024, Prof. Marvin K. Bugeja and Prof. Tracey Camilleri were promoted to Associate Professors.

9.3 Recognition of Service

- On the 15th of December 2023, Prof. Marvin K. Bugeja was awarded an appreciation award for his contribution to the IEEE Region 8 Robot Championship 2022, during the IEEE awards night. During this championship, he delivered a number of workshops to all participants and mentored the UM team.

(a)   (b)

Figure 9.1: (a) Prof. Marvin Bugeja receiving an award for contribution to the IEEE Region 8 Championship, (b) Celebrating with the MSc graduates Simon Sultana, Cheryl Guilford, Fabian Camilleri and Aiden Bezzina

9.4 MSc Awards

- On the 11th of March 2024, Ms Cheryl Gilford, Mr Fabian Camilleri, and Dr Mario Farrugia were awarded the degree of MSc in Engineering.

- During the same graduation, Mr Aiden Bezzina and Mr Simon Sultanta were awarded the degree of MSc in Signals, Systems and Control.

9.5 Ph.D Awards

- In May 2024, Dr Ing. Rachael Duca was awarded the degree of Ph.D. in Engineering.

10. Social Activities

Alone we can do so little; together we can do so much.

Helen Keller

The Department of Systems and Control Engineering values the importance of teamwork and recognizes that our contributions to society can be enhanced when we work well together. To encourage stronger relationships, the department organizes activities that take place outside the typical office or lab environment. On the 5th of February, department members joined colleagues from the Faculty of Engineering and the Faculty of Science for a walk from the University to Gzira Marina, supporting the Smiling with Jerome Foundation to raise funds for Chemo Bags of Hope. On the evening of Thursday, 28th March, several members participated in the Good Friday Puttinu walk from Mellieha to Valletta in support of cancer patient care. A team-building event was also held in Gozo on the 2nd of April, where department members visited Dbiegi Crafts Village and Ta' Pinu in Gharb, played a game of Mafia, and had lunch in Ghajnsielem. This event was planned and coordinated by Ms. Sanchia Lentini. Additionally, on the 10th of June, Dr. Alexandra Bonnici organized an outdoor picnic for the department. These activities provide opportunities to strengthen connections within the team in a more informal setting.

(a)

(b)

(c)

Figure 10.1: (a) Organising a lunch-break walk in aid of Similing with Jerome, (b) Participating in the Good Friday walk in aid of Puttinu Cares, and (c) A group photo at the department team building event in Gozo

11. 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
- our **Blog page**: www.systemsandcontrol.com/

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

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