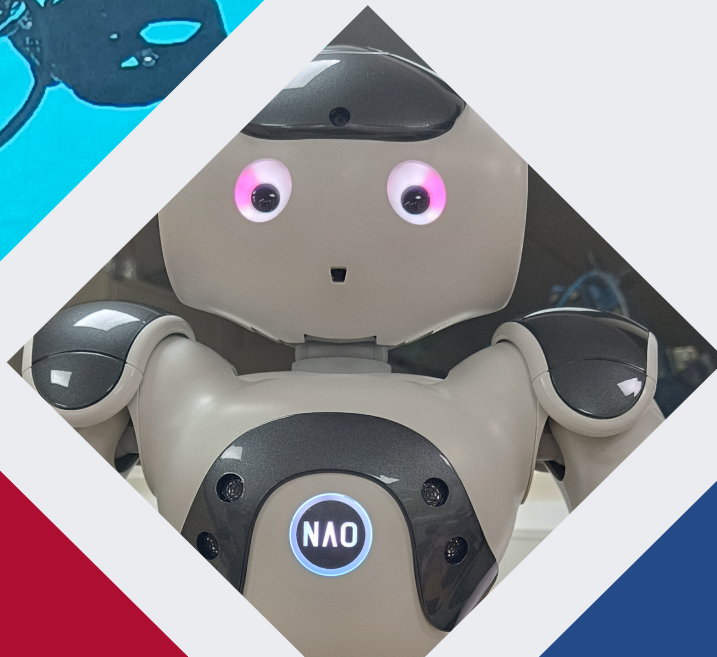L-Università ta' Malta
Faculty of Engineering

Department of Systems
& Control Engineering

Annual Report
2022 - 2023

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 IV	1
Research Support Officer II	2
Research Support Officer I	4

Research Projects   17

Research Funds Disbursed During 2020/21

International Funds	€71,340
National Funds	€121,932
Internal Funds	€8,800

Student Supervision

Supervision/Co-supervision of B.Eng. Final Year Students	2
Supervision/Co-supervision of M.Sc. by Research Students	10
Supervision/Co-supervision of M.Sc. in Signals, Systems and Control	2
Supervision/Co-supervision of M.Phil./Ph.D. Students	7
Supervision of Internships	3

Peer-reviewed Publications

Edited Books	1
Journal papers	7
Conference papers	9
White papers	2

Teaching Activities

Postgraduate study units	16 (>90 ECTS)
Undergraduate study units	22 (111 ECTS)
Pre-tertiary study units	4 (20 ECTS)

Outreach Events

Public engagement events	5
Student outreach events	13

1. Foreword

> I've learned that people will forget what you said, people will forget what you did, but people will never forget how you made them feel.
>
> *Maya Angelou*

Time is a relentless sprinter, and another year has passed, the third since I have been entrusted to lead this department. In reflecting upon this past year, I want to share some points that have define our department's achievements this year.

Firstly, I must recognise the positive feedback that our students provide, be it through the formal evaluation of the study units, but also through the informal mid-semester chats with the students. I am grateful not only for the positive experience that the department academics are providing our students, but also for the ability to be humbly accept the feedback provided to continue to improve the service we give the students. This is a quality that no amount of teaching effort metrics can ever quantify, and yet, it is the quality that I take most pride in.

The year was a busy one from a teaching perspective, having the MSc in Signals, Systems and Control running for the third iteration. Nevertheless, the department remained active in all its other endeavours. We continued our research contribution, maintaining excellence in ongoing research projects while applying for new ones. We renewed our commitment to public engagement and outreach, organising and delivering the Faculty Technology Clubs, as well as actively participating in events such as Science in the City, the STEAM fair, and other outreach initiatives. We maintained our involvement in faculty and university administration by contributing to several boards. We have also contributed to the scientific community both on a national level, through involvement in the National STEM Engagement group and the MGPEI for example, as well as the international community by serving as steering committee members in the various communities we are involved in. The year has not been without challenges, the most notable has been the availability and strength of ChatGPT which required some thoughts on the approach to student assignments. Our department members adapted by ensuring that assignments test the students' critical thinking skills and hence their understanding of the subject matter. On a personnel note, Mr. Jean Gauci transitioned to new opportunities outside the university, and we extend our best wishes for his career development. Simultaneously, we welcomed Mr. Matthew Mifsud as he joined our team as a Systems Engineer, marking a positive development for our team.

On a personal level, what struck me most this year, as we navigated changes and challenges is the strength and solidarity that can be obtained from our small community. John Donne's "No man is an island entire of itself" never rang truer.

I am grateful for the effort and commitment of each member of the Department. Thank you! and let's have another successful year ahead.

Dr Alexandra Bᴏɴɴɪᴄɪ
Head of Department
6th December 2023

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, MACM*

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*

Senior Lecturers

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

Dr Peter A. C. Varley *M.Sc., Ph.D. (Cardiff University) (until October 2022)*
Dr Srimanta Santra, *M.Sc., Ph.D. (Anna University) (from February 2023 until July 2023)*

Research Support Officer II

Mr Andre Tabone, *B.Eng. (Hons.) (Melit.), M.Sc.(Eng.)*
Mr Luke Abela, *B.Eng. (Hons.) (Melit.), M.Sc.(QMUL)*

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.)* (until July 2023)
Ms Nicole Bonnici, *B.Eng. (Hons.) (Melit.)*
Ms Erika Spiteri Bailey, *B.Eng. (Hons.) (Melit.)* (until January 2023)

Systems Engineers

Ing. Rachael Duca, *B.Eng. (Hons.) (Melit.), M.Sc.(Eng.)*
Ing. Jean Gauci, *B.Eng. (Hons.) (Melit.), M.Sc.(Eng.) (until July 2023)*
Mr Matthew Mifsud, *B.Eng. (Hons.) (Melit.), M.Sc.(Eng.), (from July 2023)*

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
  - 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
  - Doctoral School Board
  - PhD and Research Master Degrees Scholarship Board (co-Chair)
  - Board of the Institute of Physical Education and Sport (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
- 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

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

Dr 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

Dr Tracey Camilleri

- Board Member of the Centre for Biomedical Cybernetics

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 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

- Coordinator of the Department's Learning Thursdays
- Chair of the Executive Team of the IET Vision & Imaging Technical Network
- Chair of the Malta Group of Professional Engineering Institutions (MGPEI)
- Representative of the MGPEI on the steering committee of the MEDPOWER conference
- Assists in the evaluations of project proposals submitted to various Horizon 2020 calls

Dr Ing. Luana Chetcuti Zammit
- A member of the SEC Engineering Technology syllabus panel
- Coordinator of the MSc in Signals Sytems and Control
- A member of the FREC
- A member of the Faculty Sustainable Committee

Ms Sanchia Cilia Lentini
- Administrative assistance with the 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 peer review
Prof. Fabri is a reviewer on several academic journals and is a review committee member or associate editor for several 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"

- Co-investigator for the MCST National R&I Fusion funded projects:
  - R&I-2017-002-T "Deep-FIR"
  - R&I-2017-028-T "MAProHand"
  - R&I-2018-012-T "EyeCon"
  - R&I-2018-004-T "NIVS"
  - Smart Cities Thematic Funding Programme project SCP-2022-010 "SmartGaze"

- Co-investigator for the MCS Research Excellence Programme funded projects
  - REP-2022-002 "LuminEye"
  - REP-2023-022 "EyeTrack"

- Co-investigator for the TRAKE projects
  - "CAMVISM"
  - "EyeDesign"
  - "CONAI"

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

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 several journals including 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 various international programme committees of several international conferences, including the:

- ACM Symposium of Document Engineering,
- Annual International Conference of the IEEE Engineering in Medicine and Biology Society
- 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 "A vision for human-centred future cities" (VARCITIES).
- H2020 project "Activation of NATURE-based solutions for a JUST low carbon transition" (JustNature).
- Two-year research collaboration with ST Microelectronics (Malta).
- Internal seed fund Be-BoB (Beyond Boundaries of the Brain) project.
- FUSION: R&I Research Excellence Programme project MARC (Measuring the ARchitecture of Consciousness).

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 the International Journal of Systems Science and various international scientific conferences.

Dr Ing. Marvin K. Bugeja

Dr 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

Dr Bugeja is an associate editor on the EUCA Conference Editorial Board, and is reviewer and programme committee member for several international conferences and journals.

Contributions to local and international networks

Dr 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 2022

Dr Tracey Camilleri

Dr 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). During this past year, Dr Camilleri has been on sabbatical leave. Specific scholarly contributions carried out during this academic year are listed below.

Contributions to research projects

- Principal investigator for the:
    - MCST National R&I FUSION-TDP funded project R&I-2018-012-T "EyeCon"
    - MCST FUSION Smart Cities Thematic Funding Programme project SCP-2022-010 "SmartGaze"
- Co-investigator on the projects:
    - RIDT Malta Neuroscience Network Brain Fund Award "DeepMotionBCI"
    - "BRAINCON", funded by TRAKE

Contributions to peer review

Dr 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"
- Co-investigator on the TRAKE "EyeDesign" project

Contributions to peer review

Dr Bonnici is a reviewer or programme committe member for journals and conferences including:
- The Eurographics Workshop on Sketch Based Interfaces and Modelling
- 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.

Contributions to local and international networks

Dr Bonnici is a member of the steering committee of the ACM International Symposium on Document Engineering.

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:
  - TRAKE "EyeDesign" project
  - MCST Research Excellence Programme funded project REP-2022-002 "LuminEye"
- 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: Identifying Neural Functional Connectivity from MRI Data
STUDENT: Katrina Mugliett
SUPERVISOR: Dr Kenneth Scerri
CO-SUPERVISOR: Dr Claude Bajada

PROJECT TITLE: Development of a Teleoperation System for the Franka Emika Panda Cobot
STUDENT: Amarnath Venkatachalam
SUPERVISOR: Prof. Ing. Michael A. Saliba
CO-SUPERVISOR: Dr Ing. Marvin Bugeja

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: Dr 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: Dr Tracey Camilleri

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

PROJECT TITLE: Anomaly Detection on Smart Meter Data
STUDENT: Mr Michael Farrugia
SUPERVISOR: Dr Kenneth Scerri
CO-SUPERVISOR: Dr Andrew Sammut [1]

PROJECT TITLE: A Real Time Hand-movement Motion Capture System for Rehabilitation of Children with Cerebral Palsy
STUDENT: Mr Mario Farrugia

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[1]Department of Electronic Systems Engineering

SUPERVISOR: Prof. Ing. Simon Fabri
CO-SUPERVISOR: Dr Ing. Owen Casha [2]

PROJECT TITLE: Pedestrian Detection and Pose Estimation for Intention Recognition in Autonomous Vehicles
STUDENT: Mr Gilbert Vassallo
SUPERVISOR: Dr Ing. Stefania Cristina

PROJECT TITLE: Integrating Contextual Cues in Pedestrian Behaviour Prediction for Autonomous Driving
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 [3]
CO-SUPERVISOR: Dr Kenneth Scerri

PROJECT TITLE: Anomaly Detection in Visual Road Traffic Data STUDENT: Ms Nicole Bonnici
SUPERVISOR: Prof Adrian Muscat [4]
CO-SUPERVISOR: Dr Kenneth Scerri

PROJECT TITLE: Multi-Camera Tracking of Road Vehicles
STUDENT: Mr Pierre Zahra
SUPERVISOR: Prof Adrian Muscat [4]
CO-SUPERVISOR: Dr Kenneth Scerri

4.2.3 Taught M.Sc. in Signals, Systems and Control Students

PROJECT TITLE: Detecting Multiple Object Eye Contact from a 3rd View Camera
STUDENT: Mr Aiden Bezzina
SUPERVISOR: Dr Ing. Stefania Cristina
CO-SUPERVISOR: Prof. Ing. Kenneth P. Camilleri

PROJECT TITLE: Design and Development of a Unicycle Robot
STUDENT: Mr Simon Sultana
SUPERVISOR: Prof. Ing. Simon Fabri

4.2.4 M.Phil. / Ph.D. Students

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

PROJECT TITLE: Electrode Modelling for Applications of Functional Electrical Stimulation
STUDENT: Ms Mary Grace Cassar [5]
SUPERVISOR: Prof. Cristiana Sebu [5]
CO-SUPERVISOR: Prof. Ing. Kenneth Camilleri

[2]Department of Microelectronics and Nanoelectronics
[3]Department of Physiology & Biochemistry
[4]Department of Computer and Communications Engineering
[5]Department of Mathematics

PROJECT TITLE: Analysis of Temperature Transient Patterns using Dynamic Infrared Thermography
STUDENT: Mr Jean Gauci [6]
SUPERVISOR: Dr Owen Falzon [6]
CO-SUPERVISOR: Prof. Ing. Kenneth Camilleri

PROJECT TITLE: Towards More Compact Chip to Chip Communication Methods
STUDENT: Mr Andre Micallef [7]
SUPERVISOR: Dr. Ing. Marc Anthony Azzopardi [7]
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

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 [8]
SUPERVISOR: Prof. Michael Saliba [8]
CO-SUPERVISOR: Prof. Ing. Simon G. Fabri

PROJECT TITLE: Dual Fuel Engine Dynamic Behaviour Improvement Through Control Techniques
STUDENT: Mr Anthony Theodore Saliba
SUPERVISOR: Prof. Mario Farrugia [8]
CO-SUPERVISOR: Dr Kenneth Scerri

4.2.5 Internships

PROJECT TITLE: Investigating Blockchain Technology
STUDENT: Mr Tarek Latef
SUPERVISOR: Dr Ing. Luana Romano

PROJECT TITLE: Application of Artificial Intelligence to Music Analysis and Interpretation
STUDENTS: Ms Sena Ceper and Ms Beyza Keyhan
SUPERVISOR: Dr Alexandra Bonnici

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)

[6]Centre for Biomedical Cybernetics
[7]Department of Electronic Systems Engineering
[8]Department of Mechanical Engineering

- 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)

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

Table 4.1: Undergraduate study units offered by the Department in 2020/2021

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

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		
ENR5006	Research Methods for Engineers (part of)	5
ENR5026	Science Communication in Engineering (part of)	5
GSC5504	Instrumentation and Ocean Data Systems (part of)	10
ARI5321	Automation and Applied Robotics (part of)	5

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 23rd June until the 25th June, two M.Sc. by Research students, Mr Shawn Darmanin and Mr Fabian Camilleri, participated in presenting their M.Sc. work during the Engineering Exhibition organised by the Faculty of Engineering.

4.4.2 Engineering Students Summer Training Course

Between the 3rd of July and the 9th of August 2023, 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. More-over, 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, 16 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 International Week, Universite De Lorraine, Nancy, France

Between the 23rd and the 256th of May 2023, Dr Alexandra Bonnici and Dr Ing. Stefania Cristina represented the Department and the University of Malta at the International Week held at the Universite De Lorraine, Nancy, France (refer to Figure 4.1 (a)) . As part of the week's activities, Dr Bonnici and Dr Cristina delivered two lectures on the topics of computer vision and deep learning to Electrical engineering students at the Universite de Lorraine, while re-kindling discussions for collaborations the two institutions.

4.4.5 Erasmus visit - Lecturing and Research visit at Brno University of Technology, Czech Republic

Between the 9th and 18th April 2023, Dr Ing. Marvin Bugeja visited (through Erasmus+) the Department of Mechatronics at Brno University of Technology (BUT), hosted by the head of department Prof. Robert Grepl. During his visit, Dr Bugeja delivered several lectures and practical sessions on "Nonlinear Control Systems", and "Technical Report Writing and Presentations", to groups of undergraduate and postgraduate students (refer to Figure 4.1 (b)). Moreover, he discussed a number of possibilities for future internships, joint research projects and extended lecturing visits between the two departments. As a result of this collaboration, a PhD candidate from BUT is expected to do an internship at our department in 2024.

4.4.6 University of Malta Research Expo 2023 - UMRE 2023

Department members participated in the first University of Malta Research Expo 2023 held on Wednesday 17th May 2023 and which was organised under the pro-rectorate's office of Prof. Ing. Simon Fabri, who is also one of the senior members of our department. During this expo, department members presented four posters showcasing ongoing research works on:

EOG-based eye-gaze tracking presented by Dr Tracey Camilleri, Prof. Kenneth Camilleri, Dr Nathaniel Barbara and Mr Matthew Mifsud

Bayesian modelling of neural connectivity from MRI imagery presented by Dr Kenneth Scerri

Analysis of traffic data from soical media presented by Dr Luana Chetcuti Zammit

Text binarisation and segmentation presented by Dr Alexandra Bonnici, Dr Stefania Cristina, Mr Luke Abela and Mr Andre Tabone

Figure 4.1: Academic activities carried out by SCE members. (a) Dr Alexandra Bonnici and Dr Stefania De Battista Cristina participating in the staff week at the Universite De Lorraine, Nancy, France, (b) Dr Ing. Marvin Bugeja during one of his practical lab sessions at the Brno University of Technology in Czechia, (c) Dr Alexandra Bonnici delivering a tutorial alongside with Prof Steven Simske during the 23rd ACM Symposium on Document Engineering, (d) Dr Stefania Cristina delivering a tutorial during the 23rd ACM Symposium on Document Engineering.

In addition, Ing. Rachael Duca delivered a talk on her Ph.D. research work during one of the parallel presentation sessions. Ing Duca is carrying out her research under the supervision of Dr Ing. Marvin Bugeja.

4.4.7 Participation in the EUCA General Assembly meeting - Bucharest, Romania

As the Maltese representative on the European Control Association (EUCA), Dr. Ing. Marvin Bugeja attended the EUCA General Assembly meeting, held between 13th June to 16th June 2023. As is customary, the EUCA General Assembly met just before the opening ceremony of the European Control Conference (ECC). Among several items, the agenda of this meeting included the election of new members of the assembly, and the consideration and selection of proposals for the organisation of the European Control Conferences (ECC) of 2027.

4.4.8 The ACM Symposium on Document Engineering

Document engineering is the computer science discipline that investigates systems for documents in any form and in all media. As with the relationship between software engineering and software, document engineering is concerned with principles, tools and processes that improve our ability to create, manage, and maintain documents. The ACM Symposium on Document Engineering is an annual meeting of researchers active in document engineering. This year, symposium was held in Limerick, Ireland between 22nd and the 25th of August 2023 and was attended by 40 researchers. Department members were active in the symposium as follows:

- Dr Alexandra Bonnici joined Prof. Steve Simske from the Colorado State University to deliver a tutorial titled 'Reviewer 2 must be stopped! Or the art of providing good reviews' (refer to Figure 4.1 (c)).

- Dr Stefania Cristina delivered a tutorial titled 'Looking Beneath the Surface: The Science and Application of Eye-Gaze Tracking for Assessing Visual Attention' (refer to Figure 4.1 (d)).

- Dr Alexandra Bonnici was entrusted with the role of Program Chair for DocEng 2023, coordinating the peer review process, preparing the conference program and preparing the proceedings for publication. The conference attracted 65 paper submissions, eight of which were accepted as full papers and a further 20 as short papers.

4.4.9 Participation in GoodBrother COST Action Meetings

Dr Stefania Cristina participated in the Working Group meeting held in February 2023, in Reading, UK, where she also delivered a presentation entitled, "Vision-Based Eye-Gaze Tracking for Human Computer Interaction". Dr Cristina then participated in the annual Management Committee meeting held in September 2023, in Tarragona, Spain.

4.4.10 Visit to AquaBioTech Group

On the 2nd December 2022, Dr Ing. Marvin Bugeja, Dr Stefania Cristina and Dr Alexandra Bonnici participated in a visit to AquaBioTech Group. AquaBioTech Group welcomed the engineering faculty and students from the University of Malta yesterday to give them an overview of our various departments and ongoing projects, hoping to attract local talent for our ever-evolving Career and Internship opportunities, to further increase development for future innovation in our Department of Systems and Control Engineering.

4.5 Publications

Edited Books

1. A. Bonnici, and K. P. Camilleri, eds. Interactive Sketch-based Interfaces and Modelling for Design. CRC Press, January 2023.

Journal Publications

1. N. Barbara, T. Camilleri, and K. P. Camilleri, "Real-Time Continuous EOG-Based Gaze Angle Estimation with Baseline Drift Compensation under Stationary Head Conditions", Biomedical Signal Processing and Control, September 2023.

2. M. Mifsud, T. A. Camilleri, and K. P. Camilleri, "HMM-Based Gesture Recognition for Eye-swipe Typing", Biomedical Signal Processing and Control, vol. 86, Part A, September 2023.

3. N. Padfield, A. Agius Anastasi, T. Camilleri, S. Fabri, M. Bugeja, and K. Camilleri, "BCI-Controlled Wheelchairs: End-Users' Perceptions, Needs, and Expectations, an Interview-Based Study", Disability and Rehabilitation: Assistive Technology, May 2023.

4. N. Barbara, T. Camilleri, and K. P. Camilleri. "Monopolar and Bipolar Electrooculography Signal Characteristics Due to Target Displacements - Have we Seen the Whole Picture?." Physiological Measurement, April 2023.

5. M. Aquilina, K. G. Ciantar, C. Galea, K. P. Camilleri, R. A. Farrugia, and J. Abela. "The Best of Both Worlds: A Framework for Combining Degradation Prediction with High Performance Super- Resolution Networks". Sensors, 23(1), 419, December 2022.

6. R. Cassar, K, Hat, T. Leutritz, K. Scerri, K. Sandberg, M. Wierzchon, P. Galdi, and J. C. Bajada. "A Travelling Heads Study Investigating qMRI Metrics on Cortical Regions", The Organization for Human Brain Mapping, 2023.

7. K. G. Ciantar, C. Farrugia, P. Galdi, K. Scerri, T. Xu, and C. J. Bajada. "Geometric Effects of Volume-to-Surface Mappping of fMRI Data", Brain Structure and Function, 227(7), 2457, 2022.

Conferences Publications (Peer Reviewed)

1. R. N. Duca, and M. K. Bugeja, "A Multi-Robot Allocation Scheme for Coverage Control Applications with Multiple Areas of Interest", 9th International Conference on Control, Decision and Information Technologies (CoDIT'23), Rome, July 2023.

2. M. Mifsud, T. A. Camilleri, and K. P. Camilleri. "Training an EOG-Based Wordometer Without Reading - A Simple HCI Application to Quantify Reading Metrics", in 25th International Conference on Human-Computer Interaction, Copenhagen Denmark, Proceedings Part 1, July 2023.

3. A. Bezzina, and L. Chetcuti Zammit. "Traffic Data Analysis from Social Media". In proceedings of the 9th International Conference on Vehicle Technology and Intelligent Transport Systems, Prague, Czech Republic. 144-151, April 2023.

4. R. Adámek, M. K. Bugeja, S. G. Fabri, and R. Grepl. "Enhancing the Obstacle Avoidance Capabilities of a Smart Wheelchair." In Proceedings of the 20th International Conference on Mechatronics – Mechatronika, Pilsen, Czech Republic. 1-7, December 2022.

5. C. von Brockdorff, Y. Aquilina, R. Cauchi, M.A. Saliba, J. Attard, and K. P. Camilleri. "An Integrated Force Feedback System for a Prosthetic Hand". In IECON 2022–48th Annual Conference of the IEEE Industrial Electronics Society (pp. 1-6). October 2022.

6. M. Farrugia, K. Scerri, and A. Sammut. "Detection of Consumer Electrical Load Profile Anomalies", IEEE EUROCON 2023-20th International Conference on Smart Technologies, 2023

7. A. T. Saliba, M. Schembri, K. Scerri, and M. Farrugia. "Implementation of Electronic Throttle for Control of a Dual Fuel Diesel Engine", 2023 International Conference on Control, Automation and Diagnosis (ICCAD), 2023

8. M. Farrugia, K. Scerri, and A. Sammut. "Imputation of Electrical Load Profile Data as Derived from

Smart Meters", 2022 IEEE 21st Mediterranean Electrotechnical Conference (MELECON), 2022

9. A. T. Saliba, E. Agius, K. Scerri and M. Farrugia. "Simulation of Operation and Control of LNG and Diesel Dual Fuel Engine for Marine Application", 7th Offshore Energy & Storage Symposium (OSES 2023), 2023

White Papers

1. S. Aleksic, M. Atanasov, J. C. Agius, K. P. Camilleri, A. Cartolovni, P. Climent-Peerez, S. Colantonio, S. Cristina, V. Despotovic, H. K. Ekenel, and E. Erakin, "State of the Art of Audio- and Video-Based Solutions for AAL", arXiv preprint, 2022 [online]. Available: https://arxiv.org/pdf/2207.01487

2. 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", bioRxiv, 2022

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 Thursdays

5.1.1 3rd November 2022: Mr Matthew Mifsud

During this session, Mr Matthew Mifsud delivered a presentation on his recently completed M.Sc. by Research studies. His topic of study concerned dwell-free typing on a virtual keyboard that is controlled via electrooculography (EOG). Gaze controlled virtual keyboards provide individuals with mobility impairments an alternative mode of communication through which one can use instant messaging applications, edit documents and send emails. The vast majority of such applications require users to fixate upon each key sequentially for a period of time known as the dwell time. However, the use of dwell times negatively impacts the user's attainable typing speed. To this effect, our work presents the development of a dwell-free typing application which avoids the use of dwell times. Instead, users are required to simply glance their point of gaze in the vicinity of the desired keys similar to how one swipes their finger on a touchscreen-based device.

5.1.2 1st December 2022: Ing. Jean Gauci

This session was delivered by Ing. Jean Gauci regarding the research of his Ph.D studies.

Current methods for the analysis of dynamic thermal video data from human participants, such as the estimation of mean temperatures from manually selected regions of interest, are rudimentary and provide very limited insight about temperature dynamics. This work proposes a method for the decomposition and analysis of dynamic thermal data to identify different sources of temporal temperature changes in the data.

Principal component analysis (PCA) was applied to thermal video data to identify different sources of changes in temperature. The implemented algorithms were applied on dynamic thermal data of a thermally passive, inanimate object as well as thermal video data of the plantar aspect of human feet.

Different sources of temperature variations, consisting of a combination of passive surface cooling,

environmental processes and physiological processes were identified. The passive cooling of the skin, typically observed during acclimatization, was noted to last over 60 min, much longer than the five to 20 min durations suggested in the literature. The decomposition that results from the proposed method uncovers underlying temperature dynamics that would typically not emerge from conventional analysis approaches since these would be overshadowed by this passive cooling component.

This method of decomposition of the temporal changes in dynamic thermal data can provide a deeper understanding of the processes driving the temperature changes.

5.1.3   5th April 2023: Dr Srimanta Santra

This learning session was delivered by Dr Srimanta Santra, an RSO-IV who had recently joined the department to work on the CONAI - TRAKE project 'Artificial Intelligence for Control of Complex Systems' led by Prof. Ing. Simon Fabri with the collaboration of Prof. Ing. Kenneth Camilleri and Dr Ing. Marvin Bugeja.

Recent studies have confirmed that significant changes typically occur in complex dynamical systems such as wind energy sources, water distribution networks, and communication networks worldwide, complexities that are exacerbated by future uncertainty where resources will become scarcer and even more precious. According to the World Economic Forum, wind, water, and communication crises are the top global risks in terms of impact. However, fault detection methods in distribution systems literature are typically evaluated on benchmark networks that do not include real-time experimental testbeds or on private commercial datasets, making the reproducibility of results difficult. Additionally, realistic modeling of faults on dynamical system components, sensors, and actuators is often unavailable.

This presentation investigated a framework for the application of fault-diagnosis methodologies on large-scale water distribution systems. A small-scale water distribution network, constructed at the KIOS Centre of Excellence at the University of Cyprus using industrial components and devices, serves as a replica of a water transport network, and communications are implemented to resemble a water utility's Supervisory Control and Data Acquisition (SCADA) system. A general problem formulation for fault diagnosis on water systems is provided in accordance with the mathematical model. The research focuses primarily on the areas of control theory and fault diagnosis, with a focus on systems subject to uncertainty and ambiguity. Recent advances in information and communication technologies have enabled the modernization of wind energy and water systems with the installation of sensors, actuators, data processing units, and wireless communications, thereby facilitating the collection of real-time data related to the systems.

The objective of this presentation was to provide a general overview of current advances in the modeling of distribution systems from a systems and control perspective. Illustrative results on monitoring, control, and fault tolerance of distribution networks will be presented, and possible future research directions were discussed.

5.1.4   12th July 2023: Mr Nipun Sandamal Ranasekara Pathiranage

During this session, Mr Nipun Sandamal Ranasekara Pathiranage delivered a presentation on the MCST-funded project LuminEye - Robust Eye-Gaze Tracking Under Variable Illumination Conditions and Iris Occlusions, supervised by Prof. Ing. Kenneth Camilleri.

For many years, the process of estimating the eye-gaze exploited the use of the ocular shape or features around the eye region. With the emergence of deep neural networks and their application to eye-gaze tracking, most recent research work started focusing on using the image information in its entirety rather than relying on specific features alone, achieving promising results. Furthermore, technological advancements have spurred an interest in pervasive eye-gaze tracking, where the eye movements are tracked and analysed in daily life conditions.

Fuelled by an interest in pervasive eye-gaze tracking for assisting persons with limited mobility, years of research work have led us to develop a passive eye-gaze tracking platform that can estimate the eye-gaze by integrating information regarding the centre of the iris region and the head pose, into a model that compensates for appearance changes due to head rotation in estimating the eye pose. While we have achieved angular gaze errors comparable to the state-of-the-art when the iris was sufficiently visible, the Achilles' heel of the platform has remained the robust localisation of the iris centre coordinates under varying illumination conditions and iris occlusions.

In light of these challenges, this project aims to develop deep learning methods for robust iris centre localisation under varying illumination conditions and occlusions. The primary application is human-computer interaction, whereby we aim to provide persons with physical impairments with an alternative modality to control a computer.

5.2   Courses and Training Followed by Staff Members

- Dr Luana Chetcuti Zammit completed the course "Foundations of University Teaching and Learning". The course is designed to support UM academics in developing an integrated understanding of university teaching and learning issues.

- Dr Marvin Bugeja followed the "Health & Safety Certification" course offered by the Building and Construction Authority (BCA) and Building Industry Consultative Council (BICC) and which was held on the 26th and 27th of January 2023. Dr Bugeja also attended the "Concepts for the Decarbonisation of the Building Industry" course also offered by the Building & Construction Authority (BCA) and Building Industry Consultative Council (BICC) and which was held on the 26th of January 2023.

- In March 2023, Dr Alexandra Bonnici completed the "Train the Online Lecturer" course. This course covers the use of technological tools to aid the preparation, evaluation and continuous improvement of online courses.

- 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 July 2023, Ms Rachael Duca and Mr Matthew Mifsud attended the "Management of Laboratory Equipment in the Fixed Asset module in AIMS" offered by the University of Malta.

- Between the 6th and 12th of September 2023, Mr Noel Agius, participated in an Erasmus+ staff mobility training with the Department of Electrical, Electronics and Computer Engineering at the University of Catania. Here, he shadowed technical staff members at the University to learn and share good practices in laboratory management.

- Between the 14th and 20th of September 2023, Ms Sanchia Cilia Lentini participated in an Erasmus+ staff mobility training with the Department of Electrical, Electronics and Computer Engineering at the University of Catania. Here, Sanchia shadowed administrative staff members at the University to learn and share good administrative practices.

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: Srimanta Santra (until August 2023)
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 mental state command with a paradigm of continuous BCI control would lead to a more natural

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

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, Ella Miceli Farrugia
FUNDING BODY: MCST FUSION Smart Cities Programme
FUNDING AMOUNT: €149,982
AWARDEE: Dr 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 - Eye-based Control using EOG

MAIN INVESTIGATORS: Tracey Camilleri, Kenneth Camilleri, Nathaniel Barbara
RESEARCH SUPPORT OFFICER: Matthew Mifsud
FUNDING BODY: MCST FUSION R&I Technology Development Programme
FUNDING AMOUNT: €122,772 (out of the total project funding €194,910 for the consortium)
PROJECT LEADER: Tracey Camilleri

EyeCon aims to use a particular eye movement recording technique known as electrooculography (EOG), whereby the electrical activity of the human eyes is captured using electrodes attached to the face in close proximity of the eyes, to develop a practical human-computer interface (HCI) system as shown in Figure 6.1. This project aims to address practical issues related to the usage of EOG-based systems, particularly to fuse head pose information and develop head movement compensation algorithms, to allow the user to interact with an eye movement-based assistive application naturally and without restrictions.

This project started in mid February 2020 and was finalised in March 2023. The University of Malta
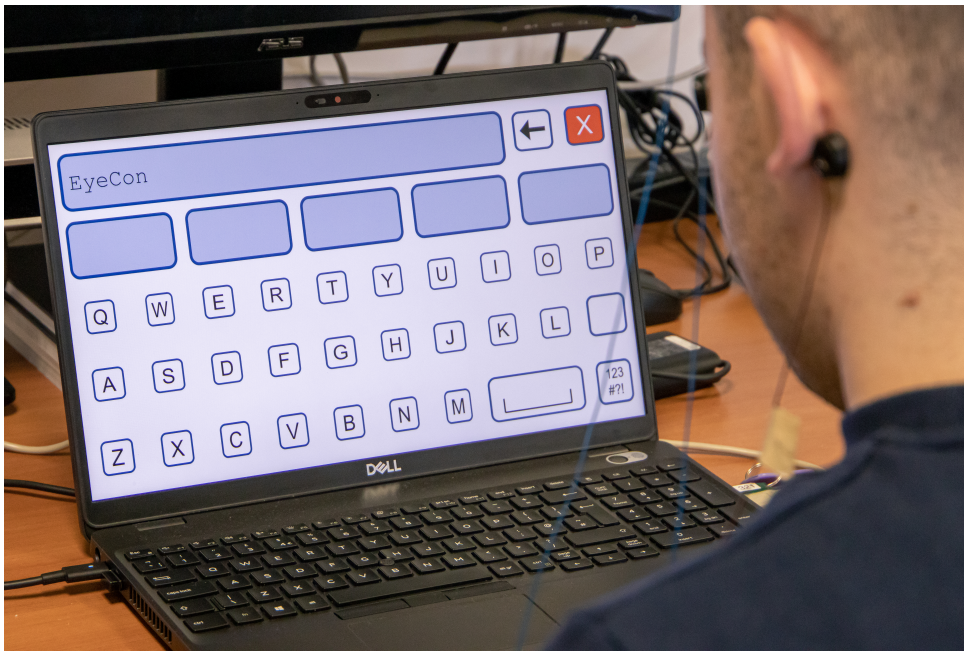
Figure 6.1: Typing using an EOG-based interface.

took care of developing the necessary algorithms for point of gaze estimation with varying head pose. EOG was used for the measurement of eye movements while an electromagnetic 6 degrees of freedom system was used for the tracking of the user's head pose and position. The external partner has started re-writing these algorithms onto the EyeCon platform and will soon start to incorporate the recording of the eye and head pose measurements. Once this is completed, the platform will be tested on a number of subjects, replicating the tests that the team at UM have already carried out in the lab. At the end of this project, a public engagement was held at Esplora on Wednesday 5th July 2023.

A sub-contractor has also been employed through the project to develop a customised EOG glasses including measurements from various electrodes as well as an orientation sensor to be able to measure the yaw, pitch and roll of the user's head while using the developed EOG-based human computer interface system.

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

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[3] University of Parma, Italy

further development of brain-machine interfaces, building on the University of Malta's track record of work on scalp EEG brain-computer interfacing, which in turn may be used to control external devices without muscle control or drive neural prostheses.

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

Doc2Speech - Document binarization for text-to-speech applications

MAIN INVESTIGATORS: Alexandra Bonnici, Stefania Cristina
RESEARCH SUPPORT OFFICERS: Andre Tabone, Luke Abela, Erika Spiteri Bailey (until December 2022)
FUNDING BODY: MCST Research Excellence Program
FUNDING AMOUNT: €50,000
PROJECT LEADER: Alexandra Bonnici

While text-to-speech tools exist, these often support the more common languages, used by millions of people rather than a few hundred. Moreover, many of these text-to-speech tools assume that the text is easily distinguishable from the page background. This is not necessarily the case, particularly in children's books where pictures and illustrations are often part of the background. In these cases, simple binarisation algorithms will fail to distinguish the text from the illustration and the text-to-speech algorithm fails to read such text correctly. This project aims to investigate techniques to eliminate this problem by increasing robust text extraction algorithm able to distinguish text from the illustrations. We also aim to continue developing our earlier work in the development of a text-to-speech algorithm for the Maltese language.

LuminEye - Robust Eye-Gaze Tracking Under Variable Illumination Conditions and Iris Occlusions

MAIN INVESTIGATORS: Stefania Cristina, Kenneth P. Camilleri
RESEARCH SUPPORT OFFICER: Nipun Sandamal Ranasekara Pathiranage
FUNDING BODY: MCST Research Excellence Program
FUNDING AMOUNT: €49,507
PROJECT LEADER: Stefania Cristina

For many years, the process of estimating the eye-gaze exploited the use of the ocular shape or features around the eye region. With the emergence of deep neural networks and their application to eye-gaze tracking, most recent research work started focusing on using the image information in its entirety rather than relying on specific features alone, achieving promising results. Furthermore, technological advancements have spurred an interest in pervasive eye-gaze tracking, where the eye movements are tracked and analysed in daily life conditions.

Fuelled by an interest in pervasive eye-gaze tracking for assisting persons with limited mobility, years of research work have led us to develop a passive eye-gaze tracking platform that can estimate the eye-gaze by integrating information regarding the centre of the iris region and the head pose, into a model that compensates for appearance changes due to head rotation in estimating the eye pose. While we have achieved angular gaze errors comparable to the state-of-the-art when the iris was sufficiently visible, the Achilles' heel of the platform has remained the robust localisation of the iris centre coordinates under varying illumination conditions and iris occlusions.

In light of our challenges, this project aims to develop deep learning methods for robust iris centre

localisation under varying illumination conditions and occlusions. Our primary application is human-computer interaction, whereby we aim to provide persons with physical impairments with an alternative modality to control a computer.

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.

Intelligent Control Systems

MAIN INVESTIGATORS: Simon Fabri, Marvin Bugeja
GRANT: SCERP01-23

This project centred on the implementation of the control system for a unicycle robot (Figure 6.2(a)). The aim is to implement a self-balancing robot that stands on a single wheel (unicycle) and balances and propels itself forwards or backwards. A reaction wheel is mounted on the body of the robot to achieve sideways balance and maintain a vertical posture. The dynamics of this system are highly nonlinear and of the same type as that of an inverted pendulum in 3D. Through closed loop digital control of the angular momentum of the reaction wheel in combination with the driving wheel, the unicycle robot can be made to balance vertically and correct for any destabilising effects.

Application of Computer Vision Algorithms for Music Analysis

MAIN INVESTIGATORS: Dr Alexandra Bonnici
GRANT: SCERP02-23

Optical music recognition (OMR) is the musical equivalent to optical character recognition and deals with the extraction of musical information, in the from of pitch, rhythm, lyrics and other data from the musical document. Traditionally, OMR is carried out through hand-crafted features, designed specifically to extract some artefact from the musical document. This could include techniques such as run-lengths, wavelets, the Hough transform for identification and removal of staff-lines, template matching or morphological operations for the identification of musical symbols and more. One common aspect with these methods is that they often rely on some heuristics which, while tuned to achieve good results with one specific style of document, are not easily re-tuned to provide good results on other styles. In more recent years, researchers have turned to artificial intelligence, using neural networks and their many variants to preform the various tasks of the OMR. These may range from using classification techniques to separate the musical score into various layers hence performing the image pre-processing step of the OMR pipeline; to borrowing of the object detection methods to preform symbol recognition, bypassing the document pre-processing step. The advantage of artificial neural networks, and their variants is that, to change from one style of musical document to another does not require manually changing some heuristic rules, but rather, can be achieved by retraining the network. Such retraining can often be carried out with smaller datasets given some pre-trained networks. Artificial neural-network methods are not without their problems. Specific to optical musical recognition is the fact that musical symbols are typically small in comparison to the musical document. Moreover, the document page is often densely packed with many symbols which are also highly connected and overlapping providing a challenge to existing object detection methods.

This research work investigates the state of the art in artificial intelligence approaches applied for optical music recognition, performing a comparative study of some of these algorithms to determine the research problems that remain. Since neural network-based approaches rely on the existence of
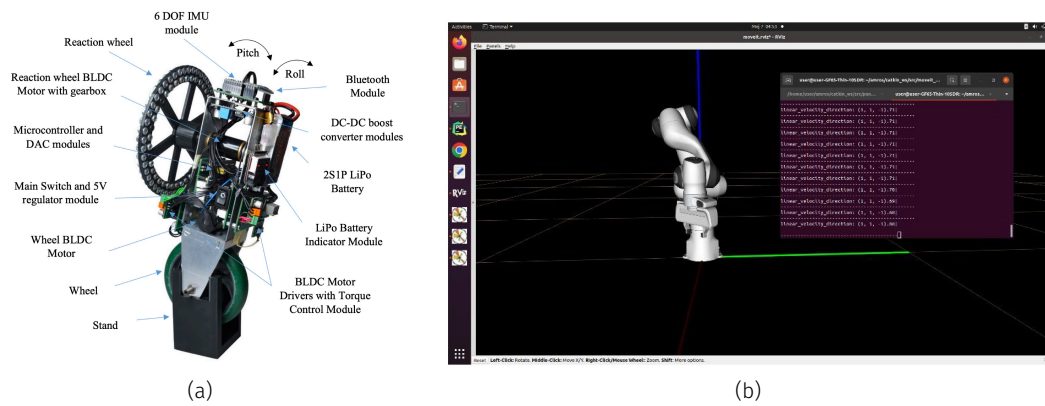
Figure 6.2: (a) The cobot in simulation, (b) The unicycle robot

adequately labelled datasets, the paper will also provide an overview of existing datasets discussing their merits, scope and utility.

Intelligent Traffic Junctions

MAIN INVESTIGATORS: Dr Kenneth Scerri

GRANT: SCERP01-23

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.

Robotics: Design and Construction

MAIN INVESTIGATORS: Simon G. Fabri, Marvin Bugeja

GRANT: SCERP04-23

Projects in this area study various aspects of control systems engineering, robot control on different platforms, including mobile robots, and other automation systems. This year this area saw two projects; one at undergraduate level and another at postgraduate level.

   This project focuses on various aspects of control systems engineering and robot control on different platforms. Specifically this grant supported the development of a teleportation system for the Franka Emika Panda cobot. The project experimentally studied ways of making a 7-axis robotic manipulator mimic the arm movements of a human operator in real-time. The project made use of the Xsens DOT IMU-based motion capture device (now renamed to Movella DOT) to capture the operator's arm motion in real-time. The developed algorithm processes the captured acceleration and velocity signals and sends the appropriate command to the robotic arm. The project generated a set of promising simulation and experimental results as shown in Figure 6.2(b)). The work was carried out in collaboration with the Department of Mechanical Engineering.

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

MAIN INVESTIGATORS: Kenneth P. Camilleri, Stefania Cristina

GRANT: SCERP05-23

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: Dr Tracey Camilleri

GRANT: SCERP15-23

The objectives of this project were the following:
- To fine tune a current wordometer application which processes electrooculographic (EOG) eye movement data of the subject while reading and compare this to other techniques available in the literature.
- To investigate how error related potentials can be reliably detected from electroencephalographic (EEG) signals of someone making use of a BCI and how they can be used to cancel or possibly correct any classification errors done by the system.
- To investigate how a motorised wheelchair can be controlled through an SSVEP-based BCI system
- To analyse how the brain processes flickering stimuli with different characteristics typical in SSVEP-based BCI systems, such as colour, shape and texture, using both fMRI and EEG data. This will help to determine whether certain stimuli generate reliable data that can be detected from non-hair bearing areas, making the BCI more practical for everyday use.

Intelligent Transportation Systems

MAIN INVESTIGATORS: Ing. Luana Chetcuti Zammit

GRANT: SCERP14-23

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: SCERP15-23

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 exploring ideas to permit eye-gaze tracking in less constrained conditions, such as by extending the user-camera distance to a few metres, and to reduce the need for calibration before the user can interact. If successful, this can potentially extend the user's interaction space to one's 3D environment. 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

Coordination and Control of Multi-Robot Systems

MAIN INVESTIGATORS: Marvin Bugeja
RESEARCH STUDENTS: Rachael Duca

For several decades, the robotics community has focused its research on the design of optimal and robust algorithms that enable a mobile robot to individually and autonomously perform a specific task. However there are times when it is very difficult, if not impossible, for a single robot to execute the given task on its own. For instance, the task at hand can be too complex for a single agent, or it might involve a large physical space. Moreover, a system of multiple robots working together to achieve some common goal, often leads to a quicker, more robust and more efficient solution. However such systems can only be designed if the task at hand is split and distributed in a manner that 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. A conference research paper has been presented and published in CoDIT 2023, and an article in IEEE Access has been submitted for review about this work. Furthermore, the framework is designed to exploit the heterogeneity of the robots in two ways: the controller is designed to be energy efficient and the areas segmented for each robot to cover are created such that the more capable robots have a larger area to cover.

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

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[4] Centre for Entrepreneurship and Business Incubation
[5] Faculty for the Built Environment

neighbourhoods are more biologically diverse than others. In this regard, the overall objective of JUST-Nature 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.

Varcities - A vision for human-centred future cities

LOCAL INVESTIGATORS: Daniel Micallef [6], Edward Duca [7] and Kenneth Scerri
FUNDING BODY: EU H2020 SC5-14-2019

In an increasingly urbanised world, governments are focusing on boosting cities' productivity and improving citizens' living conditions and quality of life. Despite efforts to transform the challenges facing cities into opportunities, problems such as overburdened social services and health facilities, air pollution and exacerbated heat create a bleak outlook. With these challenges in mind, the EU-funded VARCITIES project aims to create a vision for future cities with the citizen and the so-called human community at the centre. It will therefore implement innovative ideas and add value by creating sustainable models for improving the health and well-being of citizens facing diverse climatic conditions and challenges around Europe. This will be achieved through shared public spaces that make cities liveable and welcoming.

DeepFIR - Restore Very Low-Resolution Facial Images

MAIN INVESTIGATORS: Reuben A. Farrugia [8], Kenneth Camilleri, John M. Abela [9]
RESEARCH SUPPORT OFFICERS: Christian P. Galea [8], Matthew Aquilina [8]
FUNDING BODY: MCST FUSION R&I Technology Development Programme

The Deep-FIR project is run by the Department of Communications and Computer Engineering of the Faculty of ICT. The project aims to design and implement a face image restoration algorithm that is able restore very low-resolution facial images captured by CCTV systems with unconstrained pose and orientation. The user will be able to restore the whole head, including the hair region, which is important for person identification, while minimising the manual work of the operator. Apart from improving the quality of the restored facial images, this project intends to reduce the complexity and therefore the time needed to enhance an image or video frame The developed algorithm will be tested on real-world CCTV videos and compared against existing video forensic tools used by forensic experts in their labs.

DeepFIR project was concluded and presented during a public engagement event held at Esplora on 1st August 2023.

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[6] Faculty for the Built Environment
[7] Centre for Entrepreneurship and Business
[8] Department of Communications and Computer Engineering
[9] Department of Computer Information Systems

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

MAIN INVESTIGATORS: Alfred Gatt [10], Cynthia Formosa [10] 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[11] 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 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[11], Simon G. Fabri and Owen Casha[12]
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.

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[10] Department of Podiatry
[11] Department of Industrial and Manufacturing Engineering
[12] Department of Microelectronics and Nanoelectronics

CuraClap - Conformity and Usability Risk Assessment for SMARTCLAP Commercialisation

INVESTIGATORS: Philip Farrugia[13] 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[13], Marvin Bugeja Margaret Camilleri Fenech[14]
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 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.

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[13] Department of Industrial and Manufacturing Engineering
[14] Institute for Climate Change and Sustainable Development

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.

Husky ground mobile robots A pair of all-terrain unmanned ground vehicles were added to the ever-growing collection of robots of the department, forming part of the TRAKE Robotics Lab.. One of the Husky ground mobile vehicles is equipped with a stereo visual camera, while the other is equipped with a UR5 manipulator. Both UGVs are equipped with a LiDAR SICK LMS111, IMUs and an onboard computera that facilitates an open architecture that allows them to be programmed, and driven using console controllers.

Husarion ROSbot 2.0 Pro A swarm of eight Husarion ROSbot 2.0 Pro robots was added to the collection of robots, forming part of the TRAKE Robotics Lab. The ROSbot 2.0 Pro is a 4x4 drive autonomous mobile robot platform equipped with LiDAR, RGB-D camera, IMU, encoders and distance sensors. This robot swarm is ideal for research in multi-robot systems.

VideoRay Pro 4 Ultra Underwater ROV The VideoRay Pro 4 Ultra is an underwater remotely operated vehicle (ROV), which is a new spectrum of the robotics research embarked on by the department. This underwater ROV forms part of the equipment purchased for the new Robotics Lab in the new TRAKE building. This ROV is equipped with numerous sensors including a front-facing camera that allows a researcher to collect visual data underwater.

Benchtop equipment A new set of benchtop oscilloscope and power supply units were purchased to furnish the new Robotics Lab as part of the TRAKE project.

Real-time DAQ boards DS1104 A set of 15 dSPACE DS1104 R&D controller boards were purchased as part of the new equipment used to furnish the Robotics Lab in the new TRAKE building. The DS1104 R&D Controller Board upgrades a PC to a development system for rapid control prototyping.

Laboratory-scale development unit A set of five dSPACE MicroLabBoxes were purchased as part of the new equipment used to furnish the Robotics Lab in the new TRAKE building. MicroLabBox is an all-in-one development system for the laboratory that combines compact size and low system costs with high performance and versatility.

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 and which are listed below.

8.1 STEM outreach in schools

8.1.1 Talk to students about engineering courses

Dr Bonnici was invited to deliver a number of talks, as part of a STEM outreach programme, to various students in different primary and secondary schools.

- On the 10th November 2022, Dr Alexandra Bonnici delivered a talk to the students of St Monica Gzira, as part of their career week activities.
- On the 6th December 2022, Dr Bonnici visited a group of students at St Martin's College Sixth Form and delivered a talk about the engineering degree courses offered by the Faculty.
- On the 9th March 2023 Dr Bonnici met with and delivered an online career talk to 100 students and parents attending St Monica School, Birkirkara. The talk was intended to assist students in making their options choices.
- On the 29th May 2023, Dr Bonnici delivered a talk to two groups of De La Salle Sixth Form students about the engineering degree courses offered by the Faculty.

8.1.2 Laboratory visit about the Department research

On the 28th February 2023 a group of students from San Andrea School were welcomed in our Biomedical Engineering lab, where the students were shown a short presentation and demonstration of some of the research we do in the Biomedical lab.

8.1.3 Talks to guidance teachers

During the year, Dr Alexandra Bonnici organised/participated a number of talks and presentations delivered to guidance teachers as part of the training provided to these teachers.

- On Monday 7th December 2023, a talk was delivered to all guidance teachers about issues relating to gender balance in courses. The talk was given by Prof Carmen Sammut, pro-Rector for Student and Staff Affairs, and Outreach, Ms Marcelle Bugre Zanya, Equity Coordinator, Dr Francois Mifsud a lecturer on Inclusion and Access to Learning and Dr Alexandra Bonnici. During the talk, Dr Alexandra Bonnici gave an overview of the different facets of engineering, as well as the need to have a greater representation of female engineers.
- On the 28th February 2023, 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.

- On Friday 5th May 2023, Dr Alexandra Bonnici participated in the STEM Career Guidance training, as part of the discussion panel. The event was organised by Esplora. During the discussion, Dr Bonnici shared her experiences on the route and motivations that led her to become an engineer, her experiences as a female engineer, the qualities that career guidance teachers need to look out for to encourage students to become engineers. Dr Bonnici also mentioned the Certificate in Engineering Sciences as one of the newer routes for students interested in becoming engineers as well as the Faculty exhibition and the Technology Clubs as opportunities for students and teachers to explore and become familiar with the engineering profession.

8.1.4 Unconventional Science Careers, #STEAM@UM

On the 2nd of December 2022, the UM held its first 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 SCE 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.

8.1.5 Engineering Technology Clubs

The Department maintained its efforts in organising the Engineering Technology Clubs and participated algonside the other Faculty departments in delivering practical workshops for school children at Year 11, assisting these students in their "options" choices. Throughout the academic year, these workshops reached 640 students from various middle schools across the islands.

8.2 Funded Projects Engagement Events

8.2.1 MAPProHand

On the 8th March 2023, Prof. Ing. Kenneth Camilleri participated in the MAPProHand Public Engagement Event at MCST, marking the completion of the project. The MAProHand is a lightweight dexterous prosthetic hand that can be controlled by an amputee. The department collaborated in this project alongside the Department of Mechanical Engineering and the Department of Artificial Intelligence, contributing to the machine learning and artificial intelligence aspects that control the hand.

8.2.2 EYECon

On Wednesday 5th July 2023, the team working on the EyeCon project, including Dr Tracey Camilleri and Dr Ing. Nathaniel Barbara, presented their work at the public engagement event held at Esplora. This project involved the use of electrooculography to control an assistive communication application. The project was done in collaboration with 1888 Limited.

8.2.3 DeepFIR

On Tuesday 1st August 2023, Prof. Ing. Kenneth Camilleri and the team of DeepFIR, presented the project DeepFIR (funded by Fusion, the R&I Programme administered by MCST) during the public engagement event.
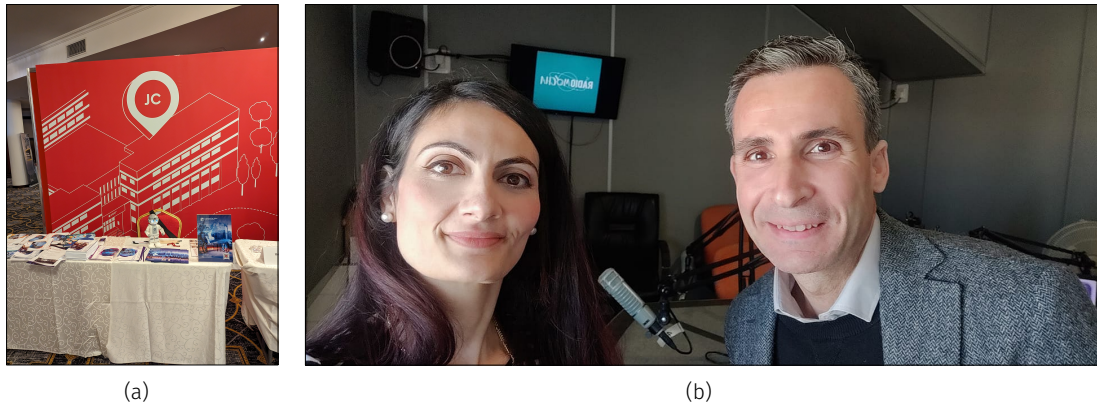
(a)   (b)

Figure 8.1: (a) The Department's stand at the iChoose Careers Fair, (b) Dr Ing. Marvin Bugeja being interviewed by Danielle on Radio Mocha

8.3 Participation in National Events

Department members also participated in national events and science-related festivals that took place during the academic year as described hereunder.

8.3.1 World Children's Day

On Sunday 20th November, the Department celebrated World Children's Day by participating in the weekend events at Esplora. Dr Bonnici showcased the Department's work in augmented reality, filling up a corridor with some exotic animals which children could interact with using hand gestures.

8.3.2 Engineer your career

On the 29th November, Dr Alexandra Bonnici represented the Department in the Engineer your Career live event organised by the Chamber of Engineers at Fort St Elmo.

8.3.3 iChoose Careers Fair

Dr Alexandra Bonnici, Dr Marvin Bugeja and Dr Ing Stefania Cristina participated in the iChoose fair held at Hotel Excelsior. During this careers fair, our academics showcased some of the Department's robotic systems to the audience, while they promoted the engineering career to the visiting students.

8.3.4 Science in the City 2023

Members of our department participated in Science in the City on the 29th and 30th of September. On Friday 29th September, Dr Tracey Camilleri, who is coordinating the SmartGaze project, was joined by Dr Nathaniel Barbara, Mr Matthew Mifsud and Mr Salah Ad-Din Ahmed Youbi and discussed the use of electrooculography (EOG) for the control of computer applications and smart devices while Ing. Rachael Duca demonstrated the Department's research in robotics together with a display of some of the robots owned by the Department. On Saturday 30th September Dr Bonnici then presented the work carried on text recognition and reading from difficult images which was carried out under the Doc2Speech project.

8.4 Media Exposure

8.4.1 Appearance on Radio Mocha

On the 6th February 2023, Dr Ing. Marvin Bugeja has participated in an interview on radio program Radio Mocha, hosted by Danielle. During this interview Dr Ing. Bugeja spoke about the use of robots in daily life, the importance of engineering education for a career in robotics, and the various related research projects in the department.

9. Prizes, Awards and Appointments

9.1 Elections and Appointments

- Dr Alexandra Bonnici has been elected to the position of Secretary and Treasurer of the ACM Special Interest Group on Hypertext and the Web from 1 July 2023 up to 30 June 2025.

- Dr Ing. Marvin Bugeja was appointed as a regular Associate Editor on the EUCA Conference Editorial Board (March 2023 onwards)

9.2 New Staff Appointments

- In July 2023, Mr Matthew Mifsud was appointed as Systems Engineer with the Department of Systems and Control Engineering.

9.3 Ph.D Awards

- On the 6th March 2023, Dr Ing. Rosanne Zerafa and Dr Ing. Nathaniel Barbara were awarded the degree of Ph.D. in Engineering.

9.4 MSc Awards

- On the 16th March 2023, Mr Matthew Mifsud was awarded the degree of MSc in Engineering.

10. 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:

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

- on **Messenger**: m.me/um.scedepartment

- Secretarial Office - Ms. Sanchia Cilia Lentini: 2340 3385.