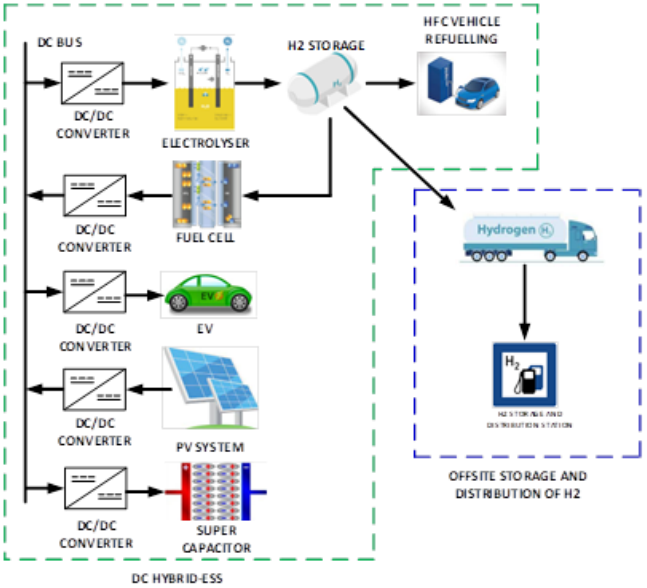
Hybrid energy storage system for green energy transportation

Project Proposer:	Dr. Ing. John Licari, john.licari@um.edu.mt, Department of Electrical Engineering
Main Supervisor(s):	Dr. Ing. John Licari, john.licari@um.edu.mt, Department of Electrical Engineering
Co-supervisor (if any):	Prof. Cyril Spiteri Staines, cyril.spiteri-staines@um.edu.mt, Department of Electrical Engineering

Problem Background:

Hybridisation of energy storage devices is a solution to a range of problems experienced by Microgrids and renewable energy sources (RES) such as energy intermittency, power quality, stability etc.... Depending on the problems to be addressed, different energy storage components can be integrated to form a hybrid energy storage system. Generally, these components are classified as high-power storage or as high-energy storage and the components choice depends on the purpose for hybridisation.



This project shall be exploring the combination of energy storage components using a DC microgrid to maximise the full potential of RESs generated energy applied to green energy transportation. This will involve the use of a battery system and a hydrogen production unit that will serve both as an energy storage device and as a green generated fuel.

Project Objective(s):

- Literature review that investigates different hybrid DC microgrid topologies and control strategies.
- Develop models for the chosen DC microgrid components and their control system in Simulink and PLECS models.
- Develop the primary level control system for the microgrid.
- Simulation of the microgrid operation under different operating scenarios.
- Analyse the microgrid individual components' performance.

Project Resources:

- Budget: N/A
- Indicate source of funds: N/A

	• Equipment/Software/Literature: MATLAB Simulink & PLECS
Industrial Partners involved:	• N/A
Expected Project Deliverables:	• Comprehensive literature review that summarizes the current state of the art in hybrid microgrids topologies and their control strategies. • Simulation models of the converters and their control loops of the components employed in the DC microgrid. • Simulation results and analysis for various operating scenarios.
Student background / interest:	• Power Electronics, Energy Storage, Renewable Energy, Green Fuel Generation
IP Issues	☐ The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Modeling and Simulation of MVDC Link Architectures

Project Proposer:	Prof. Alexander Micallef, alexander.micallef@um.edu.mt, Department of Electrical Engineering
Main Supervisor(s):	Prof. Alexander Micallef, alexander.micallef@um.edu.mt, Department of Electrical Engineering
Co-supervisor (if any):	Prof. Maurice Apap, maurice.apap@um.edu.mt, Department of Electrical Engineering
Problem Background:	The traditional power grid relies on Alternating Current (AC) transmission and distribution. However, with the increasing penetration of renewable energy sources, energy storage systems and DC loads, Medium Voltage DC (MVDC) links are emerging as a promising alternative to address these limitations of AC grids. MVDC links offer several advantages, including reduced transmission losses, improved power flow control, and enhanced integration of renewable energy sources. MVDC technology is rapidly evolving, and the benefits it offers are driving increased adoption in various grid applications. MVDC links can be applied in various scenarios within the power grid, including connecting offshore wind farms, interconnecting power grids, and integrating renewable energy sources. Selection of the optimal topology for an MVDC link and the design of its control loops are crucial for maximizing these benefits.
Project Objective(s):	• Literature review that investigates different MVDC link topologies and control strategies. • Develop Simulink and PLECS models for the chosen MVDC link topologies. This includes modeling the power electronics converters, control algorithms, and the DC transmission line. • Perform simulations in MATLAB Simulink & PLECS to evaluate the dynamic behavior of the MVDC link under various operating conditions. • Analyze key performance metrics such as voltage regulation, power flow control, and transient response.
Project Resources:	• Budget: N/A • Indicate source of funds: N/A • Equipment/Software/Literature: MATLAB Simulink & PLECS
Industrial Partners involved:	• N/A
Expected Project Deliverables:	• Comprehensive literature review that summarizes the current state of the art in MVDC link technology, focusing on topologies, control strategies, and modeling techniques. • Detailed design of the chosen MVDC link topology. • Simulink/PLECS models of the converters, control loops, and the entire MVDC link. • Simulation results and analysis for various operating scenarios, including steady-state and transient conditions.
Student background / interest:	•

IP Issues	☐ The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Analysis of Aircraft Power System including Harmonics

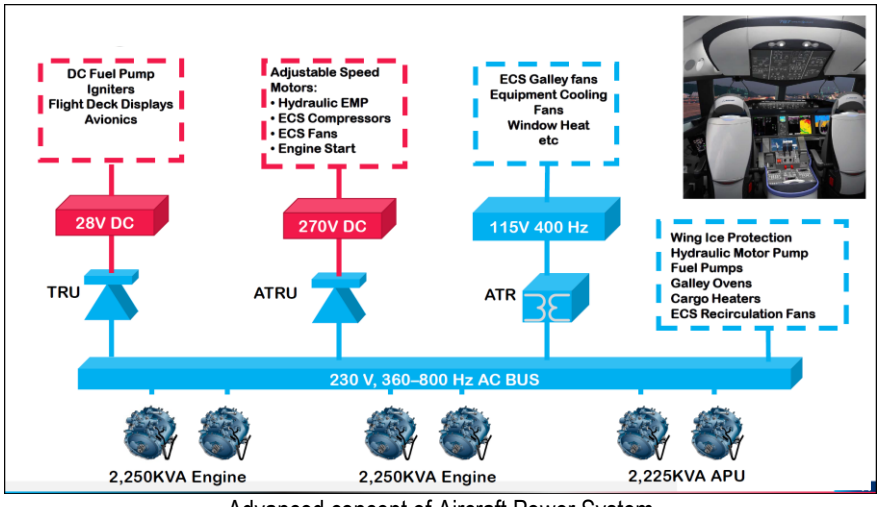
Project Proposer: Prof. Dr. Cyril Spiteri Staines, cyril.spiteri-staines@um.edu.mt, Dept. of Electrical Engineering

Main Supervisor(s): Prof. Dr. Cyril Spiteri Staines, cyril.spiteri-staines@um.edu.mt, Dept. of Electrical Engineering

Co-supervisor (if any): Dr. John Licari, Dept. of Electrical Engineering

Problem Background:

The generator system on commercial Aircraft could consist of: a fixed frequency system controlled by a constant speed shaft; or a 'frequency wild' generator together with a power converter. For the latter the generator would operate at a voltage of 230V and a frequency of 360-800Hz. The frequency variation depends on the point of operation of the aircraft during its mission, the most critical being take-off and landing. The idea is to set-up a laboratory based system which makes use of a programmable 3-Phase AC Power Supply to emulate the method of power generation and couple this to a typical rectifier unit similar in operation to that used in aircraft. These units are called Auto Transformer Rectifier Unit (ATRU). The project shall involve the analysis of the generator side current harmonics for different secondary side connections of the ATRU. The latter shall require design of inter-bridge reactors for optimal voltage output.



Advanced concept of Aircraft Power System

Project Objective(s):

- Determination of typical generator profile according to mission (for programming the laboratory ac source).
- Determination of typical aircraft loads.
- Modelling and connection of generators to ATRU.
- Harmonic analysis of input and output side.
- Simulation of system with typical loads.

Project Resources:

- Equipment/Software: Department,

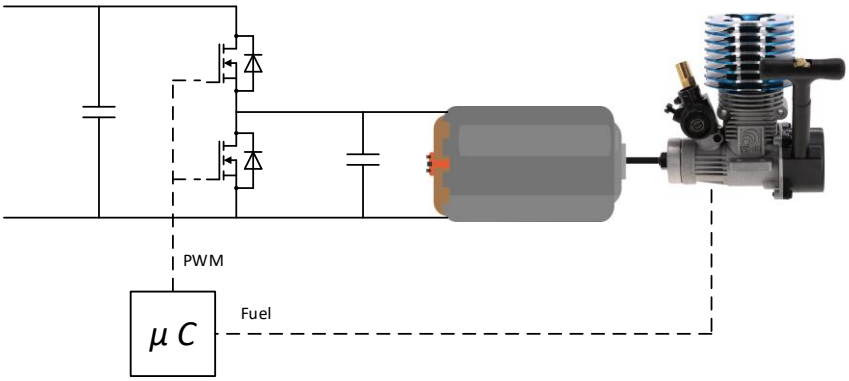
	• Literature: I. Moir, A. Seabridge, Aircraft Systems, Mechanical, electrical, and avionics subsystems integration, Third Edition, John Wiley and Sons (2008).
Industrial Partners involved:	• SR Technics Malta
Expected Project Deliverables:	• Aircraft generator models. • Study of ATRU topologies and connections • Development of simulation model for aircraft power system • Harmonic study for aircraft power generation systems
Student background / interest:	• Electrical Machines • Power systems
IP Issues	☐ The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Interfacing of protection relays with real-time power network software models

Project Proposer:	Prof. Cedric Caruana, cedric.caruana@um.edu.mt
Main Supervisor(s):	Prof. Cedric Caruana, cedric.caruana@um.edu.mt
Co-supervisor (if any):	
Problem Background:	Power networks are experiencing radical changes in the global efforts to reduce CO_2 emissions. With the increasing network complexity, protection schemes play an increasingly important role. It is imperative for protection relays to operate dependably and securely to minimize damage to the system. Testing of the protection relay operation on a real network can cause significant disruption. Software models can represent the protection relay operation but the accuracy of the modelling directly affects the closeness of the resulting performance. Hardware-in-the-loop testing in combination with real-time simulations can wedge the gap between the behaviour of simulated and real systems. The aim of this project is to interface actual protection relays to real-time simulation models of selected power networks and test the relay operation under realistic scenarios.
Project Objective(s):	• Review of power network test cases published by established technical bodies such as IEEE • Development of real-time simulation models for selected test cases • Study of applicable protection schemes • Familiarisation with and programming of available protection relays • Interface of protection relays to network simulator • Hardware-in-the-loop simulations of realistic network protection schemes.
Project Resources:	Network simulator and protection relays are already available in the Department laboratories. Small components required for interfacing will be funded by the Department.
Industrial Partners involved:	N/A
Expected Project Deliverables:	• Literature review of test cases and applicable protection schemes • Detailed design of relay settings for desired protection system performance • Comprehensive procedure for setting the relays with the designed settings • Analysis of the protection relays' performance in the hardware-in-the-loop simulations carried out.
Student background / interest:	• Electrical Power Systems • Renewable Energy

IP Issues	☐ The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Auxiliary power unit for drones

Project Proposer:	Dr Ing. Reiko Raute, *Reiko.Raute@um.edu.mt, Industrial Electrical Power Conversion*
Supervisor(s):	Dr Ing. Reiko Raute, *Reiko.Raute@um.edu.mt, Industrial Electrical Power Conversion*
Co-supervisor[1] (if any):	Dr Robert Camilleri, *Robert.c.camilleri@um.edu.mt, Institute of Aerospace Technologies*
Problem Background	Multi rotor drones need 4 or more independent controllable motors. They are usually electric motors with very dynamic electronic control. Most drones use batteries as energy storage which provides an electric voltage for the motor controllers. However, due to the limited energy/ weight density of available battery technology flying times are rather low. The idea of this project is to use petrol as fuel which has a significant higher energy density than a battery. A combustion engine coupled to an electric generator shall be used to generate the required voltage for the propulsion motor drives. The generator set shall be regulated to guarantee a stable constant DC output voltage under varying load conditions. For the implementation, a microcontroller shall be used to control a power electronic circuit with a variable PWM signal and adjust the fuel supply of the combustion engine. 
Project Objective(s):	• Setup an electric generator set driven by a mechanical combustion engine (couple a RC model engine to an electric motor/generator) • Build a power electronic converter, voltage and current measurement circuitry • Implement a control algorithm inside a micro controller to regulate a constant voltage regulation of the generator unit (regulate fuel supply to combustion engine and control the power electronic PWM switching to regulate the DC output voltage)
Project Resources	• Budget: €0 • Indicate source of funds: Lecturer's Funds • Equipment/Software/Literature

[1] Only one co-supervisor per project, if any.

Industrial Partners involved:	N/A
Expected Project Deliverables:	• A fully functional prototype auxiliary power unit with dynamic load voltage regulation
Student background / interest:	• Electric power generation • Electric machines • Power Electronics • Micro controller programming
IP Issues	☐ The project has patent possibilities; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Stable self-levelling control of a Stewart Platform

Project Proposer:	Prof. Simon G. Fabri, simon.fabri@um.edu.mt Dept of Systems & Control Engineering
Main Supervisor(s):	Prof. Simon G. Fabri, simon.fabri@um.edu.mt
Co-supervisor (if any):	
Problem Background:	The Stewart Platforms is one type of parallel robotic manipulators having 6 degrees of freedom operating in 3D space. It is used in applications such as aircraft and vehicle simulators, machine tooling devices, earthquake simulators and self-leveling platforms. This project deals with the latter application, the main idea being to automatically control the platform such that an object located on its top plate remains stabilized in a level position despite random disturbances affecting the platform's posture. This project would build upon work completed in previous projects where a Stewart Platform was designed, constructed and some basic position/orientation control was implemented, without any guarantees of system stability. In essence, the main challenge of this project would be to design and implement a controller that is *guaranteed* to self-level the top plate of the platform *without having the system going unstable*, despite external random inputs disturbing the position of the platform, and the inherent nonlinear effects that characterize its dynamics.
Project Objective(s):	• Modelling and simulation of the Stewart Platform dynamics. • Design and implementation of a stable closed loop control algorithm that uses the feedback signals from the IMU to self-level the object in the presence of external disturbances. • Modelling and simulation of the Stewart Platform control system. • Improvement of the inertial measurement system used to sense the platform's motion. • Physical implementation and testing of the closed loop controller.
Project Resources:	• Budget: €0 • Indicate source of funds: UM internal research seed fund. • Equipment/Software/Literature: PC with Matlab/Simulink (available), control interface board (dSPACE) (available), Stewart Platform (available), electrical and electronic components for additional components that may be required.
Industrial Partners involved:	• None
Expected Project Deliverables:	• Literature and theoretical review on stable control systems for the nonlinear Stewart Platform dynamics. • Simulation studies for modelling and control of the platform and the control system. • Design, implementation and physical testing of the stable, closed loop, self-levelling Stewart Platform controller. • Testing and evaluation of results.
Student background / interest:	• Control systems theory • Robotics • Computer interfacing and electronics

	• System modelling • Matlab/Simulink
IP Issues	NO The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Augmented Storytelling: Bringing Drawings to AR

Project Proposer:	Alexandra Bonnici, alexandra.bonnici@um.edu.mt
Main Supervisor(s):	Alexandra Bonnici, alexandra.bonnici@um.edu.mt
Co-supervisor (if any):	n/a
Problem Background:	Storytelling is important for children as it sparks imagination and fosters empathy and creates a strong bond between storyteller and listener, all of which are important to create an environment for learning. There are different ways to tell a story. Drawings allow the child to tell stories without using words, with each picture showing characters, places, or feelings. In recent years, Augmented Reality (AR) has introduced new possibilities to enrich the storytelling experience, allowing for the superposition of digital content onto the physical world, allowing the child to interact with characters and environments in a way that was previously impossible (Squire & Jan, 2007). This increases the child's engagement and immersion in storytelling activities (Nannan Xi et al., 2020). This project aims to combine storytelling through drawings with AR by creating digital 3D content based on drawings in such a way that these can be interacted with in the AR environment. The project will start by first looking at the seminal work Teddy (Igarashi T. et al., 1999) to establish how to create inflated 3D models from sketches

	and overlay these into the AR environment using Microsoft HoloLens, for interaction. The project will then investigate newer techniques for creating 3D objects from drawings. **Squire, K. D., & Jan, M. (2007**). "Mad City Mystery: Developing scientific argumentation skills with a place-based augmented reality game on handheld computers." Journal of Science Education and Technology, 16(1), 5-29. **Nannan X., Wei L., Xiaoqing G., & Guodong Y. (2020).** "Interactive Augmented Reality Storytelling Enhances Preschool Children's Narrative Skills." Frontiers in Psychology, 11, 562168. doi: 10.3389/fpsyg.2020.562168 **Igarashi, T., Moscovich, T., & Hughes, J. F. (1999).** Teddy: A Sketching Interface for 3D Freeform Design. In Proceedings of the 26th Annual Conference on Computer Graphics and Interactive Techniques (SIGGRAPH '99), pp. 409-416. DOI: 10.1145/311535.311607
Project Objective(s):	• To create an inflated 3D model from a drawing • To display this model in an AR environment
Project Resources:	• Budget: €0 (the HoloLens has already been purchased) • Indicate source of funds: Academic's own funds • Equipment/Software/Literature
Industrial Partners involved:	• N/A
Expected Project Deliverables:	• A literature review on 3D reconstruction methods and 3D sketch interaction methods • An algorithm that obtains a 3D model from a drawing • An interface that allows interaction with the constructed 3D model in AR
Student background / interest:	• Good programming skills • Interest in image processing and computer vision • Familiarity with Unity would be preferred (or willing to follow tutorials in summer)
IP Issues	☐ The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Ball Detection and Tracking in Football Games

Project Proposer:	1. Dr Stefania Cristina (stefania.cristina@um.edu.mt) 2. *Department of Systems and Control Engineering*
Main Supervisor(s):	3. Dr Stefania Cristina (stefania.cristina@um.edu.mt) 4. *Department of Systems and Control Engineering*
Co-supervisor (if any):	5. N/A
Problem Background:	The use of tracking data for game analysis in sports has been growing in popularity, because it enables sports persons, coaches and newscasters to analyse game strategies and evaluate the players' performance. In football, the location of the ball on the pitch at any time instance provides crucial information that can allow the calculation of several ball metrics, such as possession and shot distribution, and the detection of important in-game events. The use of vision-based systems that collect this information solely from camera images are increasingly attractive, because they do not require the integration of additional sensors within the ball itself. However, the task of ball detection and tracking is a challenging one, because the ball's shape and appearance in the camera images keeps changing over time, depending on the speed that it is travelling with and its distance from the camera. Furthermore, the ball is frequently occluded by the players, making its detection and tracking even more difficult. This project aims to investigate methods for detecting and tracking the position of the ball on the pitch, with particular interest in doing so by the application of deep neural networks.
Project Objective(s):	• Review of the literature on ball detection and tracking techniques in football games. • Implementation of methods for ball detection and tracking. • Identification of suitable dataset/s for evaluation. • Performance testing and evaluation of the implemented methods.
Project Resources:	• Indicate source of funds: N/A • Equipment/Software/Literature: Equipment available in the Department's laboratories.
Industrial Partners involved:	• N/A

Expected Project Deliverables:	• Literature review of ball detection and tracking techniques in football games. • Methods for ball detection and tracking. • Quantitative performance results and evaluation of the implemented methods.
Student background / interest:	• Interest in computer vision and image processing. • Interest in artificial intelligence and deep learning. • Interest in programming (especially with Python).
IP Issues	6. □ The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

EMG-Based Elbow Joint Angle Estimation Under Different Hand Load Conditions

Project Proposer:	Prof. Ing. Kenneth P. Camilleri (kenneth.camilleri@um.edu.mt)
Main Supervisor(s):	Dr Ing. Nathaniel Barbara (nathaniel.barbara@um.edu.mt)
Co-supervisor (if any):	Prof. Ing. Kenneth P. Camilleri (kenneth.camilleri@um.edu.mt)
Problem Background:	Electromyography (EMG) is a technique which uses surface electrodes to measure the electrical activity generated by skeletal muscles. Beyond its clinical applications for evaluating muscle function and diagnosing neuromuscular disorders, EMG signals may serve as control inputs in the development of human-machine interface (HMI) systems, enabling the control of prosthetic devices or exoskeletons, for example. Such systems are primarily aimed to aid individuals with limb loss or mobility impairments, helping to restore lost function and enhancing mobility. This in turn enables greater participation in daily activities and societal engagement. Specifically, prosthetic devices strategically place electrodes over residual or adjacent muscles in an amputated limb. This setup records EMG signals during muscle contractions which are subsequently processed to estimate specific joint angles that trigger corresponding movements of the prosthetic device. Similarly, in exoskeletons, EMG signals from the user's muscles are used to initiate and modulate the assistance provided by the exoskeleton, thereby augmenting the user's mobility and functionality.
Project Objective(s):	This project aims to use EMG signals to estimate the elbow joint angle during elbow flexion and extension. Furthermore, this project seeks to investigate the effect of hand loading on the recorded EMG signals and subsequently develop techniques to estimate the elbow joint angle accurately and robustly, considering various hand load conditions. Hence, the objectives of this project are as follows: • Familiarisation with the EMG signal acquisition equipment and VICON system for ground-truth elbow joint angle determination; • Recording EMG signals and ground-truth elbow joint angles under different hand load conditions; • Systematically investigating the EMG signal characteristics for various hand loads; • Implementing techniques to accurately estimate the elbow joint angle, taking into consideration different hand load conditions.
Project Resources:	• Equipment/Software: All equipment, namely equipment for EMG signal acquisition, VICON system, related software and dumbbells, will be provided.
Industrial Partners involved:	None.
Expected Project Deliverables:	• Literature review on existing techniques for EMG-based joint angle estimation; • Literature review on the effect of load on EMG signals; • Protocol for EMG signal recording and ground-truth elbow joint angle determination; • Implementation of selected method(s) for estimating the elbow joint angle under various hand load conditions;

	• Quantitative performance results of the implemented methods.
Student background / interest:	Interested students are expected to be proficient in signal processing and programming, in Matlab or Python.
IP Issues	☐ The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Towards a secure urban traffic network

Project Proposer:	Dr. Ing. Luana Chetcuti Zammit
Main Supervisor(s):	Luana Chetcuti Zammit luana.chetcuti@um.edu.mt *Department of Systems and Control Engineering*
Co-supervisor (if any):	NA
Problem Background:	The fast-growing technologies in ITS make it possible for most of the data to be stored and analysed by centralized platforms which might be subject to malicious attacks, performance limitations or simply improper operations. Moreover, the lack of necessary mutual trust among ITS entities increases the complexities in ITS. Hence these issues point towards the use of blockchain technology in ITS. In blockchain technology, network participants can verify other users' interactions with the network using specialized consensus protocols. Blockchain can be viewed as a novel decentralized architecture and distributed computing paradigm. It generates data with distributed consensus algorithms, stores data with encrypted chained blocks, and manipulates data with self-executed program scripts. While it is still a new technology, this project will focus on the investigation of using such technologies to ITS. Current ITS works are far from dealing with such fundamental issues of security, and trust. According to the works of [1], without the underlying bases on security and trust, the high- level emerged intelligence in ITS, including the development of new land, roads, smarter devices e.g. cameras and self-driving cars, is expected to be fake and fragile intelligence. Therefore, there is vital need to develop a secured, trusted and decentralized system in ITS. This technology will be applied to interconnected signalized traffic junctions. Throughout the project, Aimsun software will be used to simulate traffic conditions and generate massive data flow. Interface algorithms need to be developed to interface the software simulation with blockchain technologies. The resources in the TRISP lab will also be made use of. *[1] Towards Blockchain-based Intelligent Transportation Systems Yong Yuan1 and Fei-Yue Wang2 2016 IEEE 19th International Conference on Intelligent Transportation Systems (ITSC) Windsor Oceanico Hotel, Rio de Janeiro, Brazil, November 1-4, 2016*
Project Objective(s):	• Familiarize oneself with blockchain technology • Familiarize oneself with Aimsun simulation software • Interface the software simulation with blockchain technologies. • Apply this technology to connected signalized traffic junctions
Project Resources:	• Budget: €__0___ • Indicate source of funds: NA • Equipment/Software/Literature: Aimsun software, literature from internet and books

Industrial Partners involved:	• NA
Expected Project Deliverables:	• Literature of Blockchain technology; • Applying blockchain technology to ITS; • Interfacing the software simulation with blockchain technologies; • Testing such technology to connected signalized traffic junctions.
Student background / interest:	• Interest in road network management • Aptitude to learn blockchain technology
IP Issues	☐ The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Eye blink detection and characterization

Project Proposer:	Dr Tracey Camilleri tracey.camilleri@um.edu.mt
Main Supervisor:	Dr Tracey Camilleri tracey.camilleri@um.edu.mt
Co-supervisor:	Dr Nathaniel Barbara nathaniel.barbara@um.edu.mt
Problem Background:	The act of blinking, a seemingly involuntary action, is a gateway to understanding various facets of human physiology and behaviour. On average, human beings blink 15-20 times per minute and the detection and characterization of eye blinks can hold significant implications for health monitoring, driver safety, human-computer interaction and emotion recognition. Abnormalities in blink patterns can serve as early indicators of neurological disorders, eye diseases, fatigue, drowsiness, or emotional distress. However, the effectiveness and robustness of different technologies in detecting and characterizing these blinks remains a pertinent question. Two primary approaches for recording eye movements include vision-based eye gaze trackers and electrooculograms (EOGs). Vision-based eye gaze trackers process real-time images to extract valuable data, such as pupil-size, from which blink dynamics can be extracted. EOGs, on the other hand, record electrical signals during eye movements through electrodes placed around the eyes. Processing of these signals can also provide valuable insights on the blink dynamics.
Project Objective(s):	The goal of this project is to explore and compare the robustness of blink detection and characterization using two different technologies: a vision-based eye gaze tracker and an electrooculogram. The objectives of this project are thus the following: • Familiarize oneself with the Biopac ETV head-mounted glasses and EOG recording equipment. • Establish a synchronized setup for simultaneous data collection using both technologies. • Conduct experiments to record blink-related data from human subjects. • Utilize open-source code and customize signal processing algorithms to extract blink-related information accurately from both technologies. • Analyse and compare the blink characteristics derived from vision based data and EOG recordings and evaluate the strengths and weaknesses of each. Throughout this project the student will foster technical skills in data acquisition, signal processing, programming and data analysis.
Project Resources:	All equipment needed to carry out this project is available in the Biomedical Engineering Lab.
Industrial Partners involved:	Not applicable
Expected Project Deliverables:	• Literature review on eye blink detection and characterization. • Setup for recording eye blinks using a head-mounted eye gaze tracker and an electrooculogram. • Eye blink dataset recorded from human subjects.

	• Algorithms for the detection and characterization of eye blink data. • Performance comparison of the effectiveness of the developed algorithms to extract robust eye blink dynamics using the two different technologies.
Student background / interest:	Interested students are expected to be proficient in signal processing and possess **good** programming skills. While familiarity with Python is beneficial, it is not a prerequisite, however students should be open to acquire proficiency in Python as necessary, considering the availability of open-source code in this language.
IP Issues	Not applicable.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Identifying Optimal Investment Strategies with Deep Learning

Project Proposer:	Kenneth Scerri, *kenneth.scerri@um.edu.mt, SCE*
Main Supervisor(s):	Kenneth Scerri, *kenneth.scerri@um.edu.mt, SCE*
Co-supervisor (if any):	
Problem Background:	Can machines be better investors than humans? The rise of Artificial Intelligence (AI) and cloud computing has seen the birth of the Fintech industry - that is the adoption of computing and cloud technologies in the financial markets. One main use of modern computing in the financial world is in the identification of advantageous investment decisions through the use of Machine Learning (ML) and AI. Often, this is also coupled with automated rapid investment by the algorithms unsupervised by any human investor. The aim of this thesis is to investigate the use of deep learning in identifying profitable investment strategies. As a first step, stock prices will be read through various APIs as input to the algorithms. Various deep reinforcement learning techniques will be tested with special attention at capturing the non-stationary nature of the data. A comparison of these methods will be carried out based on the financial returns obtained by each algorithm as a result of simulated investments. For a deeper insight on the problem and some of the techniques, please read: https://www.mdpi.com/2076-3417/13/3/1956
Project Objective(s):	• Develop a module to read and store stock prices • Develop an investment simulator based on stock prices • Develop and compare deep learning algorithms for automated investments
Project Resources:	• Budget: € 0 • Indicate source of funds: N/A • Equipment/Software/Literature: All software and literature available
Industrial Partners involved:	
Expected Project Deliverables:	• A module to read and store stock prices • An investment simulator • A comparison of different deep learning methods aiming to identifying advantageous investment strategies
Student background / interest:	• AI and Deep Learning • Data Science • Programming skills (programming will be done in Python - though no previous Python experience is required.)

IP Issues	☐ The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Development of a Camera System for the Inspection of Small-Diameter Boreholes

Project Proposer:	*Prof. Ing. Andrew Sammut, andrew.sammut@um.edu.mt* *Electronic Systems Engineering*
Main Supervisor(s):	*Prof. Ing. Andrew Sammut, andrew.sammut@um.edu.mt* *Electronic Systems Engineering*
Co-supervisor (if any):	*Dr Ing Evan Dimech, evan.dimech@um.edu.mt* *Electronic Systems Engineering*
Problem Background:	Traditionally, the nature and quality of rock and its discontinuities have been assessed by gathering samples through rock core extraction and inspecting them in a laboratory. A drawback of this technique is that samples are often extracted in a severely disturbed state after borehole drilling, making the identification of fissure patterns a difficult task. This is especially true for small-diameter boreholes (63 mm and 101 mm boreholes). Another technique that has been recently used involves the insertion of electronic instruments – including cameras – in pre-drilled boreholes. The key advantage of this technology is that it requires minimal site intervention, allowing geotechnical engineers better understanding of the rock mass and its discontinuities before excavation. Currently, a multidisciplinary project (RockSense) is underway, in which a prototype electronic instrument for borehole inspection is being developed. (https://www.um.edu.mt/newspoint/news/2023/11/rocksense-project).
Project Objective(s):	• To establish the requirements of a camera system that could be integrated in a downhole probe, to obtain information that may be useful to characterise the rocks. • To procure a number of cameras that fulfill the established requirements. • To benchmark a number of cameras by deploying them in various boreholes. • To design and build a prototype camera system, with the ancillary hardware (e.g. lighting) and software (e.g. control of camera parameter).
Project Resources:	• Indicate source of funds: Department funds / research funds / Project RockSense. • Literature related to project RockSense is available. • A number of small-diameter boreholes previously drilled close to the Faculty of Engineering Building will be available for testing purposes. • Equipment to test devices in small-diameter boreholes is available.
Industrial Partners involved:	• None
Expected Project Deliverables:	• A list of requirements for a camera system that could be integrated in a downhole probe, to obtain information on the rock mass. • Benchmarking a number of candidate cameras. • Developing a prototype downhole device to test a number of cameras together with their ancillary hardware and software, in real boreholes.

Student background / interest:	• Working on multidisciplinary projects. • Microprocessors and interfacing. • Prototype development.
IP Issues	☐ The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

AI-driven Trajectory Planning for Aviation

Project Proposer:	*Dr Ing. Brian Zammit, brian.zammit@um.edu.mt,* *Department of Electronic Systems Engineering*
Main Supervisor(s):	*Brian Zammit, brian.zammit@um.edu.mt* *Department of Electronic Systems Engineering*
Co-supervisor (if any):	*Dr Ing. Jason Gauci, jason.gauci@um.edu.mt,* *Institute of Aerospace Technologies*
Problem Background:	In the field of aviation, trajectory planning is a critical component for enhancing operational efficiency and safety. Traditional planners rely on mathematical optimization models that are limited to adapt to changing conditions and therefore struggle with the complexities of real-time aviation environment, such as weather disturbances, traffic congestions and no-fly zones. With the increasing capabilities of artificial intelligence (AI), the situation can be greatly improved. Solutions could leverage machine learning to optimize and improve routing decisions using inputs such as historical patterns and real-time information. Based on the real-time conditions, an AI based system could formulate and solve a routing problem that allows for improved flight efficiency, reduced fuel consumption, enhanced safety and minimised delays.
Project Objective(s):	• Review of machine learning algorithms and their application to trajectory planning. • Identification of required data, such as historical flight paths, weather patterns, air traffic data and review of how this can be used to train the AI models. • Development of AI based trajectory planner. • Training of the model. • Testing using simulated scenarios.
Project Resources:	• Indicate source of funds: ESERP09-24: AERO-PATH AI: Adaptive Efficient Routing & Operational PATH-planning with Artificial Intelligence. • Equipment/Software/Literature: Phyton OR MATLAB.
Industrial Partners involved:	• None
Expected Project Deliverables:	• Literature review on AI based models for trajectory planning. • Datasets used for training purposes. • Development and training of a trajectory planning model. • Testing of the resulting model using simulated scenarios.
Student background / interest:	• Artificial Intelligence. • Programming.

IP Issues	☐ The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Design of a Wireless Communication System for Inter-Vehicular Data Exchange

Project Proposer:	*Dr Paul Zammit, paul.zammit@um.edu.mt* *Department of Electronic Systems Engineering*
Main Supervisor(s):	*Dr Paul Zammit, paul.zammit@um.edu.mt* *Department of Electronic Systems Engineering*
Co-supervisor (if any):	*None*
Problem Background:	According to the NSO, an average of 32 new vehicles per day were license in 2022, and this trend has been sustained over several years. The obvious consequence of this is an ever-increasing traffic congestion problem on the local road network. To mitigate this problem, the government has embarked on an extensive upgrade of the road network. However, this is expensive (Marsa Junction project alone cost around €30M) and has a significant impact on the environment. An alternative approach is the use of intelligent traffic management system (ITMSs), where congestion is alleviated through the management and/or optimal routing of traffic. The aim of this project is to design a wireless communication system intended for use in an ITMS. The system is envisaged to allow the exchange of data between vehicles on the road in order to enable the monitoring, and eventually the management of road traffic.
Project Objective(s):	• Design of the system. • Development of the associated software/firmware. • Testing.
Project Resources:	• ESE labs, IDEs, PCB CAD software, PCB assembly. • Budget for ICs and PCB manufacturing available.
Industrial Partners involved:	
Expected Project Deliverables:	• Dissertation. • Conceptual design of the system. • Prototype of the system firmware.
Student background / interest:	• Electronic systems design. • Embedded systems. • Embedded software development. • Hardware design and prototyping. • Basic PCB antenna design.
IP Issues	☐ The project is IP sensitive; please specify.

Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Comparative Analysis of Pre-Compliance EM Conducted and Radiated Emissions in Automotive Products

Project Proposer:

Dr. Ing. Evan Dimech, evan.dimech@um.edu.mt
Department of Electronic Systems Engineering

Main Supervisor(s):

Dr. Ing. Evan Dimech / evan.dimech@um.edu.mt
Department of Electronic Systems Engineering (Electromagnetics Research Group)

Co-supervisor (if any):

Prof. Lourdes Farrugia, lourdes.farrugia@um.edu.mt
Department of Physics (Electromagnetics Research Group)

Problem Background:

Industrial automotive products, including electronic components and systems, are subject to stringent regulations regarding electromagnetic interference (EMI). EMI can adversely affect the performance of these products and may interfere with other electronic devices, posing safety and reliability concerns. Therefore, assessing and mitigating EMI during product development and testing phases is crucial. While accredited laboratory test houses are commonly utilised for EMI testing due to their adherence to standardised procedures and recognised certifications, their use during product development is often limited by their high cost and availability issues. Given these challenges, pre-compliance laboratories offer a viable alternative, providing cost-effective solutions for initial EMI testing during product development. Pre-compliance testing allows manufacturers to identify potential issues early on, reducing the likelihood of costly rework and delays in the production cycle. Additionally, pre-compliance laboratories often offer greater flexibility and shorter lead times than accredited test houses, making them more accessible to businesses of varying sizes and resource capacities. Overall, leveraging pre-compliance laboratories can streamline the EMI testing process, offering a practical solution for ensuring regulatory compliance and product quality while minimising expenses and overcoming availability constraints. Given these considerations, it's noteworthy that the University of Malta, through the TRAKE project, has recently invested in an EMC pre-compliance laboratory. This development presents a significant opportunity for both academia and industry. This study aims to leverage this new resource to conduct a comparative analysis of conducted and radiated EMI measurements obtained from certified products and those produced through the pre-compliance laboratory at the University of Malta. By conducting such a comparative analysis, one can assess the pre-compliance laboratory setup's effectiveness and reliability in accurately predicting industrial products' EMI performance.

Project Objective(s):

This study will provide insights into the university's laboratory's capabilities in supporting industrial EMI testing needs and its alignment with recognised standards and regulations.

To achieve this, the following steps will be undertaken:

- Conduct a comprehensive literature review of conducted and radiated EM emissions testing, measurement procedures, and setups.
- Review relevant industrial EM conducted and emissions standards and corresponding limits.
- Identify multiple automotive products accredited for EM conducted and emissions testing.
- Familiarise with the different EM-conducted and radiated test equipment and software used in the university's EMC Pre-Compliance Laboratory.
- Develop the required experimental procedures to perform the necessary EM conducted and radiated emissions tests.
- Conduct a comparative analysis between the results obtained through the Pre-Compliance measurements and those obtained from accredited test houses to assess the level of measurement coherence.

Project Resources:	• Indicate the source of funds: University of Malta. • Hardware and software for EM-conducted emissions testing available within the EMC Pre-Compliance Laboratory and the EM Laboratory within the Department of Physics. • Hardware and software for EM-radiated emissions testing available within the EMC Pre-Compliance Laboratory and the EM Laboratory within the Department of Physics.
Industrial Partners involved:	• Methode Electronics Malta Ltd. (Ing. Steve Zahra).
Expected Project Deliverables:	• EM conducted and radiated emissions setup development. • Design and develop necessary ancillary hardware and software to support measurement procedures. • Design and develop EM Conducted and Radiated Emissions Measurement Procedures. • Comparative study of emissions measurements *obtained through the pre-compliance measurements and those obtained from accredited test houses.*
Student background / interest:	• Electromagnetics and RF/Microwave Engineering. • Analogue and Digital Electronics.
IP Issues	✓The project is IP sensitive; please specify. (This project will be covered by a Non-Disclosure Agreement (NDA) between the University of Malta and Methode Electronics Malta Ltd. regarding the automotive electronic products to be tested.)
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Software Radio for a UHF Phased Array Ground Station

Project Proposer	*Prof. Ing. Marc Anthony Azzopardi, marc.azzopardi@um.edu.mt* *Department of Electronic Systems Engineering*
Main Supervisor(s):	*Prof. Ing. Marc Anthony Azzopardi, marc.azzopardi@um.edu.mt*
Co-supervisor (if any):	*None.*
Problem Background:	As part of the ASTREA project we are developing an innovative ground station based on a geodesic phased array antenna (GDPAA) in preparation for the launch of our first set of satellites. This requires the development and completion of software the drive a multi-beam phased array coupled to an accurate Dual-channel Software Defined Radio (SDR) System. The Department has invested in a sophisticated FPGA - based SDR hardware platform to allow the implementation of a flexible setup that can implement all the necessary algorithms that are required to implement the radio downlink and uplink from/to satellites operating in the UHF range. The project also involves electronically steering multiple highly directional beams of radio waves to allow rapid computer-controlled scanning of the sky, which is particularly useful during the initial localisation and tracking of newly deployed satellites. A secondary role of this project is to create a working SDR system based on the said platform to down-convert, demodulate and decode radio signals received from any satellite operating in the UHF range and interface the SDR to a ground station PC. The uplink portion is also required to operate in tandem with the downlink.
Project Objective(s):	***This is primarily a Software / Firmware development project!*** • Conduct a detailed literature review and of all prior work. • Familiarise with the Software Radio Platform and associated software. • Design and implement a working beam forming and beam steering system. • Test the beam-forming and software radio setup using existing satellites. • Improve functionality and robustness as necessary.
Project Resources	• Source of funds: ASTREA Project and Supervisor's industrial partners. • Resources available in the Department include: Advanced software radio. system, RF front end and antenna prototypes, Design software tools, PCB prototyping, assembly and diagnostic equipment, RF oscilloscopes, RF sources and spectrum analyser, Literature, and some of the raw materials.
Industrial Partners:	• None
Expected Project Deliverables:	• D1: Literature review on hardware design for UHF Phased Array front ends. • D2: Software Defined Radio based on the provided platform. • D3: Beam forming and beam scanning software on PC.
Student background / interest:	• ESE3203 (FPGAs), ESE3204 (RF electronics), ESE4105 (Radio Electr.) • An interest in communications and radio-frequency electronics. • Excellent technical skills and experience in hardware implementation. • Good first-hand experience with embedded systems & programming.
IP Issues	☐ The project has patent possibilities; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form online available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee

	(UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Autonomous Ground Vehicle Guidance and Navigation

Project Proposer:	*Prof. Ing. David Zammit-Mangion,* david.zammit-mangion@um.edu.mt *Department of Electronic Systems Engineering*
Main Supervisor(s):	*Prof. Ing. David Zammit-Mangion,* david.zammit-mangion@um.edu.mt *Department of Electronic Systems Engineering*
Co-supervisor (if any):	*none*
Problem Background:	This project title is broad and the student can, on discussion with the supervisor, choose the specific area and tasks to be carried out in the project. The general aim is to develop an automatic ground vehicle guidance and navigation system for a radio control vehicle to run automatically (without radio control input). Specific tasks to choose from include (but are not limited to): • Development of integration algorithms to integrate GPS with inertial data, using Kalman filters. A loosely coupled system will be sufficient. • The development of guidance and control algorithms. • The implementation of algorithms in a target (microcontroller) system. • The integration of sensors with a target microcontroller. Sensors include GPS and an inertial measurement unit (IMU). • The integration of the microcontroller system onto a radio-controlled vehicle. • Validation of the algorithms and evaluation of the system performance. Depending on the specific tasks chosen by the student, the work can be either primarily on software (using hardware-in-the-loop testing) or may involve the complete integration and testing of a physical system (ie: including the physical vehicle). In the latter case, the system, which will be installed on a small radio-controlled vehicle modified for the task, should be able to navigate and guide the platform through pre-programmed paths.
Project Objective(s):	• To design, build and test an autonomous guidance and navigation system for a radio-controlled car.
Project Resources:	• Indicate source of funds: Institute of Aerospace Technologies • Equipment/Software/Literature: Matlab/C++/target processors; sensors; radio-controlled vehicle.
Industrial Partners involved:	• None.
Expected Project Deliverables:	• A working prototype (software and hardware, as appropriate). •
Student background / interest:	• Electronics and interfacing. • Microprocessor/target systems. • Control systems (preferably). • Software development.

IP Issues	☐ The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.