

Department of Electronic & Electrical Engineering

MEng/BEng in EEE

19496 Individual Project

This document is organised in to six parts:

PART 1: STATEMENT OF INTENT
PART 2: PROJECT WORK PLAN
PART 3: RESOURCE REQUIREMENTS
PART 4: RISK ASSESSMENT
PART 5: SUSTAINABILITY, ETHICS, INCLUSIVITY
PART 6: SAFETY DECLARATION & ETHICS APPROVAL

- All parts of the form must be completed jointly by the student and Project Supervisor, and lodged (by the student) on MyPlace by 14.00 on 18th October 2023.
- Copies of the completed form should be sent to the Project Supervisor.
- The student is advised to retain a copy of the completed form for future reference - ideally affixed inside their project logbook.
- Students will be asked to reflect upon parts 1, 2 and 4 at the interim stage and also in the final report.

Supervisor's Name: Dr Carmine Clemente	Student's Name: Andrew McAllister
Project Title: Investigation into Information Extraction from Raw SAR Data using AI Approaches	

PART 1: STATEMENT OF INTENT

The purpose of this section is: (i) to provide a concise description of the project, and (ii) to state a set of objectives that will provide the guide for assessing the project. Students should note the importance of item (ii), which should be discussed in detail with their project supervisors.

A. Project Description:

The student, in consultation with the Project Supervisor, is required to describe the project in THEIR OWN WORDS in the space provided below (in about 200 to 300 words). Note that simply copying descriptions in the project listing is unacceptable. THIS PART SHOULD NOT BE COMPLETED BY THE PROJECT SUPERVISOR other than ensuring the accuracy of the description. DO NOT ATTACH EXTRA PAGES.

The core objective of this project is to improve current methods of processing and image acquisition from Synthetic Aperture Radar(SAR) data by using Deep Learning. It aims to do this by deploying a processing framework that, using an artificial neural network, is able to recognise targets from raw SAR Data. This work is very valuable as currently in order to recognise targets data must be processed to produce an image which is then used to identify targets. Unfortunately this process is both time and power consuming therefore this project if successful will greatly improve the efficiency of this process by being able to analyse raw SAR data, pick out any targets and perform the image acquisition process on only targets as opposed to wasting energy and time producing target-less images. An example of this process would be in maritime ship detection as instead of wasting energy on producing frames containing just the ocean, a neural network could be trained to pick out ships so that only frames of interest (containing ships) would be processed.

Due to the investigation nature of this project significant research will be required in both the fields of SAR and in Neural Networks in order to determine both the feasibility and best approach to take in order to be successful. Significant research will be undertaken in the field of SAR data processing to fully understand the principles of SAR as well as the processing of the systems data including the image acquisition process.

The AI approach this project will concentrate on is Deep Learning. The preferred Neural Network to be used in this project is a Spiking Neural Network however this is not a necessity and if after research it becomes clear that this is not possible/optimal then other types of network will be used.

The selection of this project has also taken into account the United Nations Sustainable Development Goals (UNSDG's) which are 17 goals set to inspire action in order to ensure that by 2030 all people enjoy peace and prosperity. One of these goals involves innovation of technology which this project can be considered as doing as it conducts research into new technologies surrounding radar processing.

B. Project Objectives:

Project objectives must be stated in such a way that they can be translated into achievable goals during the conduct of the project. For this reason, the stated objectives must be specific and realistic to be attained within the time provided. It will be very helpful if supervisors encourage their students to come up with initial objectives from students' perspective as this exercise could help students to better understand the aims of the project. It is important to note that the achievements of the project work will be measured against the objectives stated here. Copies of this section will be made available to persons involved with the assessment of this project.

1. Under the "Importance" column below, enter one of the following as appropriate: "Major", "Minor", or "Optional".
2. If at a later stage, the project objectives change significantly, these changes must be communicated clearly in the interim and final report as appropriate.

Project Objectives	Importance
Research Synthetic Aperture Radar systems and image acquisition process	Minor
Conduct research into different types of AI Neural Networks	Minor
Identify appropriate and substantial datasets to be used and label (if not already)	Major
Develop a Processing Framework to perform object detection from Raw SAR Data	Major
Improve efficiency of current processing method of raw SAR data	Major
Perform a Performance Assessment of the Processing Framework	Major
Investigate Spiking Neural Networks and incorporate into Processing Framework	Optional

PART 2: PROJECT WORK PLAN

Identify project milestones and summarise your work plans in the table below in the order you do them.
(Example: preliminary design, prototyping, simulation modelling, results validation, write-up, etc.).

	Project Milestones/Work Phases	Expected Week Time Enter start and end week Ex.: Week 6 to week 8
1	Research Synthetic Aperture Radar systems and image acquisition process	Sem1 Week 3 to Week 5
2	Conduct research into AI Neural Networks/ Deep Learning Methods	Sem 1 Week 5 to Week 8
3	Identify initial dataset and label(if required) and start to familiarise with it using traditional processes (Sentinal-1 Toolbox etc)	Sem 1 Week 6 to Week 8
4	Start preliminary design and planning of processing framework using selected AI approach based in research	Sem 1 Week 7 to Sem 1 Exam diet
5	Write Up of Interim Report	Sem 1 Week 7 to Week 11
6	Preparation for Feedback and Oral Examination	Sem 1 Exam diet to Sem 2 Consolidation week
7	Implementation of Processing Framework Design	Sem 2 Consolidation Week to Week 7

8	Validation of design by producing performance assessment of Processing Framework	Sem 2 Week 6 to Week 8
9	Write up of Final Report	Sem 2 Week 6 to Week 11
10	Design and make up Poster for Poster Day	Sem 2 Week 9 to 11

PART 3: RESOURCE REQUIREMENTS

A. Software:

List the software required for the project. This includes programming languages, application packages, CAD tools, etc.

Software (indicate version no. if applicable)	Software Administrator (EEE/MAE/CIS Dept, Comp. Centre)	Installed Location (Dept/Central University/ Personal computer).	Expected Usage (hours/week)
Matlab	EEE	Personal Computer	13
Python (Potentially if chosen over Matlab)	EEE	Personal Computer	13
Sentinel-1 Toolbox	Open Source	Personal Computer	4 (Will not be used every week)
PolSARpro	Open Source	Personal Computer	4 (Will not be used every week)

B. Hardware:

List major hardware components such as circuit boards, microcontrollers, LSI/VLSI integrated circuits, and special purpose equipment and facilities.

Project is entirely computer based due to nature of technology being investigated (Radar Systems & AI), so no hardware will be required for the project

C. Background Information & Required Reading

Describe sources of information (in library and elsewhere) required to undertake project

Online Video Lectures:

NASA Lectures on Synthetic Aperture Radar (YouTube);

University Materials:

(Class on AI & Deep Learning could have material of value)

MathsWorks Documentation on Radar:

AI for Radar;

SAR processing and Deep Learning Approaches in Matlab:

SAR Target Classification using Deep Learning;

Radar;

ERS SAR Raw Data Extraction and Image Formation

Library Books:

Practical MATLAB Deep Learning: A Project Based Approach;

IEEE Published Papers:
CNN-Based SAR Automatic Target Recognition Using SAR Raw Data;
Deep Learning for Radar and Communications Automatic Target Recognition;

From GitHub:
Unicorn 2008 Dataset Overview;

Provide details of the two most important sources of information already identified

From IEEE:
Title; "CNN-Based SAR Automatic Target Recognition Using SAR Raw Data",
Authors: X. Ruan, L. Wang, J. Guo, D. Zhu and C. Hu,
Delivered: 2021 CIE International Conference on Radar (Radar), Haikou, Hainan, China, 2021,
PP: 1405-1408
DOI: 10.1109/Radar53847.2021.10028316.

From IEEE;
Title; "Deep Learning for Radar and Communications Automatic Target Recognition",
Authors: Uttam Majumder, Erik Blasch, David Garren,
Delivered: Artech 2020,
DOI: 9219995.

D. Laboratory/Work Area:

Indicate the laboratory room(s) and/or project work area for the project.

Computer Lab - TIC 703

With regards to practical work there is no expectation/requirement that practical work on the project is carried out anywhere other than on University campus. Any work that is carried out off-site must be fully agreed by supervisor and explicitly covered by the project's risk assessment – and listed in the space provided below.

D. Logbook:

Confirmation that student has A4, hardback, bound logbook that has been viewed by the supervisor and/or arrangements have been made for shared access for electronic logbook/progress records. (Teams/OneNote recommended) YES (delete one)

PART 4: TECHNICAL RISK

Management of project work requires that technical risk be assessed in advance, during initial planning and as an ongoing process. As the first stage to this process, identify any aspects of risk associated with your project proposal. Risk in this context is taken to mean any event or action (or inaction) that would jeopardise any project outcomes or significantly impede project progress. Furthermore, having identified such potential risks, indicate what actions you would take to mitigate the effects of this risk. (Consult your supervisor for advice but examples of such risks include non-delivery of a key component, illness or absence from University, non-completion by student or other of key deliverable, equipment malfunction, extended learning curves-new techniques or software, etc.).

	Possible Risk:	Mitigating Action:
1	Insufficient data to train AI model	Can potentially edit data to create different scenarios Potential to source more data externally/ use synthetic data
2	Loss/Corruption of files containing work	Files will be stored locally on personal computer as well as externally on cloud drive and a copy on a USB drive to ensure multiple copies are kept safely.
3	Insufficient time available to access lab	Looking at possibility to book a regular slot ahead of time so I have regular weekly access to the lab computer (ideally on Tuesday/Thursdays).
4	Absence from University due to illness/ unforeseen circumstances	Keep up communication with supervisor on progress and if possible progress in areas of project that are possible from home without need of Lab (writing code, designing poster, writing report etc).
5	Fault in Lab computer	Matlab/Python will be installed on Personal Computer so potential to continue work using own device, if work requires lab computer due to complexity other work can be started ahead of schedule. Some of examples of less complex work are stated above in Technical Risk 4.
6	Unsuccessful Delivery of Processing Framework using only raw data	Overarching goal of this project is to improve the efficiency of SAR data processing so as a precaution this goal is kept in mind in the case some processing of data is required in the final framework as long as it is attempting to minimise this processing to improve overall efficiency

PART 5: SUSTAINABILITY, ETHICS AND INCLUSIVITY

All project students will in the course of their work implement and develop technological advancements, either through the creation of prototypes, software tools and or generation of new know-how/ways of doing things. The focus of such development is typically aligned to a combination of technological, societal or financial drivers.

As major drivers of technology advancement, engineers have key role in stewardship of the planet's resources. Sustainability could be demonstrated by comparing the developments, techniques and ideas that encompass the project and making comparison to status quo, how resources can be saved/reserved etc. Furthermore, new developments to address current needs should not negatively impact the ability of future generations to meet and address their own needs. How would that be achieved/developed in the course of the project?

Ethics form an essential part of engineering practise and ensure that project teams and persons affected by project outcomes are all treated fairly, equally, openly and with integrity. These ethical standards can be considered and applied to the different phases of the project: planning; sourcing and utilisation of project inputs (data, raw materials, components etc.); milestones/decision points through the course of the project; implementation of the final deliverable(s); manufacturing; safety implications, both during the course of the project and in utilisation of any final deliverable.

Engineering and technology are for everyone and technological solutions to the many challenges we face as a society should encompass and benefit all members of society irrespective of age, gender, race, ability or socio-economic standing.

In considering your project, describe how aspects of sustainability, ethics and inclusivity have been considered and impacted the project and its outcomes. The Sol can be used to capture how such factors have influenced the initial planning of the project and subsequent reports, both interim and final, can be used to record how such factors have influenced the course of the project, deliverables, milestones, and outcomes.

This project takes into consideration matters of sustainability and ethics as laid out in the United Nations Sustainable Development Goals (UN) namely Goal 9 "Industry, Innovation and Infrastructure". Within this goal the UN describe investment in innovation as crucial to economic growth and development which applies to this project as it considers the innovation of current methods of radar data processing.

The project can be said to be both sustainable and ethical since it sets out to improve current radar processing methods by improving energy efficiency. Therefore one of the key focuses that will be taken into consideration when making decisions and evaluating the outcome of this project will be to save resources. Since the overconsumption of energy is a driver of many social/environmental problems in the world such as Climate Change it is the responsibility of engineers to drive innovation where possible to minimise waste, especially of energy. This is why the core objective of this project sets out to maximise efficiency and minimise energy waste which demonstrates how ethics and sustainability as well as delivering on the UNSDG's have been considered in the selection of this project.

PART 6: SAFETY DECLARATION & ETHICS APPROVAL

SAFETY DECLARATION

All project students must be aware of the need for safe working during the conduct of their project. The Area Safety Regulations for the Department of Electronic and Electrical Engineering, which appear in the Project and Course MyPlace pages and provide general guidance. Project students should consult with their Supervisor to obtain specific instructions or written additional Risk Assessment relating to their own project. By signing at the end of this form, the project student is declaring that they have:

1. attended the EEE UG Individual Project safety seminar.
2. completed the online safety assessment quiz
3. read and understood the Area Safety Regulations and will abide by these regulations during the conduct of the project, and
4. consulted with the Project Supervisor who, if applicable, has specified any additional Risk Assessment or additional Safe Systems of Work and Standard Operating Procedures. These need to be specified in a risk assessment completed and uploaded to the University's eRisk server.
<https://safetystrath.ac.uk/> in due course.

Location (Provide a summary of intended additional risk assessments. Enter NONE if not applicable)

None	NONE
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ETHICS APPROVAL

Please indicate below if the project may require ethics approval. Approval will be required if the project will utilise or generate personal data obtained directly from individuals (interviews, surveys, on-site measurements) or use clinical or personal data obtained from a 3rd party. The supervisor has ultimate responsibility to identify and then obtain appropriate ethics approval and the project will not progress (in this area) until such approval is granted.

Summarise below where/why ethics approval may be sought and when will be applied for	Approved
NONE	Y/N

Signature of Student *Andrew McAllister*.....

Date 17/10/2023.....

Signature of Supervisor



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Date 17/10/2023.....