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# ENG 4001 Project Management Plan *Machine learning techniques for radar target recognition*

This document outlines the plan from the early stage of the project. As it is the very beginning of the project, the plan mainly acts as a flexible schedule that guides the whole process. Therefore, this plan can be refined throughout the project.

## 1 Project aim and scope

This project concentrates on using machine learning approaches in radar target recognition which could benefit the radar community. This approach aims to provide an efficient method of target recognition by automating the process to reduce the workload and strive to improve classification accuracy.

The recognition process will initially be conducted by one machine learning approach on a training dataset generated from images of known targets before classifying simulated targets. Other machine learning algorithms will be investigated with comparison in extracted accuracy that is later used to select the highest performance algorithm. The latest design is then applied to data of real targets to verify the performance before modifying for further developments.

## 2 Background

The need for target detection for military purposes has never decreased. Capturing moving targets in extreme weather is a challenge for radar operations and requires a massive workload in the detection and classification process. Inverse Synthetic Aperture Radar (ISAR) is a technique for imaging a target based on its relative movement. Automatic target recognition (ATR) is the process of using a deep learning-based technique to detect targets based on the ISAR images obtained by radar operators.

In recent years, there have been numerous successful applications of deep learning-based techniques in many fields [1]-[4]. In the radar community, deep learning techniques are widely used in detecting and classifying radar targets [4]-[5], data augmentation and synthetic aperture radar (SAR) imaging [6]. Those successful applications are great motivation and valuable resources for this project to be conducted.

Replicating previous research is a valuable contribution in its own right. Enhancing and developing something that has already been proven is essential in verifying the validity of the findings and providing the world with more opportunities for research applications. In [1], the use of a Convolutional neural network (CNN) with the 3D-ISAR point cloud in target recognition automates the process successfully with high accuracy and resolves the recognising difficulty of 2D-ISAR imagery. Therefore, this project aims to replicate and combine the ATR process of [1] and look for space for improvement.

# 3 Technical objectives

Critical technical objectives are listed in table 1 below. Each objective has detailed specifications and desired outcomes in the right column of the table. Detailed work breakdown structure (WBS) is attached in appendices.

*Table 1: Objectives of the project and their key specifications and outcomes.*

| # | Objective description | Specifications | Deliverables / outcomes |
|---|---|---|---|
| 1 | Conduct research on radar working principles and ISAR image | *• Summarize the working principle of the radar in the report<br>• Find out how ISAR image is represented and how it is generated<br>• Have the idea of images classification* | *• Report of radar working principles and ISAR image representation<br>• Demo of ISAR image classification* |
| 2 | Apply machine learning in recognising the target | *• Find a suitable machine learning algorithm to build up an ATR model.<br>• Train the model with a simulated dataset<br>• Testing for simulated target recognition* | *• Model is built successfully<br>• It can recognise and classify targets automatically* |
| 3 | Finding accuracy improvement | *• Test and record accuracy of the model<br>• Retrain or redesign the model and record extracted accuracy in a table for at least three algorithms<br>• Compare accuracy between designed models* | *• Obtain the model with the highest accuracy performance* |
| 4 | Use the ATR model on real data. | *• Test and record accuracy of the model<br>• Compare different outcomes between actual and simulated data<br>• Redesign for improvement if necessary* | *• Documents of differences in model outcomes extracted from real and simulated data<br>• Possible opportunity for improvement* |

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# 4 Gantt Chart

Figure 1 below illustrates the Gantt chart, which schedules the project plans with all critical objectives and process documents.

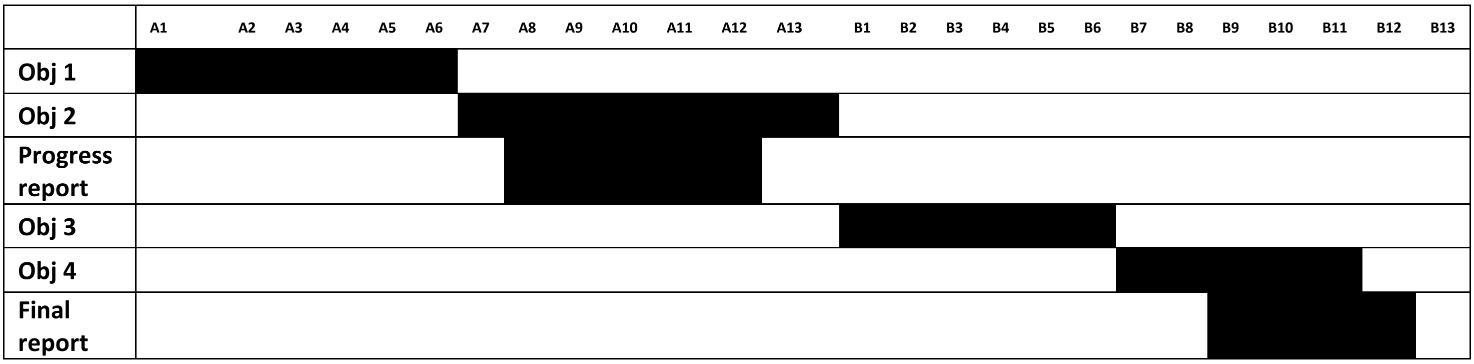


*Figure 1: Overview of the main activities of the project.*

# 5 Resources and procurement

Table 2 below details all required resources for the project. The simulated dataset to train the models and software license can be provided by The University of Adelaide. The University of Adelaide library also has books and documents needed for research.

*Table 2: In-kind resources that will be used by the project.*

| # | Item | Source |
|---|---|---|
| 1. | *Simulated dataset* | *The University of Adelaide* |
| 2. | *Required software (Matlab)* | *The University of Adelaide* |
| 3. | *Documents for research* | *The University of Adelaide library* |

# 6 Project risks

Risk assessment has been conducted and is illustrated in table 3 below with the suitable mitigation measures provided, which mainly aim to reduce the likelihood of the risk event.

*Table 3: Identified project risks, their inherent risk classifications before mitigation, and their mitigation measures.*

| # | Risk event | Impact | Likelihood / Consequence / Classification | Mitigation measures |
|---|---|---|---|---|
| 1 | *Late conduction for Project Plan* | *Delay starts on implementation* | *Unlikely / Major / Medium* | *Spend at least 3 hours a day on it* |
| 2 | *creeping research scope* | *Late conduction of Literature review, delay starts on implementation* | *Possible / Major / High* | *Write down the research questions and try to stick to them.* |
| 3 | *Models fail in target recognition* | *Project failed* | *Possible/ Severe / Very high* | *Write down the mistakes and redesign the model with more papers researched.* |

| | | | | |
|---|---|---|---|---|
| 4 | *Data sets not available* | *Models cannot be trained* | *Possible/ Major / High* | *Seek other resources on the internet or re-request the University* |
| 5 | *Lack of computing resources* | *Training and Testing algorithms take lots of time or cannot be completed* | *Likely/ Major / Very high* | *Request for permission to use the University resource* |
| 6 | *Fail in improving the accuracy within the time bound* | *The project does not meet the specification* | *Unlikely / Major / Medium* | *Conduct each step of the research carefully and always check for improvement. The last option is to conduct the report on the model with the best performance.* |

# 7 References

[1] C. Pui, B. Ng, L. Rosenberg and T. Cao, "Target Classification for 3D-ISAR using CNNs".

[2] M. Pak and S. Kim, “A Review of Deep Learning in Image Recognition,” in 2017 4th International Conference on Computer Applications and Information Processing Technology (CAIPT). IEEE, 2017, pp. 1–3.

[3] Effects of data count and image scaling on Deep Learning training

[4] Ship Classification in High-Resolution SAR Images Using Deep Learning of Small Datasets

[5] Z. Zhao, K. Ji, X. Xing, W. Chen and H. Zou, "Ship Classification with High Resolution TerraSAR-X Imagery Based on Analytic Hierarchy Process", *International Journal of Antennas and Propagation*, vol. 2013, pp. 1-13, 2013. Available: 10.1155/2013/698370.

[6] Y. Li, C. Peng, Y. Chen, L. Jiao, L. Zhou and R. Shang, "A Deep Learning Method for Change Detection in Synthetic Aperture Radar Images," in *IEEE Transactions on Geoscience and Remote Sensing*, vol. 57, no. 8, pp. 5751-5763, Aug. 2019, doi: 10.1109/TGRS.2019.2901945.

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# 8 Appendices

## Appendix A – Work breakdown structure (WBS)