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Master Thesis Proposal

Federated Learning for Object Detection Using 3D Depth Images

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1 Introduction

1.1 Topic of This Thesis

- TODO: Put a story or a very basic scenario here to make the reader understand the problem.

1.2 Relevance of This R&D Project

- Who will benefit from the results of this R&D project?
- What are the benefits? Quantify the benefits with concrete numbers.

2 Related Work

2.1 Survey of Related Work

- What have other people done to solve the problem?
- You should reference and briefly discuss at least the “top twelve” related works

2.2 Limitation and Deficits in the State of the Art

- List the deficits that you have discovered in the related work and explain them such that a person who is not deep into the technical details can still understand them. For each deficit, provide at least two references
- You should reference and briefly discuss at least the “top twelve” related works

3 Problem Statement

- Object detection using multiple modalities has become a topic of increasing interest in recent years. However, despite the wealth of research in this area, there is still a lack of comprehensive analysis and practical implementation

of state-of-the-art methods under adverse weather conditions. Therefore, the primary objective of this research project is to provide a thorough analysis and practical implementation of state-of-the-art methods for object detection using multiple modalities, including but not limited to camera, LiDAR, and radar.

- The comparative analysis of the results will include an assessment of the strengths and weaknesses of each approach with respect to existing state-of-the-art methods.

4 Project Plan

4.1 Work Packages

WP1 Literature Study

- WP1.1 Conduct a comprehensive literature review of state-of-the-art methods for object detection under adverse weather conditions using multiple modalities
- WP1.2 Analyze and compare various fusion strategies for exploiting the complementary characteristics of different sensors
- WP1.3 Search for suitable public datasets with adverse weather conditions and multimodal sensors data

WP2 Data Collection and Preparation

- WP2.1 Acquire the necessary datasets for multimodal object detection under adverse weather conditions, such as K-radar, DENSE, and aiMotive
- WP2.2 Develop tools for pre-processing and augmenting the datasets to enhance the performance of the models
- WP2.3 Perform statistical analysis to identify the main characteristics and challenges of the datasets, including data imbalance and class imbalance

WP3 Model Design and Implementation

- WP3.1 Design and implement an existing multimodal object detection architectures that integrates camera, LiDAR, and radar data
 - WP3.2 Investigate various fusion strategies, such as concatenation, mixture of experts, attention-based fusion etc, to determine the most effective approach
 - WP3.3 Explore deep learning architectures, such as CNNs, RNNs, and Transformers, to improve the performance of the multimodal model
 - WP3.4 Optimize the model's hyperparameters and train the model on the acquired datasets
- WP4 Model Evaluation and Validation
- WP4.1 Evaluate the performance of the developed multimodal object detection model on the acquired datasets under adverse weather conditions
 - WP4.3 Compare the proposed model's results to existing state-of-the-art or baseline methods and analyze the strengths and weaknesses of each approach
 - WP4.4 Identify the limitations of the proposed model and suggest possible future improvements
- WP5 Project Report
- WP5.1 Write a detailed report that includes the research problem, objectives, methodology, results, and conclusion
 - WP5.2 Present the research findings in a clear and concise manner, highlighting the contributions and limitations of the proposed multimodal object detection model
 - WP5.3 Discuss possible future research directions based on the outcomes of the study

4.2 Milestones

- M1 Literature review completed and best practice identified

- M2 Data collection and preprocessing completed, including cleaning and augmentation
- M3 Initial model development and testing completed
- M4 Evaluation and optimization of the model completed
- M5 Final model development and testing completed, including comparison with existing state-of-the-art methods and analysis of strengths and weaknesses of each approach.
- M6 Project report completed

4.3 Project Schedule

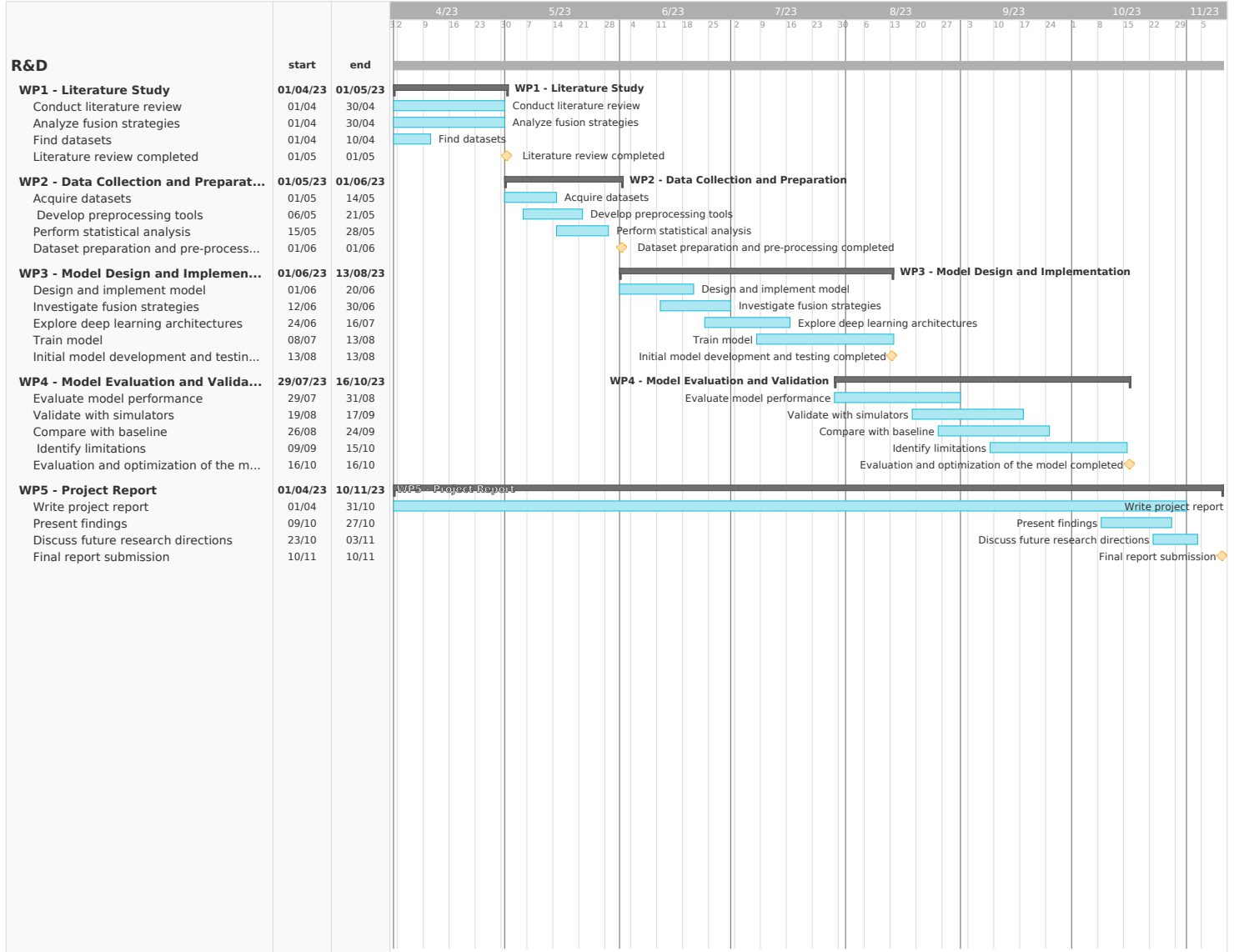


Figure 1: Gantt chart of the project schedule

4.4 Deliverables

Minimum Viable

- Conduct a comprehensive literature review on state-of-the-art multimodal object detection methods and their fusion strategies
- Develop and test existing models for object detection
- Perform a comparative analysis of at least two methods on one dataset
- Produce a project report that summarizes the work done and the results obtained

Expected

- Compare the performance of more advanced methods with the baseline methods
- Complete the final development and testing of the model, including comparison with existing state-of-the-art methods and analysis of the strengths and weaknesses of each approach.
- Produce a more extensive project report that details the methodology, experimental setup, results, and analysis.

Desired

- Compare the developed models' performance on one or more additional datasets.
- Propose improvements to the baseline fusion methods.

References

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