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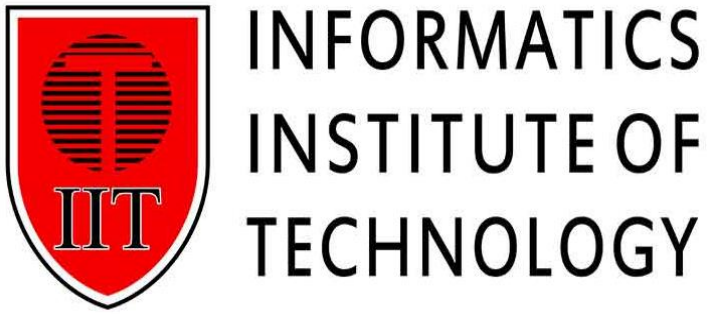

Traffic Management System

A Project Proposal by

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This Project Proposal is submitted in partial fulfilment of the requirements for

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List of Abbreviations

CNN	Convolutional Neural Network
ML	Machine Learning
DL	Deep Learning
IOT	Internet of things
OCR	Optical Character Recognition
DNN	Deep Neural Network
VDL	Virtual Detection Lines
LIDAR	Light Detection and Ranging
GPS	Global Positioning System
IPTO	Improved Phase Timing Optimization
GSP	Generalized System of Preferences
ITS	Intelligent Transportation System

1.1 CHAPTER OVERVIEW

In this chapter the author has written an explanation about the aim of writing of this proposal, the problem domain is also explained by adding the problem statement where it is elaborate about the addressing problem of the research. Along with that is provides an organized explanation of the exsiting working of the research problem to be addressed. Also the research gap where the research is about to address along with the aim, the objectives, the contributions towards the technological and problem domain and the challengers about the research. The author also provides the scope of the research as well and it is further elaborated using prototype feature diagram.

1.2 INTRODUCTION

By providing a structural overview of traffic management, this proposal aims to comprehensively understand how it impacts daily commuters as well as road management institutions and authorities. A review of existing work on the research topic will also be presented. Furthermore, the problem-solving approach suggested by the author is also discussed in the proposal.

1.3 PROBLEM DOMAIN

Effective Traffic Management

Congestion may boost the number of accidents, harm economic growth, and result in higher gas emissions. Currently, traffic congestion is seen as a severe threat to urban life. Suffering as a result of increased car traffic, insufficient infrastructure, and inefficient traffic management has exceeded the tolerance limit. (Naveed et al., 2022) With an ever-increasing population growth in cities around the world, continuous production of all kinds vehicles by manufacturers, and the number of vehicles on the roads will only continue to rise. This naturally leads to increased traffic congestion, especially in large metropolitan areas and even more so during peak rush hour time. This phenomenon constantly puts pressure on researchers, city officials, and urban planners to continue to improve traffic management systems in ways that are safer and economically more efficient. In order to address this evolving problem, a number of studies have been conducted that have resulted in some notable improvements such as designated lanes for emergency vehicles in urban areas. (Avatefipour, 2018)

Issues faced by drivers and the Government due to traffic congestion

With ever-growing population growth in cities around the world, continuous production of all kinds of vehicles by manufacturers, and the number of vehicles on the roads will only continue to rise. This naturally leads to increased traffic congestion, especially in large metropolitan areas and even more so during peak rush hours. This phenomenon constantly puts pressure on researchers, city officials, and urban planners to continue to improve traffic management systems in safer and economically more efficient. (Avatefipour, 2018) Traffic management tools can be beneficial for both the public and private sectors because they can improve public safety, manage resources more efficiently, and increase economic output.

The importance of a traffic management system

The traffic inflow prediction adapts the traffic movement phase time accordingly and avoids long waiting queues and congestions at intersections. The smart navigation enables the optimal distribution of traffic to possible paths and subsequently improves road safety at intersections. (Deepajothi et al., 2021) Traffic management tools that use image-based intelligence and camera vision can help to alleviate traffic congestion by reducing the need for manual input, predicting traffic patterns, and providing real-time information to drivers. IoT can also help to improve public safety by providing information about potential hazards on the road. In addition, traffic management tools that use IoT can increase economic output by reducing the amount of time that vehicles are idling in traffic.

Traffic congestion can be solved using camera vision and image-based intelligence as part of a traffic management tool. A camera vision system can be applied to monitor traffic flow and identify congestion hotspots. It can also be used to provide real-time information to drivers about traffic conditions. Traffic congestion can be reduced with the help of this information, which may help drivers choose better routes.

1.3 PROBLEM DEFINITION

The traffic management system of a metropolitan city is a keystone for urban mobility. With the rise of the population, the demand for vehicles grows up and hence the requirement of transportation has also increased. Infrastructural development becomes an indispensable part of complementing the population growth to augment urban mobility. (M. K. M. Rabby et al.,

2019) Traffic congestion problems consist of incremental delay, vehicle operating costs, such as fuel consumption, pollution emissions and stress resulting from vehicle interference in the traffic stream, particularly as traffic volumes approach a road's capacity.

Traffic congestion occurs when demand is greater than available road capacity. Many reasons cause congestion. Almost all of them reduce the road's ability at a certain point or over a certain distance. There are always concerns that traffic congestion may delay emergency vehicles during critical moments when they need to arrive at the scene as quickly as possible.

1.3.1 Problem Statement

Matching the traffic demand with the optimal usage of available roads along with the concomitant optimization of citizens' private resources for travel needs is very important. Informally without using road traffic can be seen as managing traffic optimally on a road network using available public resources is very much crucial. This allows travelers to complete their travelling needs optimally and efficiently.

1.4 RESEARCH MOTIVATION

Traffic is a common day-today matter in all around the world and there are many existing systems in many technologies. IOT based Intelligent Transportation Systems make the exchange of information possible through cooperative systems that broadcast traffic data to enhance road safety. (S. Kumari et al., 2020) This rapid expansion has motivated many researchers all over the world to incorporate camera vision into traffic management systems. The result was an increase in accuracy in finding the cause and a higher level of traffic density in modern systems. Moreover, most of these solutions lack one common element: an effective monitoring system that can accurately measure traffic.

1.5 RELATED WORK

As the author's work is mainly focused on camera/computer vision-based techniques, a comparison was conducted along that path. Computer / Camera vision approaches using images and video processing as the input for detection models have been frequently used and implemented in Traffic Management Systems by most researchers.

Citation	Brief Description	Limitations	Improvement
(Sowmya et al., 2021)	This paper proposed an adjustable traffic signal timer to be used to calculate the traffic density using YOLO object identification and live pictures of cameras. Through that the paper elaborate the decreasing of the road traffic congestion and other traffic.	Some extra time added because of the lag in each vehicle suffers during start-up and the non-linear which increase in lag suffered by the vehicles which are at the back.	The proposed traffic control system is developed using a self-adaptive road traffic algorithm based upon DL which can promotes intersection flow of vehicles and reduces congestion, CO2 emissions, etc.
(Deepajothi et al. , 2021)	In this paper the author elaborates on Edge Cloud-centric IoT based smart traffic management system for traffic inflow prediction and time optimized smart navigation of the vehicles. The smart navigation optimizes the distribution of traffic flow into possible paths and subsequently improves road safety as well.	This proposed model will most beneficial to the surrounding residents in the facilities while providing safe, direct, vehicular access to new facilities.	This CNN based traffic management system will not be affected by weather conditions. This is also coordinate between multiple intersections connected to ensure smooth traffic flow. It also has the prioritization of emergency vehicles.
(kumari et al., 2020)	In this paper an IOT based Intelligent Transportation Systems is introduced to make the exchange of information	Fixed-time signal control system is not work properly due to the daily changers in traffic ratio.	The proposed project has used Blob Detection Algorithm that has the capability

	through cooperative systems to broadcast traffic data. Traffic light assistance systems can utilize real-time traffic light timing data by accessing through this from the traffic management center.	In the algorithm second part it is not accurate to get the capacity of traffic.	of noise reduction which is used in video stream but at the local server.
(Bhuiyan et al. , 2019)	In this paper, the author proposed a vision based traffic monitoring system to help to maintain the traffic system smartly. In here the author emphasize on detecting and counting vehicles with a proposed method to provide an easy and cost effective solution with an operative traffic monitoring system along with the gathered information to an efficient traffic model.	DNN based detection and classification model is very expensive when consider the computational resources and time it is not suitable for real time.	Camera is cheaper than radar or LIDAR.
		The two VDL is minimizes the chance of missing or counting twice.	The proposed method uses Haarlike feature based Adaboost classifier that is faster to compute and provide a very good accuracy in detection.
		The accuracy of the method decreases in the rush hours.	
(Nayak et al. , 2019)	In this paper the author has used machine vision and the algorithm will be developed to maintain the traffic signal status to smoothen the traffic. This has also used image processing and also OCR to read license plates of the vehicles to map the number with the connected database.	The proposed model has used the MATLAB as processing tool mechanism but for remote usage Raspberry Pi can be used as RTOs based board on which various processing of video frames are executed after extraction along with OCR.	The calculation of vehicle density on the roads are mainly calculated by Image Matching.

TABLE I COMPUTER/CAMERA VISION BASED IMPLEMENTATIONS

1.6 RESEARCH GAP

The huge number of vehicles on the roadways is making congestion a significant problem. The line longitudinal vehicle waiting to be processed at the crossroads increases quickly, and the traditionally used traffic signals are not able to program it properly. Manual traffic monitoring may be an onerous job since a number of cameras are deployed over the network in traffic management centers. (B. Sowmya, 2021) Researchers, however, solved this issue by creating sophisticated multi-layer filters combined with powerful image classifiers and different technologies.

Hence, the application of IoT in the smart traffic management system is not only limited to the reduction of the traffic congestion, air quality improvement, and traffic flow optimization but also extended to the continuous monitoring and ensuring the security and safety for the elderly people. (M.K.M. Rabby et al., 2019) Even so, when it came to detecting real time traffic and finding the cause and the density of it, is the most majority of the researchers faced as a huge challenge. These were occurring due to various reasons, including insufficient and imbalance datasets and inefficient classifying models.

The root cause of traffic mismanagement is the dynamic nature of the traffic on roads and the incapability of legacy systems to interpret such dynamics in real-time. (Sahil and S.K. Sood, 2021) It is crucial to capture these issues and re-classify them into their exact class type, so that captured data can be used for further model training.

1.7 RESEARCH CONTRIBUTION

The research contributes to technological and domain sectors through highlights in here.

1.7.1 Technological Contribution

A camera vision-based real-time Traffic detection and management system will be developed to properly monitor and verify traffic along with some traffic information. The detected traffic volume and density will be captured and uploaded to the cloud. This approach will be integrated into an IoT device to increase the system's efficiency and accuracy.

1.7.2 Domain Contribution

The existing traffic management systems will be reduced with the implementation of the system while ensuring the accuracy of traffic detection and managing it, the author intends to support the domain by creating a larger dataset with road traffic with time collected from the local roads.

As a developing country Sri Lanka's roads are the primary transport domain and traffic management is always an increasing matter. As a solution, the camera vision-based IoT traffic management system will be implemented by the relevant government institutions and drivers to cut down the time taken for the manual examination which will eventually improve and strengthen the road network and traffic congestion in the country.

1.8 Research Challenges

These are the identified challenges while analyzing the existing works.

1. The accuracy of some methods or approaches decreases when there is so much rush on the roads.
2. Differences in the tested environments and the real environments.
3. Gathering and managing of the well-balanced local dataset.

From above, the most challenging task will be gathering and managing a well-balanced dataset for training and testing the solution. As there will be an opportunity of increase in the number of false information in daily traffic when detecting. The other challenge will be designing a system that can detect traffic congestion during nighttime. Proper usage of different filters for extracting the camera vision features from an image at very low light should be tested continuously before training the model. In that point of view sorting out the best fitting architecture and implementing the most accurate and suitable model would be the next challenge.

1.9 Research Question

RQ1: What are the limitations of modern-day traffic management systems using IoT and camera vision?

RQ2: What are the different approaches that used in traffic management and what is the best and most suitable approach for real-time traffic management using IoT?

RQ3: What are the different camera vision based models used in traffic management?

RQ4: How to overcome the background limitations effect on traffic management and what are solutions to overcome them?

1.10 Research Aim

"The aim of this project is to design, develop and evaluate a system which could detect and manage traffic in roads and give necessary data regarding the traffic to the necessary users."

This project aims to implement a real-time traffic management system with camera vision, and it will give users relevant data to improve their routes. The information and most suitable methodology required to design and implement this project will be assembled by reviewing existing research. The model will be evaluated against accuracy and efficiency in detection to validate the derived hypothesis.

1.11 Research Objectives

Research Objectives	**Explanation**	**Learning Outcome**
Problem Identification	**RO1 -** In this potion, the author primarily focuses on selecting a problem domain where the author could identify a problem for the research.	LO1
Literature Review	**RO2 -** In here, the research will be done to analyzing the related existing works on the selected research topic to	LO2, LO4

	gather information about limitations, improvements, and future works presented by the researchers. **RO3 -** Different vision-based approaches will be analyzed by the author to find the best fit for the research and analyzing them thoroughly to selected the approach for further research. **RO4 -** Sorting out different tools, frameworks, APIs, and technologies that will be required in the development phase of the project.	
Data Gathering and Analysis	This stage the author will be focused in gathering the relevant data for conducting the research. **RO5 -** Analyzing the functional and non-functional requirements of the system will be evaluate in this section.	LO3, LO7, LO8
Research Design	The proposed solution's design steps is mentioned below. **RO6** – As the first step of designing a model for traffic management first the author will sort out the test plan for the testing phase and to designing the UI of the application.	LO5
Implementation	The proposed designs of this research will be implemented to create the prototype. **RO7 -** To develop implement and integrate the traffic management system with the IoT device along with an application.	LO5, LO6
Testing and Evaluation	For the prototype below mentioned requirements will be tested and evaluated. **RO8 -** To identify the relevant test cases and verify them.	LO8

	RO9 - To test the prototype with different testing methodologies and benchmarking the accuracy and efficiency with existing solutions.	
Research Project Demonstration	**RO10 -** The developed Prototype and the conducted research thesis will be presented to the viva panel.	LO9

TABLE II RESEARCH OBJECTIVES

1.12 Project Scope

The following research is conducted on developing an IoT device that could detect traffic management and then to provide necessary data. (cause of the traffic, density of the traffic, etc.) The main features of this research project (in-scope) and the other features that will not be covered (out-scope) are mentioned below.

1.12.1 In Scope

- Traffic management system will be implemented for real-time traffic management detection including the existing features. The proposed detection model will be able to detect and classify traffic and its conditions in different background limitations.
- The detection system will detect traffic and then collect to cloud in a certain time frame will be used to analyze and provide necessary data regarding the traffic conditions to the users.

1.12.2 Out Scope

- Alternative route suggestion to the selected route due to traffic.

1.12.3 Prototype Feature Diagram

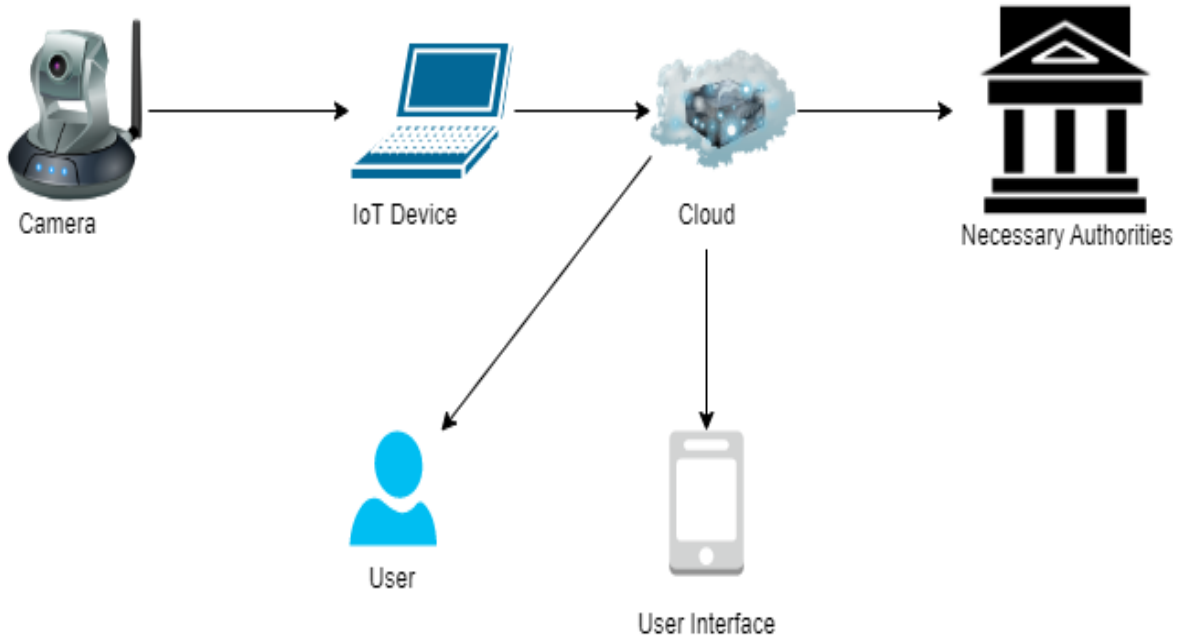

FIGURE I PROTOTYPE FEATURE DIAGRAM

1.13 CHAPTER SUMMARY

This chapter covers the introduction towards the research by addressing the problem to be addressed along with the magnitude of the research alongside providing the comprehensive detail about the exsiting work comparison, aim, challengers and the contributions for the technological and problem domains.

2. METHODOLOGY

2.1 CHAPTER OVERVIEW

In this chapter the author will provide a solid explanation on the research methodology using onion model and also the development methodology, explaining what are the design, development and evaluation methodology using Agile.

2.2 Research Methodology

Research Philosophy	Pragmatism	Due to below mentioned reasons Pragmatism was selected by the author. 1. Since the outcome of the project is acquired through observation and measurement. 2. Along with traffic management more information will be provided rather than true and false.
Research Approach	Deductive Reasoning	This is chosen by the author because the following research aims at testing an existing theory and possible theoretical contribution like extension to the theory can be involved.
Research Strategy	Literature Strategy	For the research following have selected as Research Strategy because the Literature results obtained using an questionnaire will be evaluated alongside the expected results and existing results.
Research Choice	Mixed Method	Mixed Method will be used because Pragmatism is selected as the Research Philosophy.
Time zone	Cross Sectional Time Zone	Cross sectional time zone will be selected because the data will be gathered using a questionnaire and the collected data will be used in future works.
Technique and Procedure	Through a camera and Questioners	The final section focuses on the procedures on how the required data is being collected and

		analyzed. Data will be collected through a camera and Questioners will be sent out to gather information and opinions about the proposed solution.

TABLE III RESEARCH METHODOLOGY

2.3 Development Methodology

2.3.1 Design Methodology

In this research, the author chose OOAD over SSADM as the design methodology. SSADM uses the traditional waterfall methodology, which requires system requirements to be well defined at the outset. OOAD, on the other hand, is favorable to changing requirements and the iterative procedure.

2.3.2 Software Development Methodology

The proposed study will use Evolutionary Prototyping as the methodology for software development. In addition to the lack of well-defined requirements at the start of the project, requirements often change as development progresses. The model also helps to reduce development time, and increase testing time, by building a functional base prototype with well-defined requirements first. The following research will benefit from evolutionary prototyping.

2.3.3 Evaluation Methodology

The performance of the developed system will be assessed by computing the confusion matrix based on the detected traffic conditions. The average precision (mAP), average recall (AR), and mean average recall (mAR) matrices will be used to evaluate the performance. The detection device will be tested on local streets to assess the performance of the device and detection time. The system will be assessed based on the diverse limitations throughout the day and night. To verify the system's accuracy, tests will be conducted for a specific time period as well.

2.4 CHAPTER SUMMARY

The author has well explained on the research methodology using onion model by selecting pragmatism as the philosophy along with deductive leaning and mixed methods as the research strategy and choice accordingly. And also the development methodology, explaining what are the design, development and evaluation methodology using Agile, waterfall methodology, evolutionary methodology, matrix based prototyping.

3. PROJECT MANAGEMENT METHODOLOGY

1.1 CHAPTER OVERVIEW

In this chapter the author has focused on the project management and it's planning from documentation to the final product by listing all the identified hardware, software, device requirements with risk involved with them.

3.2 Project Management

According to the author, AgilePM was used as the project management methodology for the following study. Tests, specifically the variety of types of tests, are one of the major reasons why AgilePM is preferred over other project management methodologies. In addition, since this is a real-world project, it is necessary to make numerous revisions and changes during the project's development cycle if the prototype version is to be effective. This research project would benefit from AgilePM.

3.3 Gantt Chart

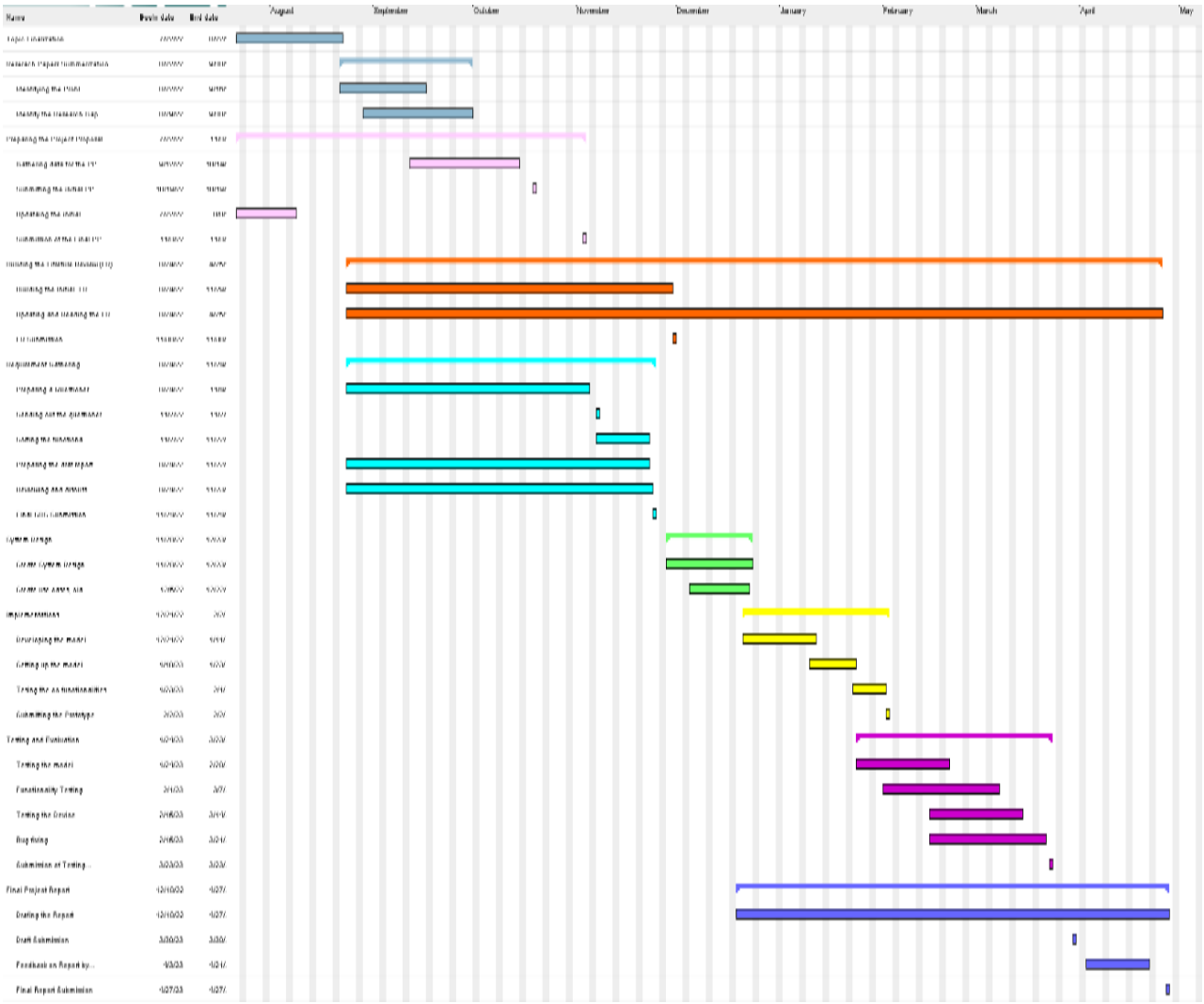

FIGURE II GANTT CHART

3.4 Deliverables

Deliverable	Date
Project Proposal	3rd November 2022
Submission of SRS	24th November 2022
Initial Project Specifications Design and Prototype (PSDP) Submission	2nd January 2023
Project Specifications Design and Prototype (PSDP)	2nd February 2023
Test and Evaluation Report	23rd March 2023
Submission of Draft Project Reports	30th March 2023
Final Research Paper	27th April 2023

TABLE IV DELIVERABLES

3.5 Resource Requirements

Following are the resources are identified as requirements in order to conduct the final year research project and to do the implementations. The resource requirements are divided into three categories;

1. Software
2. Hardware
3. Skills

3.5.1 Software Requirements

Requirement	Purpose
Operating System – macOS 64 bit or Windows 10 64 bit or Linux 64 bit	To develop the implementation for the research and for preparing the necessary data for that.
MS word, Google Docs	For the documenting purposes of the research project.
Git	For the solution source code management.
Google Drive and One drive	For storing the project related documents.
Mendeley	For managing the references.
GanttProject	To create the Grantt chart of the project.
Visual Studio Code	Used as the IDE for coding purposes.

TABLE V SOFTWARE REQUIREMENTS

3.5.2 Hardware Requirements

• Detection Device Requirements

Requirement	Purpose
Nividia Jetson nano	Used for the IOT implementations
4 GB RAM or more	For smooth object detection and identification
NVIDIA Maxwell architecture with 128 NVIDIA CUDA® cores	For smooth process in the real-time object detection
64GB and above	Storage purposes
Dash camera	To get the real-time videos of road traffic

TABLE VI DETECTION DEVICE REQUIREMENTS

• Device Requirements

Requirement	Purpose
128GB and above	For data storing.
Intel Core i5 or above	To be used for the testing and evaluations of the solution.
8 GB RAM or more	For smooth process when working with large amount of data.

TABLE VII DEVICE REQUIREMETS

3.5.3 Required Skills

Required Skill	Purpose
Knowledge about the Problem and the Research Domains	In order to get a clear idea of exsiting work, solution approaches and the primary concepts used which are mentioned in the research / survey papers this skill is required.
Programming Skills	In order to develop the required prototype, a fluent understanding about the programming language is required and mainly about IoT related ones are crucial.
Knowledge about IoT development	The final aim of the research is to build a device and have a good knowledge about how these devices work is highly required.
Understating of Algorithms and Architectures	When developing the prototype understanding about different algorithms and architectures are highly needed to find the best for the final product.
Project Management	An important skill that is needed when comes to meet the deadlines when working in this research project.

TABLE VIII REQUIRED SKILLS

3.6 Risk Management

Risk item	Severity	Frequency	Mitigation plan
Domain understanding.	5	5	A proper understanding about different the models and their advantages. Reviewing more existing work to understand how the models are being improved. Building small test projects using these models will improve the knowledge.
IoT related understanding.	5	4	Implementing test models to understand the different modules and their interaction.
Changing project requirements	4	3	Due to the iterative nature of Aglie methodology it makes it easier to manage new requirements while continuing with the development.
Not enough time to learn required know how and acquire the skills and Getting sick.	3	2	Work according to the plan and make sure the work is balanced with the help and the guidance of the Supervisor. Applying for Self-Mitigation or Mitigation

TABLE IX RISK MANEGEMNET

3.7 CHAPTER SUMMARY

The author has elaborated the project management using AgilePM and its planning using the Grantt chart which provides the time frame required in this research project documentations to implementations. Also it provides the identified hardware, software, device requirements with risk involved with them. Risk has been elaborated by providing the severity and the frequency of the each.

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