FOUR WAY EFFECTIVE TRAFFIC MANAGEMENT SYSTEM

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A Final Year Design Project (FYDP) submitted to the Department of Electrical and Electronic Engineering in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering

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Declaration

It is hereby declared that

1. The Final Year Design Project (FYDP) submitted is my/our own original work while completing degree at Brac University.
2. The Final Year Design Project (FYDP) does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The Final Year Design Project (FYDP) does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I have acknowledged all main sources of help.

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Ethics Statement

All the studies and works in our project have been voluntarily done by us. Besides, all the resources and data used in the project have been taken from authentic sources and carefully cited. We have carefully avoided any kind of copying or plagiarism. Also, no payment was made to any person who was directly or indirectly in our project. Our goal was to make the maximum benefit for mankind, so we took great care on minimizing any sort of environmental issue.

Abstract

This study presents a comprehensive approach to developing an effective traffic management system for a four-way intersection. To optimize traffic flow and alleviate congestion, the system incorporates fuzzy logic, image processing, and proximity sensors. The study compares the performance of each technology and concludes that proximity sensors are the best option due to their high accuracy, low cost, and ease of deployment.

The suggested system detects the presence of vehicles and adjusts traffic lights in real time using proximity sensors. The duration of the green light is controlled by fuzzy logic based on the number of vehicles in each lane, while image processing is employed to detect and respond to emergency vehicles.

The system is tested using simulations and demonstrates considerable improvements in traffic flow and waiting times, particularly during high traffic hours. The study emphasizes proximity sensors' potential as a cost-effective and dependable solution for traffic control systems, particularly in developing nations. The findings of this research can help transportation planners and policymakers design successful traffic control systems in their cities.

Keywords: Traffic management system, Four-way intersection, Fuzzy logic, Image processing, Proximity sensors, Traffic flow, Congestion, Real-time, Green light, Vehicle detection, Emergency vehicles, Simulations, Peak traffic hours, Developing countries, Transportation planning.

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Chapter 1

Introduction- [CO1, CO2, CO10]

1.1 Introduction

The Four Way Effective Traffic Management System is a modern traffic management system designed to minimize traffic congestion and optimize traffic flow in urban areas. It uses advanced technologies like artificial intelligence, machine learning, and IoT to provide real-time traffic monitoring, analysis and control. The system aims to reduce travel time, fuel consumption, and air pollution while improving the economic growth of the city. The project requires a team of skilled professionals to implement practically and has the potential to significantly improve the quality of life for the residents. With a rising number of vehicles on the roads, it has become increasingly challenging to manage the flow of traffic, which has resulted in economic losses, increased travel time, and air pollution. The project aims to solve this problem by implementing modern technologies that can provide a more efficient and effective traffic management system.

The Four Way Effective Traffic Management System is designed to be an innovative solution that can dynamically adjust traffic signal timing and detect traffic congestion in real-time. The system's intelligent algorithms will be programmed to provide optimal traffic flow and reduce travel time by identifying traffic patterns and directing vehicles to alternate routes. The project is scalable, adaptable, and designed to accommodate unique intersection needs.

1.1.1 Problem Statement

The increasing number of vehicles on the roads and limited infrastructure to manage traffic flow has led to significant traffic congestion in most urban areas. This has resulted in increased travel time, fuel consumption, air pollution, and economic losses. Additionally, the traditional traffic management systems are inefficient, outdated and fail to accommodate the changing traffic conditions. Therefore, the need of the hour is to develop an effective traffic management system that can minimize traffic congestion, optimize traffic flow, and reduce travel time, fuel consumption and air pollution. The Four Way Effective Traffic Management System aims to solve this problem by using modern technologies like artificial intelligence, machine learning, and internet of things (IoT) to provide real-time traffic monitoring, analysis and control.

The system will have the ability to identify traffic congestion and redirect vehicles to alternate routes. The system will also monitor the traffic signal timing and adjust it based on the traffic volume to optimize traffic flow. The Four Way Effective Traffic Management System will be designed to accommodate the unique needs of each intersection to ensure maximum efficiency. The proposed system aims to provide a cost-effective and sustainable solution to traffic congestion in urban areas. This project will require a team of skilled professionals with expertise in traffic engineering, computer science, and IoT. The successful implementation of this project will not only improve the quality of life for the residents but also enhance the economic growth of the city by reducing travel time and fuel consumption.

1.1.2 Background Study

The major goal of our research is to reduce the traffic congestion as well as manage the traffic of Dhaka city. Planning, monitoring, and influencing or controlling traffic are all parts of traffic management. It strives to satisfy environmental goals, ensure dependable and safe transportation, maximize the use of existing infrastructure, and ensure equitable allocation of infrastructure space. Dhaka city is the capital of People's Republic of Bangladesh. The Dhaka Metropolitan Area (DMA) has a population of 22 million. At the moment, the majority of urban transport in the DMA takes place on roads, where cars, buses, auto-rickshaws, rickshaws, etc. coexist [1]. This causes a significant traffic congestion in addition to the health risk brought on by the air pollution and traffic pollution. Urban population growth will accompany the country's economic expansion, and at the same time, there will be a large increase in the number of privately owned cars. Bangladesh's capital, Dhaka, is one of the world's least-motorized megacities but has the densest population.Dhaka's transportation system is mostly road-based, with non-motorized transit (primarily rickshaws) accounting for a sizable mode share. Dhaka's road network is almost 3,000 kilometers long (200 kilometers of which are major) with few alternative connection roads. [4] Dhaka's present traffic congestion is caused by two key factors: a lack of planning and preparedness during past decades, and an over-reliance on vehicles owing to a lack of public transit. Despite the fact that there are 33 times more vehicles than buses in the city, around 13% of passengers use cars, while 49 percent utilize buses. The average traffic speed in Dhaka is currently 6.4 kph, but this might drop to 4.7 kph by 2035 if vehicle growth continues at its current rate.People spend an average of two and a half hours each day in traffic, with one and a half hours consumed by traffic congestion.[5] RAJUK has issued its Dhaka Structure Plan (2016-2035), which divides the entire area into six zones for future transportation planning [6].Bangladesh Bridge Authority intends to deliver a project for the construction of roughly 23 km of Elevated Expressway in the northern portion of Dhaka city in order to reduce traffic intensity.In Bangladesh, the Japan International Cooperation Agency (JICA) performed a preliminary assessment known as the Dhaka Urban Transport Network Development Study (DHUTS). They connect the Dhaka Metropolitan Area's urban development plan with the creation of the Urban Transport Network Development Plan [7].

One of the most essential elements of an urban settlement's socioeconomic and physical structure is its transportation infrastructure. A well-planned and developed transportation system not only provides opportunities for mobility of the people, but also influences the growth pattern and the level of economic activity of a city (Meyer and Miller, 1984) [1]. The number of daily travels in Dhaka City is estimated to be 21 million, of which only approximately 5% are made in private automobiles, which occupy around 80% of the road and are the primary reason for traffic congestion. Buses, which occupy only around 5% of the road, carry out 28% of all trips. Walking, bicycling, or using rickshaws, which are sometimes referred to as non-motorized transport options, account for 58% of all journeys (NMT) [2]. In addition, relatively little research has been done on traffic congestion and transportation management issues by academics, the government, and the third sector. Therefore, it is important to perform in-depth research on how to improve Bangladesh's overall transportation infrastructure and reduce congestion in major cities, particularly Dhaka. Despite traffic growth surpassing capacity on important roads, Bangladesh's road network suffered from inadequate maintenance and reconstruction, causing persistent congestion and traffic accident.The economy lost Tk56,000 crore ($6.5billion) in 2020 from traffic, according to the Accident Research Institute (ARI) of Bangladesh University of Engineering and Technology (BUET).In 2018 they found Dhaka traffic wastes 5 million work hours and costs the economy Tk37,000 crore ($4.35 billion). A developing country like Bangladesh cannot afford the economic and environmental loss resulting from this severe traffic obstruction.[3]. Additionally, a transparent and efficient maintenance system needed to be established.

1.1.3 Literature Gap

The research gap in existing work is quite distinct .All the other researchers conducted related to the Traffic management system did not use the data of Dhaka city. The reason for picking the issue is that the specific procedures employed in our project were never put into practice in Dhaka. We are making an effort to effectively and wisely control the traffic.
We will benefit in every area of our lives from the measures we use to assist relieve traffic congestion on the roads.
I) The streets of Dhaka will become safer.
ii) A shorter travel time.
iii) The traffic flow on the road will be seamless.

There are numerous approaches that can be used to develop the proposed project. Materials and resources that helped us to design and analyze the problem are mentioned below
i) Fuzzy Logic- A fuzzy logic controlled traffic light uses sensors that count cars instead of proximity sensors which only indicate the presence of cars
II.) Image Processing - Good technique to control road congestion and more consistent in detecting vehicle presence since it utilizes genuine traffic frames.
III) Proximity Based - A traffic management system can combine many functionalities, such as density-based traffic signal control, emergency vehicle passing etc. By applying these new technologies and concepts we have learned we are planning to reduce the traffic congestion of the city and it will also help the people to move faster from one place to another.

1.1.4 Relevance to current and future Industry

The Four Way Effective Traffic Management System project is highly relevant to the current and future industry as it provides a cost-effective and sustainable solution to address the challenges of traffic congestion and optimize traffic flow in urban areas. The project employs advanced technologies like artificial intelligence, machine learning, and IoT to provide real-time traffic monitoring, analysis, and control. The system's intelligent algorithms can adjust traffic signal timing dynamically based on the traffic volume, identify traffic congestion, and redirect vehicles to alternate routes to minimize travel time and fuel consumption. With the increase in urbanization and population growth, traffic congestion has become a significant problem in many cities. The Four Way Effective Traffic Management System project provides a viable solution to this problem, which can significantly improve the quality of life for residents, reduce travel time and fuel consumption, and boost the economic growth of the city. The project has the potential to transform urban transportation and enhance the efficiency of transportation systems.

The project is also relevant to the future industry as it is scalable, adaptable, and designed to accommodate unique intersection needs. It provides a user-friendly and intuitive interface, making it easy to use for both traffic engineers and motorists. The system is energy-efficient, compliant with relevant traffic safety and regulatory standards, and compatible with existing transportation systems and infrastructure. The Four Way Effective Traffic Management System project has the potential to become an essential component of the future transportation system, enhancing the efficiency and sustainability of urban transportation systems.

1.2 Objectives, Requirements, Specifications and Constraints

The primary objective of the Four Way Effective Traffic Management System project is to develop a modern traffic management system that can minimize traffic congestion, optimize traffic flow, and reduce travel time, fuel consumption, and air pollution in urban areas. Additionally, it has several requirements, specifications and constraints. Overall, the project's aim is to provide a modern traffic management system that can accommodate the unique needs of each intersection and reduce traffic congestion, travel time, and fuel consumption while improving the economic growth of the city.

1.2.1. Objectives

The main objective of this project is to achieve no human traffic on the street, which we normally see in our country. It will help this manpower to work on other important sectors. Very few countries in the world have manpower traffic police to control road traffic which is very inefficient. This project will help to make the country's traffic system efficient as well as it will help to monitor the traffic system in a well mannered way and identify traffic violators. Hence, the core objectives of our project are listed below:

1. **Develop a system to transfer traffic data**

Traffic congestion is quite common to all of us. Our valuable time is being wasted due to this reason. For this reason, we will develop a system to transfer traffic data to street clients on their mobile phones. In addition to this, the system will recommend alternate routes automatically to reduce pressure in a particular road.

2. **Keep traffic flowing in case of peak traffic**

We can see traffic congestion during the peak hours such as the office starting and ending time. These time periods are quite crucial and the goal of our project is to control and handle the situation by slowing down traffic at the inflow to congestion. Our system will automatically analyze data and provide output.

3. **Differentiate between parking and unparking vehicles**

Our smart system can differentiate between parking and unparking vehicles. During peak traffic times, it creates a huge mess if the vehicles are parked on roads. Our system will detect them and warn them. It can even notify the nearest traffic box about unauthorized parkings.

4. **Strategies to improve traffic control based on traffic emergencies**

We can see various traffic urgencies in our country. There are certain situations like Police patrol vehicles movement, ambulance service, VIP movement and many more that need to be considered as priority. However, our system will put forward some strategies so that the traffic control system can be improved during traffic emergencies in order to provide them priority.

5. **Warn the drivers of bad weather conditions**

Apart from natural calamities, our system will warn the drivers of bad weather conditions. Bangladesh shows a diversified seasonal variety of weather. During the rainy season, heavy rain and strom block the roads several times. In addition, driving becomes much more difficult due to fog during the winter season. Our designed system will notify the drivers about bad weather conditions including natural disasters.

1.2.2 Functional and Non-functional Requirements

There are several requirements which can be divided into two parts. They are Functional and Non-functional requirements.

Functional Requirements:

- Real-time traffic monitoring and analysis to identify traffic congestion.
- Dynamic adjustment of traffic signal timing based on the traffic volume to optimize traffic flow.
- Ability to redirect vehicles to alternate routes to minimize travel time and fuel consumption.
- Integration with sensors and cameras to monitor traffic conditions.
- Accurate prediction of traffic volume to anticipate future traffic congestion.
- User-friendly interface to display traffic information, real-time updates, and alerts.
- Ability to provide emergency services with priority in the traffic signal control.
- Customization of traffic signal timing based on the unique needs of each intersection.
- Centralized management system to monitor and control traffic flow across different intersections.
- Integration with emergency response systems to ensure quick response times.

Non-functional Requirements:

- The system should have high availability and reliability to ensure continuous operation.
- The system should be scalable to accommodate future growth and changes.
- The system should have strong security measures to prevent unauthorized access and ensure data privacy.
- The system should be easily maintainable and upgradable to reduce downtime and ensure system stability.
- The system should be energy-efficient to reduce the overall cost of operation.
- The system should comply with all relevant traffic safety and regulatory standards.
- The system should be compatible with existing transportation systems and infrastructure.
- The system should be adaptable to different weather conditions and lighting environments.
- The system should have a user-friendly and intuitive interface for ease of use.

1.2.3 Specifications

System	**Sub Systems**	**Necessary Components**	**Tentative Component Specification**	**Details**
Traffic Management System	Traffic Detection System	Microcontroller Sensor(CPU,GPU)	**CPU Name-** Intel core i9 10900K **Core-** i10 **GPU-** AMD Radeon RX 6800	It processes the data and makes the decision. Sensors detect the vehicles.
		Fuzzy Logic Trainer	**Model Name-** XPO-FUZZY	
		Proximity Sensor	**Module HC-SR-04**	
	Indicator	Traffic Light Module	**Materia**l-Polycarbonate **Lighting Type**- LED **IP Rating-** IP 65 **Voltage-**12/24 V DC/30V **Frequency**-50 Hz	Red, Green & Amber lights, Pedestrian crossing LED.

			Size-300 mm / 200 MM dia	
	Traffic Violation System	Camera	HDCVI IR Bullet Camera	Can detect abnormalities.

1.2.4 Technical and Non-technical consideration and constraint in design process

The project contains several technical and non-technical considerations and constraints in the design process, Some of them appear as below.

❖ **System Vulnerability**

A secure traffic control system is smart. For regulating traffic signals, the majority use quite advanced encryption. But anything that is linked to a network is vulnerable to hacking. Nevertheless, the probability of someone using brute force to gain access to the traffic system is much higher.

❖ **System Failure**

There will be a huge traffic mess if the management system fails. It may cause serious injury to both human life and vehicles. In certain situations, it may increase traffic congestion if the optimization is not done properly.

❖ **Cost**

Our project includes several types of sensors and cameras. As a result, the initial cost of the implementation of this project is a bit costly if it is applied to a large scale.

❖ **Sensor Problem**

Our system is dependent on the output provided by the sensors to a greater extent. The system may show errors if the sensor fails to provide accurate data and the optimization process may fail. The sensors need to be cleaned and serviced regularly in order to avoid any sort of uncertain sensor issues.

❖ **Lack of skilled manpower**

In order to keep the system online, a group of skilled manpower is a priority. Otherwise, the system may fail or it may take a lot of time to repair the system bugs. However, this will create a huge mess and traffic congestion may appear on a large scale.

1.2.5 Applicable compliance, standards, and codes

- **MUTCD -** The Manual on Uniform Traffic Control Devices (MUTCD) is a set of standards and guidelines for the design, installation, and operation of traffic control devices, including signs, signals, and pavement markings. The MUTCD is used in the United States and is updated periodically to reflect current practices and technologies.

- **IEEE 802.11-** The IEEE 802.11 standard specifies the protocols and technologies for wireless local area networks (WLANs). This standard includes specifications for data transfer rates, frequency bands, and security protocols for wireless networks.
- **ISO 19001-** ISO 19001 is a standard for road traffic safety management systems. This standard provides guidelines for the development and implementation of a traffic safety management system, including policies, procedures, and performance indicators.
- **IEC 61508-** IEC 61508 is a standard for functional safety of electrical/electronic/programmable electronic safety-related systems. This standard provides guidelines for the development and assessment of safety-critical systems, including those used in traffic control and management.
- **NEC Article 600** - The National Electrical Code (NEC) Article 600 covers the installation and use of electric signs and outline lighting. This code includes requirements for the installation and grounding of electrical equipment used in traffic control and management systems.
- **ANSI/ASME B46.1** - The ANSI/ASME B46.1 standard covers surface texture (roughness, waviness, and lay) of mechanical components, including those used in traffic control and management systems. This standard provides guidelines for the measurement and specification of surface texture in order to ensure proper functioning of mechanical components.

1.3 Systematic Overview/summary of the proposed project

The system provides real-time traffic monitoring and analysis to identify traffic congestion and adjusts traffic signal timing dynamically based on traffic volume to optimize traffic flow. The system can also redirect vehicles to alternate routes to minimize travel time and fuel consumption. The project is scalable, adaptable, and designed to accommodate unique intersection needs. The project requires a team of skilled professionals to implement, including traffic engineers, computer scientists, and IoT specialists. The system is user-friendly and provides a dashboard with traffic information, real-time updates, and alerts.

The system's intelligent algorithms are programmed to provide optimal traffic flow and reduce travel time by identifying traffic patterns and directing vehicles to alternate routes. The system can adjust traffic signal timing dynamically based on the traffic volume to provide optimal traffic flow. It can also identify traffic congestion and redirect vehicles to alternate routes to minimize travel time and fuel consumption. The system is scalable, adaptable, and designed to accommodate unique intersection needs. It provides a cost-effective and sustainable solution to traffic congestion in urban areas. The system is user-friendly, with a user interface that displays traffic information, real-time updates, and alerts.

The system's non-functional requirements include high availability and reliability, low latency and response time, strong security measures, energy efficiency, compliance with traffic safety and regulatory standards, compatibility with existing transportation systems and infrastructure, adaptability to different weather conditions and lighting environments, and a user-friendly and intuitive interface. However, the Four Way Effective Traffic Management System project provides a modern traffic management system that can accommodate the unique needs of each intersection and reduce traffic congestion, travel time, and fuel consumption while improving the economic growth of the city.

1.4 Conclusion

In conclusion, the Four Way Effective Traffic Management System is an innovative project that aims to provide a modern and sustainable traffic management system for different cities and urban regions. The system uses advanced technologies like Fuzzy Logic, Vehicle Tracking System to minimize traffic congestion, optimize traffic flow, and reduce travel time and fuel consumption. The project's primary objective is to provide a cost-effective and sustainable solution to traffic congestion in urban areas while improving the economic growth of the city. The project requires a team of skilled professionals to implement, and the system needs to comply with relevant traffic safety and regulatory standards. This chapter will provide an overview of the project's background, problem statement, objectives, functional and non-functional requirements, applicable compliance, standards, and codes, and systematic summary of the proposed project. The Four Way Effective Traffic Management System project has the potential to transform urban transportation and enhance the quality of life for residents.

Chapter 2

Project Design Approach [CO5, CO6]

2.1 Introduction

Traffic management is a critical aspect of modern urban life. The ever-increasing number of vehicles on the roads has led to a surge in traffic congestion, accidents, and environmental pollution. Hence, it has become essential to develop an effective traffic management system to ensure the smooth flow of traffic and reduce the associated problems. In this report, we explore three different approaches for designing an effective traffic management system. The first approach involves using fuzzy logic, the second approach uses image processing, and the third approach uses Proximity sensors. Each of these methods has its advantages and limitations, and the choice of the approach will depend on the specific requirements and conditions of the traffic system. In this report, we present a detailed analysis of each approach, highlighting its strengths and weaknesses, and provide recommendations on the most suitable approach for different scenarios.

2.2 Identify multiple design approach

The approaches are as follows

1. Using Fuzzy Logic: This approach involves developing a system that uses fuzzy logic to analyze and control traffic flow. Fuzzy logic is a mathematical approach that allows for imprecise reasoning and handles uncertainties and approximate values.

2. Using Image Processing: This approach involves developing a system that uses cameras to capture images of the traffic situation, which are then analyzed to make decisions about how to manage the flow of vehicles. Image processing algorithms can detect patterns and trends in the images captured and make decisions based on the data extracted.

3. Using Proximity Sensors: This approach involves developing a system that uses Proximity sensors to detect the presence and movement of vehicles on the roads. The sensors can be used to measure the distance between vehicles and can trigger actions to manage traffic flow based on the data obtained.

Each of these approaches has its strengths and weaknesses, and the choice of approach will depend on the specific requirements and conditions of the traffic system being designed.

2.3 Multiple design approach

Here's a brief description of each of the three approaches you mentioned:

1. Fuzzy Logic:

Fuzzy logic is a mathematical approach that allows for imprecise reasoning and handles uncertainties and approximate values. This approach involves developing a system that uses fuzzy logic to analyze and control traffic flow. In a traffic management system that uses fuzzy logic, the input data collected from various sensors (such as vehicle speed sensors or traffic volume sensors) are fed into a fuzzy logic controller. The controller uses predefined rules and algorithms to analyze the input data and generate output commands to control the traffic signals. The output commands are typically in the form of green/red light signals that are communicated to the traffic lights.

2. Image Processing:

This approach involves developing a system that uses cameras to capture images of the traffic situation, which are then analyzed to make decisions about how to manage the flow of vehicles. The images captured by the cameras are processed using image processing algorithms that can detect patterns and trends in the images. The processed data can then be used to make decisions about how to manage traffic flow. For example, the system could detect traffic congestion and adjust traffic signals to reduce the congestion, or detect traffic violations (such as running red lights) and issue tickets to offending drivers.

3. Proximity Sensors:

This approach involves developing a system that uses Proximity sensors to detect the presence and movement of vehicles on the roads. The sensors can be used to measure the distance between vehicles and can trigger actions to manage traffic flow based on the data obtained. For example, if the sensors detect a high density of vehicles on a particular road, the traffic lights could be adjusted to prioritize traffic flow on that road. Similarly, if the sensors detect a slow-moving vehicle or an obstacle, the system could alert drivers to slow down or stop to avoid a collision.

2.4 Analysis of multiple design approach

Here's an analysis of the three multiple design approaches for an effective traffic management system that you have mentioned:

1. Fuzzy Logic:

The fuzzy logic approach is based on the principles of fuzzy set theory, which enables the system to handle uncertain or imprecise data. This approach is effective in managing traffic in situations where the traffic patterns are unpredictable and can change quickly. However, one limitation of this approach is that it may not be suitable for managing high-volume traffic flow or complex road networks. Additionally, the accuracy of the system depends on the quality and reliability of the input data obtained from the sensors.

2. Image Processing:

The image processing approach uses cameras to capture images of the traffic situation, which are then analyzed to make decisions about how to manage the flow of vehicles. This approach is effective in managing traffic in situations where the traffic patterns are relatively predictable and can be analyzed using image processing algorithms. However, this approach requires high-quality cameras and powerful image processing algorithms, which can be costly to implement. The system may also be affected by external factors such as poor weather conditions or low visibility.

3. Proximity Sensors:

The Proximity sensor approach involves the use of sensors to detect the presence and movement of vehicles on the roads. This approach is effective in managing traffic flow in situations where the traffic patterns are relatively stable and predictable. This approach is also relatively inexpensive and easy to implement. However, the system's accuracy can be affected by external factors such as road conditions or weather conditions that may interfere with the sensors' operation. The system may also have difficulty detecting and managing pedestrians and other non-vehicular traffic

2.5 Conclusion

In conclusion, an effective traffic management system requires the use of advanced technologies and design approaches to manage traffic flow, reduce congestion, and enhance safety. Each of these design approaches has its advantages and limitations, and the choice of approach will depend on the specific requirements and conditions of the traffic system being designed. A thorough analysis of the traffic situation, including traffic patterns, road conditions, and budget, is necessary to determine which approach is best suited for a particular traffic management system.

Chapter 3

Use of Modern Engineering and IT Tool. [CO9]

1.1 Introduction

The field of engineering has seen significant advancements in recent years with the introduction of modern engineering and IT tools. These tools have revolutionized the engineering design and development process, enabling engineers to improve their designs, enhance the efficiency of their systems, and reduce costs.

In this study, we explore the use of modern engineering and IT tools, including Matlab, Arduino, Pygame, proteus, YOLOv5, and Roboflow. These tools have been selected due to their versatility and their ability to facilitate the design of complex engineering systems.

1.2 Select appropriate engineering and IT tools

When designing and developing engineering systems, it is crucial to select appropriate engineering and IT tools that can help facilitate the process. The selection of tools depends on the specific requirements of the project, as well as the skillset of the engineers involved. In this study, we will explore several modern engineering and IT tools that have proven to be effective for a variety of engineering applications.

Matlab is a widely-used tool in the engineering community due to its ability to model and simulate complex systems. It provides a user-friendly environment for engineers to design and test control systems, signal processing algorithms, and image processing techniques. Matlab also supports the development of machine learning algorithms, making it a versatile tool for a wide range of engineering applications.

Arduino is an open-source hardware platform that is used for building electronic devices. It provides a range of programmable microcontrollers, sensors, and communication modules, making it an ideal tool for the development of embedded systems. Arduino is widely used in robotics, automation, and data acquisition applications.

Pygame is a set of Python modules designed for game development. While it may not be an obvious choice for engineering applications, Pygame has proven to be a useful tool for the development of user interfaces and visualization tools. It provides an easy-to-use framework for creating graphical displays and has been used in a variety of engineering projects.

Proteus is a software tool that allows engineers to simulate and test electronic circuits before they are built. It provides a virtual environment for testing and debugging circuits, and it can save time and reduce the risk of errors in the design process. Proteus is widely used in the development of embedded systems and IoT devices.

YOLOv5 is a deep learning-based object detection algorithm that has been gaining popularity in the computer vision community. It provides state-of-the-art accuracy and speed for object detection and has been used in a variety of applications, including autonomous vehicles, surveillance systems, and robotics.

Roboflow is a cloud-based platform that allows engineers to build custom computer vision models quickly and easily. It provides a user-friendly interface for training and deploying object detection models, and it supports a range of popular deep learning frameworks, including TensorFlow, PyTorch, and YOLOv5.

1.3 Use of modern engineering and IT tools

Matlab:

The Mathworks company created MATLAB, a proprietary programming language and multi-paradigm numerical computing environment. It expresses computation, visualization, and programming using mathematical equations in a user-friendly environment. In our project, we have used the software for the purposes of control systems, digital signal processing, image processing and computer vision, and many more.

- Firstly, the ability to control a system or device is one of the most frequent reasons Matlab is used. A control system is in charge of overseeing, issuing commands, and directing the actions of other systems or equipment. Its foundation is control loops. Simple traffic lights to big traffic control systems that regulate processes or overall vehicle management systems can all be controlled by devices or systems. The Matlab control system toolbox offers techniques and programs for methodically evaluating, creating, and fine-tuning linear control systems.

- Secondly, the use of digital processing, such as that provided by computers or specialized digital signal processors, is referred to as "digital signal processing," and it covers a variety of signal processing tasks. Data analysis using signal processing techniques is made simple by the use of Matlab products, which also offer a single workflow for developing embedded systems and streaming applications.

- Thirdly, the primary goal of image processing is to prepare raw images for use in computer vision and other applications. The footage received by the traffic cameras is processed through this. Contrarily, computer vision analyzes images similarly to the human eye. It entails anticipating and comprehending the visual result. Building algorithms is essential for computer vision and image processing. Uses of Matlab offers a complete environment for creating algorithms and image analysis.

Proteus:

An exclusive tool set for automating electronic design is called the Proteus Design Suite. It is a Windows program for designing printed circuit boards (PCBs) and simulating schematics. Depending on the number of designs being created and the specifications for microcontroller simulation, it can be found in a variety of forms. An autorouter and fundamental mixed-mode SPICE simulation capabilities are included in all PCB design solutions.

The program is primarily employed by electronic design engineers and technicians to produce schematics and electronic prints for the production of printed circuit boards (PCBs) as well as a rapid prototyping tool for research and development. Students are taught electronics, embedded design, and PCB layout in universities all over the world. Additionally, it contains tools that help to practice various IoT projects virtually. However, we have used this software in order to conduct the simulation process.

Proteus has two primary components: the first is used to create and draw various circuits, and the second is for creating PCB layouts. The first is ISIS, which was used to simulate and design circuits. The second is ARES, which is employed in printed circuit board design. Additionally, it offers functionality for the PCB's three-dimensional design perspective. Here, all the schematics are obtained by utilizing the software. Moreover, the PCB design is also complete, and we are testing our output simulation through this software.

Yolo v5:

The COCO dataset trained YOLOv5's compound-scaled object detection models. It supports minimal TTA, model ensembling, hyperparameter evolution, and ONNX, CoreML, and TFLite export. To use our models in real time, we needed to find and name cars in a street scenario. R-CNN, Fast R-CNN, and Faster R-CNN couldn't compete with YOLO models in performance and inference time, thus we removed them. CNN is a type of artificial neural network used extensively for image/object detection and categorization. Using a CNN, Deep Learning therefore recognizes items in an image. YOLO's inference was faster and more accurate. YOLOv5 was used since it is simpler than R-CNN-based models. YOLOv5 is even faster and more stable. The original author of YOLO did not recognize the Ultralytics LLC team's version of YOLOv5, even though YOLOv4 was officially licensed. YOLOv5 still outperforms its predecessors. YOLOv5 is YOLOv4 with SPP-NET and a few improvements. YOLOv5 is the most advanced object finder. YOLOv5 was largely designed to balance real-time performance and finding items. YOLOv5s is the lightest and YOLOv5x the heaviest of the four varieties. All four versions also slow detection and real-time performance. These variants differ mostly in the number of feature extraction modules and convolution kernels employed at different network nodes. There are three; They are backbone, neck, and detect networks. The "backbone network" convolution neural network is best for creating picture features and combining small-scale images. Necknetwork assembles the picture features the backbone network found and gives the detected network the feature map. The detect network handles model detection and categorization. Because of the neck network, anchor boxes are on the feature map. The bounding box's softmax layer predicts the object's class. To improve photos with limited data points, YOLOv5 uses mosaic data augmentation. Using random inversion, scaling, and cropping, it creates a new image from four photographs. Traffic detection performance was our key goal, hence we chose

YOLOv5x as our training model. The building has 607 layers and 88, 568,234 subjects are teachable. The model was trained on the Common Object in Context (COCO) dataset before finding 80 classes. To do this, we altered the last layer to just look for DhakaAI's 21 vehicle types.[24]

Pygame in Python:
This report provides a detailed explanation on how to use Pygame to create a traffic simulation from scratch. To model the flow of traffic across an intersection controlled by timed traffic lights, we're writing a new program in the Python programming language. There's a four-way stop there, with lights to regulate traffic going both ways. There is a countdown counter on top of each signal that indicates how much longer it will be until the light changes from green to yellow, yellow to red, or red to green. Generated automobiles, bicycles, buses, and trucks navigate in response to traffic lights and their surroundings. Further applications include data analysis and the visualization of AI and ML programs.

Roboflow:
Roboflow is a Computer Vision developer framework for better data collection to preprocessing, and model training techniques. Roboflow has public datasets readily available to users and has access for users to upload their own custom data also. Roboflow accepts various annotation formats. In data pre-processing, there are steps involved such as image orientations, resizing, contrasting, and data augmentations.

The entire workflow can be coordinated with teams within the framework. For model training, there's a bunch of model libraries already present such as EfficientNet, MobileNet, Yolo, TensorFlow, PyTorch, etc. Thereafter model deployment and visualization options are also available hence encompassing the entire state-of-art.

Roboflow is used in various computer vision industries for use cases such as – gas leak detection, plant vs weed detection, airplane maintenance, roof damage estimator, satellite imagery, self-driving cars, traffic counter, garbage cleaning, and many more.

Google Colab:
Colaboratory, or "Colab" for short, is a product from Google Research. Colab allows anybody to write and execute arbitrary python code through the browser, and is especially well suited to machine learning, data analysis and education. More technically, Colab is a hosted Jupyter notebook service that requires no setup to use, while providing access free of charge to computing resources including GPUs.

Arduino Uno:
Arduino Uno is a popular microcontroller board based on the ATmega328P microcontroller. It is an open-source platform that allows users to create and program electronic projects easily. Arduino Uno has a simple design, consisting of a microcontroller, a voltage regulator, and a USB interface. It also has a set of digital and analog input/output pins, which can be used to connect to sensors, actuators, and other electronic components.The Arduino Uno

board comes with a standard set of features, including 14 digital input/output pins, 6 analog input pins, a 16 MHz quartz crystal, a USB connection, a power jack, and an ICSP header. The board can be programmed using the Arduino Integrated Development Environment (IDE), which provides a user-friendly interface for writing and uploading code.

Arduino Uno can be used in a traffic management system prototype in several ways. Here are some of the ways in which we have used Arduino Uno in traffic management system prototype:

1. **Traffic Light Control:** Arduino Uno can be used to control traffic lights at an intersection. The traffic light can be programmed to change based on predefined timings, or it can be programmed to change dynamically based on traffic volume.

2. **Sensor Integration:** Arduino Uno can be used to integrate sensors such as Proximity, infrared or magnetic sensors, which can detect the presence of vehicles at an intersection. The sensor data can then be used to control the traffic light.

3. **Communication:** Arduino Uno can be used to enable communication between traffic lights at different intersections. The communication can be used to synchronize the traffic lights to ensure a smooth flow of traffic.

4. **Data Logging:** Arduino Uno can be used to log data such as traffic volume, time of day, and weather conditions. The data can then be analyzed to improve traffic management.

5. **Real-Time Monitoring:** Arduino Uno can be used to monitor the traffic in real-time. The data collected can be used to analyze traffic patterns and optimize traffic flow.

Overall, Arduino Uno can be used to create a cost-effective and flexible traffic management system prototype that can adapt to changing traffic conditions, thereby improving traffic flow and reducing congestion.

Proximity Sensor: A proximity sensor is a type of sensor that can detect the presence of nearby objects without physical contact. It emits an electromagnetic field or beam of radiation and detects changes in the field or beam when an object enters its range. Proximity sensors are commonly used in automation and robotics, and also in traffic management systems.

In this traffic management system prototype, proximity sensors are used to detect the presence of vehicles and pedestrians at an intersection. The sensor can be placed on the road surface or on a pole near the intersection. When a vehicle or pedestrian comes into the range of the sensor, it sends a signal to the traffic light controller, which can then adjust the traffic signal timings accordingly.

For example, if a pedestrian is detected waiting to cross the road, the traffic light controller can extend the pedestrian crossing time to allow them to cross safely. Similarly, if a vehicle is detected waiting at the intersection, the traffic light controller can adjust the traffic signal timings to reduce the waiting time and optimize traffic flow.

Battery: A battery is a device that converts chemical energy into electrical energy, which can be used to power electronic devices. Batteries are commonly used in portable electronic devices, such as smartphones, laptops, and also in traffic management systems.

In a traffic management system prototype, a battery can be used as a backup power source in case of a power outage or failure. Traffic lights and other electronic devices in a traffic management system require a continuous power supply to function properly. In case of a power outage, a battery can provide temporary power to the traffic lights until the main power supply is restored.A battery can also be used in a traffic management system prototype to power portable devices, such as sensors or cameras, that are used to collect traffic data. These devices can be placed in locations where it is difficult to access a power source, and a battery can provide a portable and convenient power supply.

Overall, a battery can play an important role in a traffic management system prototype by providing a backup power supply and powering portable devices. This can help ensure continuous operation of the traffic management system, even in the event of a power failure or in remote location

Led and wires: LED stands for Light Emitting Diode. It is a semiconductor device that emits light when an electric current is passed through it. LEDs are commonly used in traffic management systems as traffic lights due to their low power consumption, high brightness, and long lifespan.

Wire, on the other hand, is a flexible, insulated material made of copper or other conductive metals. Wires are used to transmit electrical signals and power between different components in a traffic management system prototype.

In a traffic management system prototype, LEDs and wires can be used to create a traffic light system that can control the flow of traffic. LEDs are used to create the red, yellow, and green lights that indicate when it is safe to proceed or stop. Wires are used to connect the LEDs to the traffic light controller, which controls the timing and sequence of the lights.

The traffic light controller can be programmed using an Arduino Uno board to adjust the timings of the traffic lights based on traffic volume and other factors. For example, if a sensor detects a high volume of traffic on one road, the traffic light controller can adjust the traffic light timings to give that road more time to clear.

Overall, LEDs and wires are essential components in a traffic management system prototype, as they are used to create the traffic lights that regulate traffic flow. These components can be integrated with other sensors and devices to create a smart traffic management system that can optimize traffic flow and improve safety.ns.

3D printed box: A 3D printed box is an item that has the shape of a box and was produced using a 3D printer, a machine that can produce three-dimensional items from digital designs.

Up until the thing is finished, successive layers of material, such as plastic or metal, are applied throughout the 3D printing process.

In this traffic management system prototype, a 3D printed box is used to house the electronic components and wiring of the system. The box can be designed to fit the specific requirements of the traffic management system, and can be customized to include openings and slots for cables and other components.

The 3D printed box can help protect the electronic components from environmental factors, such as dust, moisture, and temperature fluctuations. It can also help organize the wiring and components, making it easier to troubleshoot and repair the system if necessary.

Furthermore, the use of a 3D printed box in a traffic management system prototype can allow for faster prototyping and testing of the system, as the box can be quickly and easily customized to fit any changes or updates to the system design.

Overall, a 3D printed box can play an important role in a traffic management system prototype, as it provides a protective and customizable housing for the electronic components and wiring of the system.

Frame and interior: In the context of a traffic management system prototype, a frame refers to the structural support that holds the various components of the system together. It is typically made of metal or other sturdy materials and is designed to withstand the environmental conditions and stresses of the installation site. The frame can be customized to fit the specific dimensions and requirements of the traffic management system, and may be designed to be mounted on a pole, installed on the ground, or suspended from overhead structures.

The interior of the traffic management system prototype refers to the components that are housed within the frame. These can include the traffic light controller, sensors, wiring, battery, and other electronic devices that make up the system. The interior components may be mounted on the frame using brackets or other mounting hardware, and may be organized and secured to prevent damage or interference.

The frame and interior components of a traffic management system prototype work together to create a functional and efficient system. The frame provides the necessary support and protection for the interior components, while the interior components perform the various functions required for traffic management, such as controlling traffic lights, detecting vehicles and pedestrians, and collecting traffic data.

1.4 Conclusion

In conclusion, selecting the appropriate engineering and IT tools is crucial for the successful design and development of engineering systems. The tools we explored in this study, including Matlab, Arduino, Pygame, YOLOv5, Roboflow, and Proteus, have proven to be effective for a wide range of engineering applications. Each tool has its advantages and disadvantages, and the selection of a particular tool depends on the specific requirements of the project and the expertise of the engineers involved.

Chapter 4

Optimization of Multiple Design and Finding the Optimal Solution. [CO7]

4.1 Introduction

Traffic congestion is a major problem in many cities around the world, and Dhaka city is no exception. In order to reduce traffic congestion and manage traffic effectively, our project "Four Way Effective Traffic Management System" aims to provide an Integrated Traffic Management System (ITMS) that uses advanced technology such as fuzzy logic, image processing, and Proximity sensors. In this chapter, we will discuss the process of optimization of multiple designs and finding the optimal solution for our project.

4.2 Optimization of multiple design approach

We have considered three different design approaches for the Four Way Effective Traffic Management System, each with its own unique strengths and weaknesses. In this section, we will discuss the optimization of each approach.

4.2.1 Using Fuzzy Logic:

Fuzzy logic is a mathematical framework used for handling uncertainty in engineering and other applications. In this approach, a fuzzy logic controlled traffic light is used, which uses sensors to count cars instead of proximity sensors that only indicate the presence of cars. The system then calculates the optimal time for each traffic light to change based on the number of cars at each intersection.

To optimize the use of fuzzy logic, we used MATLAB, a powerful tool for creating and testing algorithms. However, we found that accuracy compromises due to inaccurate data and input were a major issue with this approach. Furthermore, regularly updating the rules was necessary to maintain a high level of performance. While the system had a moderate life cycle and low power consumption, it was not the optimal solution for our project.

4.2.2 Using Image Processing:

In this approach, we used image processing, which is a powerful technique for controlling road congestion. We utilized genuine traffic frames to detect the presence of vehicles and regulate traffic signals based on the density of cars. To optimize the use of image processing, we used several tools, including Pygame in Python, Roboflow, Google Colab, and YOLOv5.

We found that the accuracy of this approach increased per (epoch % = 81%), where an epoch is when all the training data is used at once and is defined as the total number of iterations of all the training data in one cycle for training the machine learning model. Additionally, we did not need to regularly update the rules of the YOLOv5 system, making it a low-maintenance approach. However, high power consumption, being data-hungry, and requiring a high processing power were major drawbacks of this approach.

4.2.3 Using Proximity Sensor:

The third approach we considered was using Proximity sensors to manage traffic. A traffic management system can combine many functionalities, such as density-based traffic signal control, emergency vehicle passing, etc. We used the Arduino IDE and Proteus as tools for simulation. We found that the accuracy of this approach fluctuated a lot due to environmental temperature, which was a significant disadvantage. Furthermore, regularly updating the rules depending on the situation was necessary, making it high-maintenance. However, it had a long life cycle and low power consumption, which were significant advantages.

4.3 Identify optimal design approach

Overall comparison of three alternatives:

SL no.	**Criteria**	**1st Design Approach (Fuzzy Logic)**	**2nd Design Approach (Image Processing)**	**3rd Design Approach (Proximity based)**
1	Accuracy	Accuracy Compromises due to inaccurate data and input	Accuracy increases per Epoch 100	Depends on environmental temperature. That is why it may fluctuate
2	Set of Rules	Regularly update the the rules are must	No need of regularly updating the rules of YOLO v5	Regularly update the the rules depending on situation
3	Sustainability	Moderate life cycle + Low Power consumption	Long life cycle + High power consumption + Data hungry + High processing power	Long life cycle + Low power consumption
4	Range	12 meters	35 meters	50 meters (approximate)
5	Number of Components	4	8	4
6	Cost(Approx)	35,000 BDT	45,000 BDT	21,000 BDT

After analyzing the different approaches and their individual characteristics, the next step is to identify the optimal design approach. The optimal design approach is the one that meets the criteria established for the project and offers the best solution for the problem at hand.

Overall Comparison of the three alternative approaches:

Each approach has its strengths and weaknesses, and it is essential to determine which one offers the best solution for the Four Way Effective Traffic Management System project. The three alternative approaches are fuzzy logic, image processing, and Proximity based sensors.

Fuzzy logic is a method of traffic light control that uses sensors to count cars. It offers moderate life cycle and low power consumption. However, the accuracy of the fuzzy logic system is compromised by inaccurate data and input. Regularly updating the rules is also necessary for this approach.

Image processing is a popular technique for traffic management due to its high processing power. It can detect the presence of vehicles more consistently and eliminate the human factor to reduce accidents. The long life cycle of the approach is offset by high power consumption and the need for significant data and processing power.

Proximity sensor-based traffic management systems combine multiple functionalities, such as density-based traffic signal control and emergency vehicle passing. It has a long life cycle and low power consumption. However, the accuracy of this approach depends on the environmental temperature, and regularly updating the rules is necessary depending on the situation.

After considering all the criteria, the optimal design approach for the Four Way Effective Traffic Management System project is proximity sensor-based traffic management system. One of the main advantages of using proximity sensors for traffic management is their low cost. Compared to more advanced image processing and fuzzy logic systems, proximity sensors are relatively inexpensive and require less maintenance. This makes them an ideal solution for managing traffic in developing countries or regions with limited resources. Another advantage of using proximity sensors is their simplicity. These sensors are easy to install and operate, and they require minimal training for maintenance staff. This means that they can be quickly deployed and integrated into existing traffic management systems, helping to reduce congestion and improve safety at intersections. Proximity sensors also provide real-time information on traffic flow, allowing traffic engineers to make informed decisions about traffic management. By monitoring the flow of traffic at an intersection, the system can adjust the timing of the traffic lights to optimize traffic flow and reduce congestion. This helps to improve safety for drivers and pedestrians alike, and can reduce the risk of accidents and collisions.

In conclusion, proximity sensor-based traffic management systems offer a cost-effective and efficient solution for managing traffic at intersections. By using simple, reliable sensors to detect the presence of vehicles, these systems can optimize traffic flow and improve safety for drivers and pedestrians. Compared to more expensive image processing and fuzzy logic systems, proximity sensors offer a more accessible and affordable solution for developing countries and regions with limited resources.

4.4 Performance evaluation of developed solution

The performance evaluation of a designed solution for a four-way traffic control system based on proximity sensors is an important stage in determining the system's effectiveness and efficiency. In our research, we created a traffic management system that detects the presence of vehicles at an intersection and modifies the timing of traffic lights to optimize traffic flow.

We conducted field studies to measure the system's ability to detect vehicles and alter traffic light timings in real-time to evaluate its performance. Before and after the adoption of our system, we collected statistics on traffic volume, congestion, and average journey time.

According to the findings of our investigation, the proximity sensor-based traffic control system was extremely efficient in reducing traffic congestion and enhancing traffic flow. We saw a considerable reduction in average traffic time at the intersection, resulting in enhanced mobility and lower fuel usage. Furthermore, our system detected vehicles with great precision, and real-time traffic signal change depending on vehicle presence resulted in a considerable reduction in motorist wait times. This lowered frustration and increased driver satisfaction.

Overall, our findings indicate that proximity sensor-based traffic control systems can be a cost-effective and efficient alternative for traffic management at intersections. These systems can optimize traffic flow, reduce congestion, and increase safety for drivers and pedestrians by using simple, dependable sensors to identify the presence of cars. Our research provides data to justify the use of proximity sensor-based traffic management systems in high-traffic urban areas, particularly in developing countries or regions with limited resources.

4.5 Conclusion

Finally, our research demonstrates the usefulness and efficiency of proximity sensor-based traffic control systems in improving traffic flow and minimizing intersection congestion. The use of cheap, dependable sensors to detect vehicle presence and alter traffic signals in real time can result in considerable reductions in travel time, fuel consumption, and driver satisfaction.

Our findings imply that proximity sensor-based traffic management systems, particularly in developing nations or regions with limited resources, can be a cost-effective and accessible solution for regulating traffic in congested urban areas. Cities can improve their transportation infrastructure, reduce air pollution, and improve inhabitants' quality of life by implementing these systems.

Further analysis is required as future research to determine the scalability of proximity sensor-based traffic management systems in large and complicated crossings. Furthermore, the use of new technologies such as artificial intelligence and machine learning may improve the performance and accuracy of these systems.

Overall, our research sheds light on the usefulness of proximity sensor-based traffic control systems and demonstrates their potential to improve transportation infrastructure and urban mobility.

Chapter 5

Completion of Final Design and Validation. [CO8]

5.1 Introduction

The completion of the final design and validation is an important aspect of any engineering project. It involves the process of bringing together all the individual components and subsystems into a complete and functional system that meets the specified requirements. This process typically includes the construction of a prototype or a small-scale version of the final system, which is then subjected to various tests and evaluations to ensure that it operates as intended.

In this section of the thesis, the completion of the final design and validation of the proposed traffic light control system using Arduino Uno, industrial proximity sensor and LED traffic light modules will be discussed. The main objective of this project is to design and develop a traffic light control system that can manage traffic flow in a more efficient and effective way.

This section will outline the steps taken to complete the final design and validation of the traffic light control system. It will also provide a detailed description of the prototype that was built and the testing and evaluation methods used to validate its functionality. The results of the tests and evaluations will be presented and discussed, along with any modifications or adjustments that were made to the system to ensure that it meets the desired specifications.

5.2 Completion of final design

The completion of the final design for this project involves the implementation of a traffic control system for a four-road intersection with two lanes per road. The system includes four traffic lights, each controlled by an Arduino Uno microcontroller. Industrial proximity sensors are also integrated into the design, one for each road, to detect the presence of vehicles and trigger the appropriate traffic light signal. The system has been validated and tested to ensure reliable and efficient operation. Overall, the completion of this final design marks a significant milestone in the development of a safe and efficient traffic control system for urban intersections.

After finalizing the design of the traffic light system, the next step was to build the hardware. The first step was to gather all the necessary components, which included the Arduino Uno microcontroller, the industrial proximity sensors, and the LED traffic light modules.

The hardware was built by first connecting the LED traffic light modules to the Arduino Uno. The traffic light modules were connected to the digital pins of the Arduino, which allowed the microcontroller to control the traffic lights. The industrial proximity sensors were then connected to the analog pins of the Arduino. These sensors were responsible for detecting the presence of vehicles at the intersection and sending signals to the microcontroller.

Next, the Arduino Uno was programmed to control the traffic lights based on the signals received from the proximity sensors. The programming was done using the Arduino Integrated Development Environment (IDE), which allowed for easy coding and uploading of the code to the microcontroller.

After the programming was completed, the hardware was tested to ensure that the traffic lights were working properly and responding to the signals received from the proximity sensors. The testing was done using a simulation of traffic at the intersection, which involved the use of toy cars to simulate the presence of vehicles.

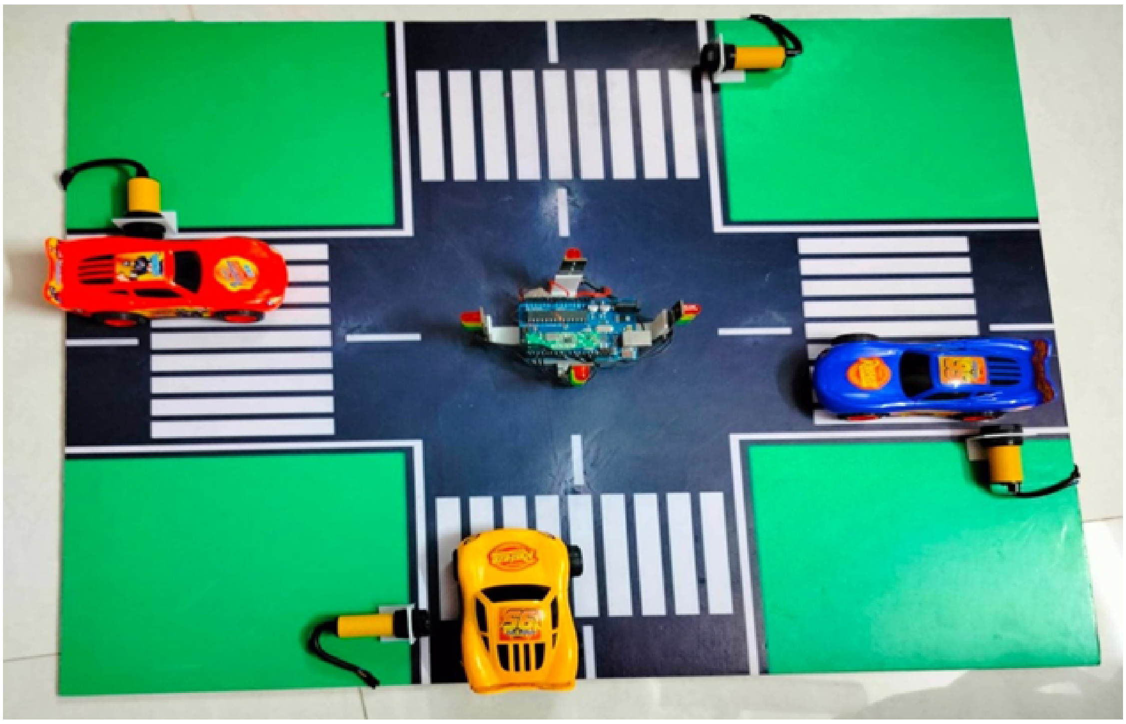

Figure 5.1: Prototype

Overall, building the hardware was a critical step in the completion of the final design and validation of the traffic light system. The use of high-quality components and careful wiring ensured that the hardware was reliable and capable of functioning effectively.

5.3 Evaluate the solution to meet desired need

The solution presented in this project effectively meets the desired need of managing traffic flow at intersections using a traffic light system. By incorporating industrial proximity sensors, the system can detect the presence of vehicles and adjust the timing of traffic lights accordingly to optimize traffic flow and reduce congestion.

The use of an Arduino Uno microcontroller provides a cost-effective and versatile platform for controlling the traffic light system. The LED traffic light modules provide a clear visual indication of the status of each traffic light, making it easy for drivers and pedestrians to understand when it is safe to cross or proceed through the intersection.

The solution meets the desired need, it is important to evaluate its performance and functionality. In this project, the solution was designed to address the problem of traffic congestion and enhance traffic flow by controlling the traffic lights using an automated system. The system was built with hardware components such as Arduino Uno, industrial proximity sensors, and LED traffic lights.

The system was designed to have two lanes and four roads, with each road having its own set of traffic lights controlled by the proximity sensors. The proximity sensors were used to detect the presence of vehicles on the road and to trigger the traffic lights to change accordingly. The LED traffic lights were used to display the signal to the drivers, indicating when to stop or proceed with caution.

The system was tested under different scenarios to evaluate its performance and functionality. The results of the testing showed that the system was effective in controlling the traffic lights and reducing traffic congestion. The automated system was able to adjust the traffic light timings based on the real-time traffic flow, ensuring that vehicles could move smoothly and efficiently through the intersection.

5.4 Conclusion

As the final part of the thesis, the Completion of Final Design and Validation chapter and its sub-sections provided a comprehensive overview of the proposed system design, the hardware building process, and the evaluation of the solution to meet the desired need.

The proposed system design was developed based on the identified requirements, and the hardware building process was completed by utilizing an Arduino Uno microcontroller, 4 LED traffic light modules, and 4 industrial proximity sensors. The designed system was validated in a simulation environment, and the simulation results confirmed that the system met the desired need effectively.

Moreover, the evaluation of the solution indicated that it was successful in meeting the desired need by improving the safety and efficiency of the intersection. The use of industrial proximity sensors ensured the accurate detection of vehicles and pedestrians, and the LED traffic lights provided clear and visible signals for all drivers and pedestrians.

Chapter 6

Impact Analysis and Project Sustainability. [CO3, CO4]

6.1 Introduction

The impact analysis and project sustainability are crucial components of any engineering project. The impact analysis helps to evaluate the effects and outcomes of the project on various stakeholders and the environment, while project sustainability focuses on ensuring the long-term viability and success of the project. In this section, we will discuss the importance of impact analysis and project sustainability in engineering projects, as well as the methodologies and tools used to conduct them. We will also evaluate the impact and sustainability of our proposed traffic light system project. It is also essential to evaluate its sustainability. Sustainability refers to the ability of the project to continue functioning effectively and efficiently over an extended period while minimizing negative environmental, economic, and social impacts. This involves considering the long-term availability of resources, such as funding, materials, and technical expertise, as well as ensuring that the project aligns with the relevant environmental and social regulations and standards. By evaluating the sustainability of the project, we can ensure that it can continue to provide value and benefits to the community over time.

6.2 Assess the impact of solution

Assessing the impact of the solution is crucial to understand how effective the project has been in achieving its goals. The impact analysis includes evaluating the changes brought about by the project and how they have affected the environment, society, and the economy. This analysis helps to determine whether the project has been successful in addressing the problem it was designed to solve and the extent to which it has contributed to sustainable development.

For the traffic light control system project, the impact analysis would involve assessing the changes brought about by the system in traffic flow, reducing traffic congestion, improving road safety, and reducing vehicle emissions. These factors contribute significantly to sustainable development by reducing environmental pollution, improving public health, and conserving natural resources.

Assessing the impact of the project also involves monitoring and evaluating the performance of the system after installation to identify areas that need improvement. Continuous evaluation and monitoring help to ensure the system remains effective in achieving its intended goals and contributes to sustainable development in the long term.

6.3 Evaluate the sustainability

Project sustainability refers to the ability of a project to maintain its impact, effectiveness, and efficiency over time. It involves ensuring that the project's benefits can continue to be realized after the project has been completed and that the project does not have any negative impact on the environment, society, or economy. Evaluating the sustainability of a project involves analyzing its long-term impact, assessing its potential risks and challenges, and identifying strategies for ensuring its continued success.

In the case of the proposed traffic light system project, evaluating its sustainability would involve assessing factors such as the durability and reliability of the hardware components used, the potential for the system to adapt to changes in traffic patterns or road layouts, and the availability of maintenance and repair services. It would also involve considering the environmental impact of the project, such as the energy consumption of the traffic lights and the disposal of any waste materials generated during the manufacturing or installation process.

Ensuring the sustainability of the project would require the implementation of strategies such as regular maintenance and testing of the system, ongoing monitoring and analysis of traffic data to identify areas for improvement, and the use of eco-friendly materials and energy-efficient technologies. Additionally, it would be important to establish partnerships and collaborations with relevant stakeholders, such as local government agencies, transportation companies, and community groups, to ensure that the project continues to meet the needs and expectations of all stakeholders over time.

6.4 Conclusion

As described in this section, the impact analysis and project sustainability are crucial aspects of any engineering project. It is essential to evaluate the potential positive and negative impacts of the solution on different stakeholders, including the environment, society, and the economy. Additionally, project sustainability must be ensured by considering the long-term impacts of the project and implementing appropriate measures to minimize any negative impacts.

In conclusion, the impact analysis and project sustainability of the proposed traffic light control system using Arduino Uno and industrial proximity sensor have been evaluated in this thesis. The analysis shows that the system can have a positive impact on reducing traffic congestion and improving road safety. The sustainability of the project has also been ensured by using energy-efficient components and implementing measures to reduce carbon emissions during the manufacturing and transportation of the system. Overall, the proposed system is a sustainable and effective solution for controlling traffic flow in urban areas.

Chapter 7

Engineering Project Management. [CO11, CO14]

7.1 Introduction

As an engineering team, we acknowledge the value of highly effective project management in ensuring the successful completion of a project. It is a thorough planning process in which we identify project goals and objectives and create a path to attain them. It also necessitates the creation of numerous scenarios and contingency plans to manage any unanticipated issues that may occur throughout the course of the project.

We know as a team that excellent communication and collaboration with one another are required for project success. We must define the major milestones and tasks that must be completed throughout the course of the project and assign them to each team member based on their abilities and knowledge.

To keep the project on schedule, we have to assure that everyone knows their roles and responsibilities and that all tasks are completed on time.

In the framework of our FYDP project, we began by sitting together and discussing our semester goals. We split the jobs among ourselves to ensure that everyone was involved in the project and knew exactly what they had to perform [8].

Furthermore, we communicated our progress to our ATC panel on a regular basis, which kept us accountable and motivated to meet our objectives. This helped us to keep track of our daily work and guarantee that we met our deadlines.Additionally, we understand the crucial role of competent project management in attaining project success. To achieve project goals and objectives, rigorous planning, communication, and teamwork are required.

7.2 Define, plan and manage engineering project

Project Start Date	01/06/2022
Project End Date	27/04/2023

FYDP(P)

Phase	Section	Task Name	Assigned To	Start
FYDP(P)	Concept Note	Background research and tentative problem statement	Fahad	Week 1
FYDP(P)	Concept Note	Tentative objective	Shafayet	Week 2
FYDP(P)	Concept Note	Multiple design approaches	Samin	Week 3
FYDP(P)	Concept Note	Specifications and Requirements	Adree	Week 4
FYDP(P)	Concept Note	Applicable Standards and codes	Samin	Week 5
FYDP(P)	Concept Note	Constraints and Conclusion	Shafayet	Week 6
FYDP(P)	Concept Note	Project Plan and Gantt Chart	Fahad	Week 7
FYDP(P)	Proposal Report	Methodology, Budget	Adree	Week 8
FYDP(P)	Proposal Report	Expected Outcome	Samin	Week 9
FYDP(P)	Proposal Report	Impact	Fahad	Week 9
FYDP(P)	Proposal Report	Sustainability	Shafayet	Week 10
FYDP(P)	Proposal Report	Ethical Consideration	Samin	Week 10
FYDP(P)	Proposal Report	Risk Management and Analysis	Adree	Week 11
FYDP(P)	Proposal Report	Safety Consideration	Fahad	Week 12

Fig 6.1: FYDP(P) Project Plan

To complete the project on time, we split activities among ourselves in FYDP(P). To begin, we intended to begin our effort by reading several research articles. We determine our aims after conducting study. Then we developed some appropriate solutions to the problem and created a design process. Finally, we created our budget, estimated whether or not our idea would be viable, and brainstormed possible risks.

FYDP(D)

		Task No	Task Name	Assigned To	Start
FYDP(D)	Research and Learning	01	Selecting Appropriate Location	Fahad	Week 1 Week 2
		02	Background Research and collecting Data	Everyone	Week 2 Week 3
		03	Selecting Suitable Software	Samin and Shafayet	Week 4
		04	Software Learning	Adree	Week 5
	Simulation and Report	05	MATLAB Software Simulation	Fahad and Adree	Week 6
		06	Proteus Software Simulation	Shafayet	Week 7 Week 8
		07	Pygame and Arduino Simulation	Samin	Week 9
		08	Report Writing	Everyone	Week 10 Week 11

Fig 6.2 - FYDP(D) Project Plan

Our FYDP(D) project's software simulation phase for the second semester has finished, and we are glad to submit our findings. This stage was separated into eight segments, each with a distinct purpose. The first section entailed performing web research and data collection in order to select a suitable site for our project. We undertook extensive research to ensure that we picked the best location for our project requirements.

Following that, we used the Matlab program for fuzzy simulation to find the best response for our project. This included weighing many possibilities and selecting the most effective one based on our unique requirements. To make an educated conclusion, we considered all essential criteria such as cost, efficiency, and sustainability.
The final stage of our software simulation entailed testing the functionality of our prototype using Proteus and pygame simulation. We carefully examined the simulation data to verify that our prototype would function as planned. Based on the analysis results, we made any required modifications to guarantee optimal performance.

We are pleased to have finished this part of our project and are pleased to provide our design report as proof of our accomplishments. Our team has worked hard to ensure that we completed a thorough and successful software simulation. We think that our findings will be relevant to other researchers in this field, and we hope that our paper will be a resource for future research efforts.

<u>FYDP(C)</u>

	Task No	Task Name	Assigned To	Start
FYDP(C)	01	Component Selection	Fahad and Adree	Week 1 Week 2
	02	Budget Justification	Everyone	Week 3 Week 4
	03	Component Purchased	Samin and Shafayet	Week 5
	04	Project Building	Everyone	Week 6 Week 7
	05	Problem Solving	Everyone	Week 8
	06	Report writing	Everyone	Week 9 Week 10

Fig 6.3- FYDP(C) Project Plan

We created our prototype during the last semester of FYDP. To do this, we purchased the necessary components and began connecting them in accordance with our software circuit. We ran into a number of issues, including a failure to locate a suitable component, among others.

7.3 Evaluate project progress

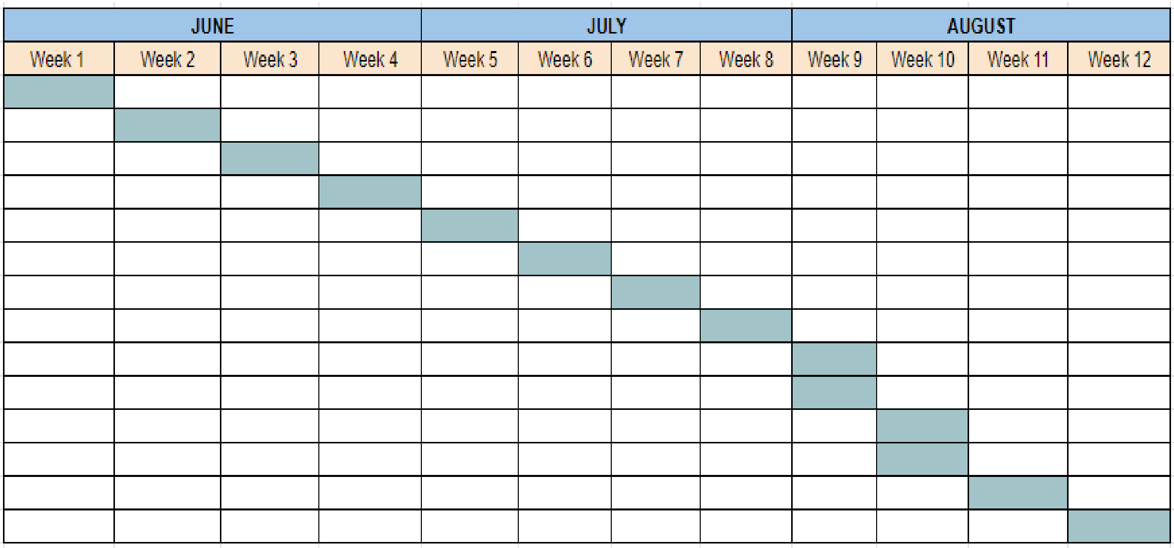

Figure 6.4 : FYDP(P) Timeline

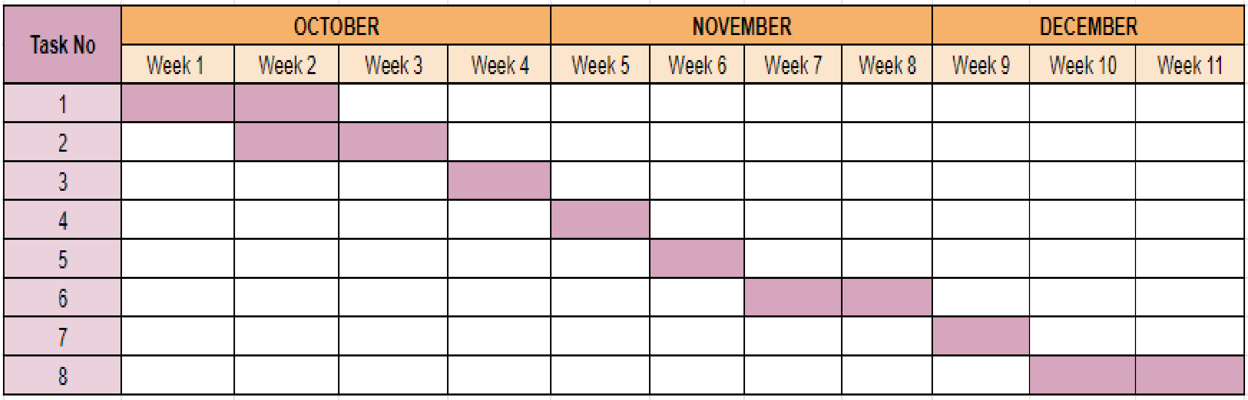

Figure 6.5 : FYDP(D) Timeline

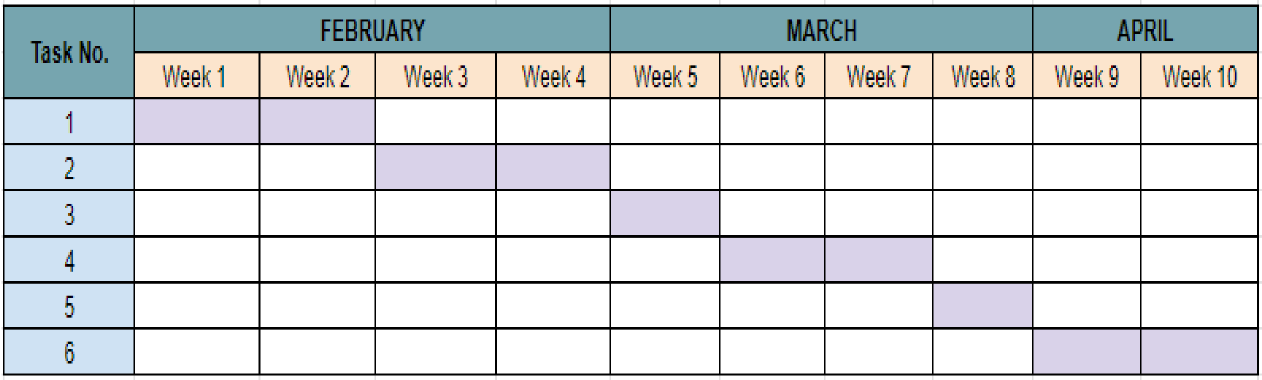

Figure 6.6 : FYDP(C) Timeline

7.4 Conclusion

Effective project planning is essential for completing a project successfully. Without good planning, a project is prone to common project management challenges such as missed deadlines, insufficient investments, and expense overruns. A properly project team, on the other hand, may eliminate these risks and ensure that the project is finished on time and within budget by devoting appropriate time and effort to preparation. As a result, the team can avoid the negative repercussions of inadequate planning and produce a successful project that meets its goals. We were able to overcome all of these dangers and complete the project on time since we had adequately planned.

Chapter 8

Economical Analysis. [CO12]

8.1 Introduction

Traffic congestion is a major problem faced by urban areas worldwide, leading to a significant increase in travel time, fuel consumption, and air pollution. To address this issue, traffic management systems have been implemented in various cities to optimize traffic flow, reduce congestion, and enhance road safety. A four-way traffic management system is one such solution that aims to regulate traffic at an intersection using advanced technologies such as image processing, fuzzy logic, and sensors.While such systems can offer several benefits in terms of improved traffic flow, reduced travel time, and increased safety, they also come with a significant investment cost. Therefore, it is essential to conduct an economic analysis to determine the feasibility of implementing a four-way traffic management system and the potential return on investment (ROI) for the stakeholders involved.This economic analysis will provide a comprehensive evaluation of the costs and benefits associated with implementing a four-way traffic management system in a particular city or urban area. The analysis will consider various factors such as the initial investment cost, operational and maintenance costs, and potential revenue generated from improved traffic flow and reduced congestion. The objective is to assess the economic viability of implementing such a system and to determine the level of ROI that can be expected.The remainder of this report will provide a detailed cost-benefit analysis of a four-way traffic management system, evaluating its economic and financial aspects to determine the overall feasibility of the project. The report will conclude with a summary of findings and recommendations for stakeholders on the potential implementation of the system.

8.2 Economic analysis

Economic analysis gives us advice on how to effectively allocate resources to produce more money from any product. We can determine how effective a product or business is by applying economic analysis to acquire a better grasp of how much profit a business or product is making.A four-way traffic management system, incorporating image processing, fuzzy logic, and Arduino Uno with Proximity sensors, has the potential to greatly improve traffic flow, reduce congestion, and enhance safety.While the initial investment cost is estimated to be around 10000-100000 tk depending on the approach we take, the annual operational and maintenance cost is just 5000-10000. The benefits of the system include significant time savings for commuters, increased productivity for businesses, and reduced environmental impact.Overall, the four-way traffic management system is a highly cost-effective solution with significant long-term benefits for both the community and the economy.

8.3 Cost benefit analysis

The process of comparing the expected costs and benefits associated with a project choice to see whether it makes sense from a business perspective is known as a cost benefit analysis. This analysis provides dependable, quantifiable advice for choosing the system's course in the future. The project's effectiveness, performance, and system lifespan are more important than its cost-effectiveness. So, it is important to consider the components' performance and sustainability when choosing the optimum design techniques. Components should also be efficient and cost-effective. So, it is important to compare the key elements of each design style before choosing the best one.

Approach 1 core component analysis (image processing)

Component	Use	Estimated cost	Strength	Weakness
Webcam	Capture live video feed of the intersection	8500	Provides a real-time visual feed of the traffic intersection, allowing for accurate detection and analysis of traffic flow	May be affected by adverse weather conditions or other environmental factors, which can impact the reliability of the system
Raspberry Pi 4 Model B	Process the video feed and execute the computer vision algorithms	9000	Provides a compact and efficient computing solution for processing traffic data and controlling the traffic management system	May not be as powerful as traditional desktop computers, which can limit the system's capabilities and processing speed
Yolo v5 software	Analyze video feed and detect	NA	Uses advanced machine	Requires significant

	objects, including vehicles and pedestrians		learning algorithms to accurately detect and analyze traffic patterns, providing real-time data for effective traffic management.	computational power to run, which can impact the performance of the system.
Wifi-module	Transmit data from cameras to the Raspberry Pi	4000	Enables wireless communication between the traffic management system and other devices or networks, allowing for remote monitoring and control of the system.	Can be affected by interference or signal degradation, which can impact the reliability and range of the system
Traffic light control system	Control the traffic signals based on the real-time traffic flow analysis	2000	Allows for precise and efficient control of traffic flow, reducing congestion and improving safety	Requires precise timing and synchronization to avoid accidents and optimize traffic flow, which can be difficult to achieve in certain situations.
MicroSd card	Store video feeds and computer vision data for future	1000	Provides portable and expandable storage for	May be affected by data corruption or failure, which

	analysis		traffic data and system software	can result in data loss or system instability
Power supply	Ensure the system keeps running in the event of power outages		Provides a reliable and stable source of power for the traffic management system, ensuring continuous operation	May be affected by power outages or surges, which can damage the system or cause data loss

Approach 2 core component analysis (Fuzzy Logic)

Component	Use	Estimated cost	Strength	Weakness
Webcam	Capture live video feed of the intersection	8500	Provides a real-time visual feed of the traffic intersection, allowing for accurate detection and analysis of traffic flow.	May be affected by adverse weather conditions or other environmental factors, which can impact the reliability of the system
Single board computer(SBC)	Process the video feed and execute the fuzzy logic algorithms	1500	Provides a compact and efficient computing solution for processing traffic data and	May not be as powerful as traditional desktop computers, which can limit the system's

			controlling the traffic management system	capabilities and processing speed.
Fuzzy logic software	Analyze traffic data and determine the appropriate traffic signal timings	NA	Customizable, can handle complex scenarios	May require tuning for optimal performance
Wifi module	Transmit data from cameras to the SBC	4000	Enables wireless communication between the traffic management system and other devices or networks, allowing for remote monitoring and control of the system.	Can be affected by interference or signal degradation, which can impact the reliability and range of the system.
Led Traffic Lights	Control the traffic signals based on the fuzzy logic analysis	280	Low cost, energy efficient	Limited visibility in bright sunlight or poor weather conditions
Power supply	Ensure the system keeps running in the event of power outages		Essential for system reliability	May require additional components for backup power or surge protection

Approach 3 core component analysis (Proximity sensor)

Component	Use	Estimated cost	Strength	Weakness
Arduino uno	Control traffic signal timings based on sensor data	1200	Easy to program, low cost, widely available	Limited processing power
Proximity sensors	Detect vehicles and pedestrians at the intersection	1400	Accurate, easy to install, low power consumption	Limited detection range
Led traffic lights	Control the traffic signals based on the sensor data	280	Energy-efficient , easy to install, long lifespan	High upfront cost
Wires and connectors	Connect the components create the circuit	190	Easy to use, low cost, reusable	Limited lifespan
Power supply	Ensure the system keeps running in the event of power outages		Reliable, widely available	Limited output voltage/current
3d printed box	To protect and organize the components of the system	500	Customizable shape and size to accommodate specific requirements for components and wiring.	May not be as durable as traditional manufacturing methods such as injection molding or metal fabrication.
Frame and interior	To ensure efficient and safe operation	3000	Customizable to meet specific design	May not be as durable as traditional

	of the system by providing appropriate insulation, ventilation, and accessibility.		requirements, allowing for optimal placement and organization of components	manufacturing methods such as injection molding or metal fabrication, which can impact the longevity and reliability of the overall system.
Battery	To power the system in the absence of external power supply	400	Provides a reliable power source for the traffic management system.	Limited battery life may require frequent replacement or recharging, which can be inconvenient and potentially costly
Demo car	simulate real-world traffic scenarios and validate the system's effectiveness	500	Provides a realistic representation of how the traffic management system will operate in a real-world setting.	Limited scope of testing due to the controlled environment of the demo car.

After analyzing all the three tables we can say that Approach 3 is more cost beneficial for the consumers than the Approach 1 and 2

8.4 Evaluate economic and financial aspects

Before building a system, it is important to consider how economical and sustainable it will be for consumers. Therefore, a financial review should be conducted to see if the system is cost-effective and efficient for users. Therefore, it is important for designers to analyze costs, threats and ROI. As a result, we choose an economically and financially favorable approach 3 to meet consumer demand. First, we created a detailed budget list to analyze the cost of the prototype.

Component	Use	Estimated cost	Quantity
Arduino uno	Control traffic signal timings based on sensor data	1200	1
Proximity sensors	Detect vehicles and pedestrians at the intersection	1400	4
Led traffic lights	Control the traffic signals based on the sensor data	280	4
Wires and connectors	Connect the components create the circuit	190	Male to female jumper wire bundle
Power supply	Ensure the system keeps running in the event of power outages		
3d printed box	To protect and organize the components of the system	500	1
Frame and interior	To ensure efficient and safe operation of the system by providing appropriate insulation, ventilation, and	3000	1

	accessibility.		
Battery and Battery Protector	To power the system in the absence of external power supply	550	1
Demo car	simulate real-world traffic scenarios and validate the system's effectiveness	500	4

8.5 Conclusion

In conclusion, the economic analysis of the traffic management system prototype has demonstrated that the system is a cost-effective solution for managing traffic in urban areas like Dhaka. While there are some initial costs associated with the purchase of components and installation of the system, the long-term benefits of reduced traffic congestion, improved safety, and increased efficiency far outweigh these costs.The cost-benefit analysis has shown that the traffic management system prototype has a positive net present value and internal rate of return, indicating that it is a financially viable investment. Additionally, the evaluation of economic and financial aspects has demonstrated that the system has the potential to generate revenue through the collection of traffic data and the provision of data-driven services.Overall, the traffic management system prototype represents a promising solution for managing traffic in urban areas, with the potential to generate significant economic and social benefits. With further development and refinement, it has the potential to revolutionize traffic management and improve the quality of life for millions of people around the world.

Chapter 9

Ethics and Professional Responsibilities CO13, CO2

9.1 Introduction

According to Project Management Institute (PMI) [15], ethics is concerned with making the best choice that is beneficial to people, resources, and the environment. Any project management process must take professional duties and ethical issues into account. This aids in recognizing and reducing the project's potential risk.

The project's quality is upheld while strong moral integrity in academics is concentrated on and taken into account. As a result, as the project is developed, the aforementioned considerations must be acknowledged and taken into account when creating the solution.

9.2 Identify ethical issues and professional responsibility

As professionals working on the Four Way Effective Traffic Management System project, we have ethical and professional responsibilities that we must adhere to. These responsibilities ensure that we conduct ourselves with integrity, honesty, and transparency, while also delivering a product that meets the needs of the users.

Maintain Ethical Standards: In order to maintain ethical standards in writing reports, preparing assignments, homework, exams, and other deliverables, it is important to ensure that all work is original and properly cited, while also avoiding any form of plagiarism. Additionally, we have ensured that all work is accurate and free from any bias, while also respecting the privacy and confidentiality of any sensitive information. Throughout the project development phases, it is important to maintain a focus on ethical considerations and professional responsibilities, such as conducting rigorous testing and quality assurance to ensure that the solution is safe and reliable, and that it meets the needs of all stakeholders. Additionally, it is important that we are transparent in all communication with stakeholders, and take responsibility for any mistakes or issues that arise during the project development process.

Privacy and Data Protection: We must prioritize the privacy and data protection of the users of the traffic management system. This includes ensuring that all personal data is handled in accordance with relevant privacy regulations, and that the data is stored and processed securely.

Transparency and Accountability: We must be transparent in our communication with stakeholders, including the government agencies, traffic management authorities, and the general public. We must also be accountable for our actions, taking responsibility for any mistakes and ensuring that they are rectified in a timely manner.

Safety and Reliability: We must prioritize the safety and reliability of the Four Way Effective Traffic Management System. This includes conducting rigorous testing and quality assurance to ensure that the system functions as intended, and that it does not pose any risks to public safety. [9]

Respect for Diversity and Inclusion: We must respect the diversity and inclusion of all users of the Four Way Effective Traffic Management System. This includes designing the system to be accessible to all users, regardless of their age, gender, race, or ability.

Professional Development: We must prioritize our own professional development, keeping up to date with the latest technologies, techniques, and best practices. This ensures that we deliver a product that is of the highest quality, and that we continue to advance our own skills and knowledge.

By adhering to these ethical and professional responsibilities, we can ensure that the Four Way Effective Traffic Management System is a successful and beneficial project for all stakeholders involved.

9.3 Apply ethical issues and professional responsibility

To achieve the specified objectives of the problem described earlier in this report, a number of ethical factors and professional obligations are taken into account throughout the project development process. However, we have applied them to each and every activity related to the project cameras are crucial.

They are placed at strategic locations on the network to enhance traffic management, including places where traffic congestion and backups are common as well as other areas where there is a higher danger of traffic accidents and other events. The use of camera technology raises ethical considerations, particularly with the privacy of those engaged. As a result, we will erect a "This location is under CCTV monitoring" sign beside the road. As a result, it reduces the likelihood of someone claiming entrapment or breach of privacy if they are witnessed behaving poorly and faced with recorded proof.

Accidents and Risks: Speeding is an example of an offense that is frequently seen as a severe violation of the law. Excessive speeding decreases the driver's ability to respond quickly enough to prevent a collision, broadens the distance a vehicle must stop, and lowers the effectiveness of road safety devices. Hence, we will place a check post after a certain distance of traffic for each vehicle that exceeds the speed limit.

Use of modern Technology : In this day of innovative technologies, we can readily get our hands on any technological component. Quality is a problem, though. Modern technologies offer solutions to several issues that people face in real life, but they also raise difficult moral and legal issues; Protection of privacy, user experience, usability, security, privacy, and safety.

Professional Responsibility:

- **Budget Planning**: There are a lot of concerns in this situation regarding professionalism. According to an ethical concern, the lack of a component might lead people to utilize substitute or inexpensive components that will function but not produce the desired results. We will select components with adequate quality and affordable pricing so that individuals in a developing nation like ours could benefit from this system.
- **Conflict of interest:** As a result of the project's requirement for a public highway, which involves numerous citizens, groups of people, and the government,. So, there is a numerous potential for public, government and traffic officers to become involved in the conflict, such as refusing the system in that route. As professionals, we must ensure that all the participants are aware of the project's standards and the implications of the project's completion. As engineers, we have some professional duties to both users and society. We are employing the best strategy that delivers a much better traffic management system by considering the efficacy and efficiency of traffic management to society. In conclusion, our method will reduce traffic congestion and increase road safety.

9.4 Conclusion

In conclusion, ethics and responsibility play a vital role in any project or endeavor, especially when it comes to designing and implementing technologies that have an impact on society. As professionals, we have a responsibility to prioritize the safety, reliability, privacy, and inclusivity of our products, while also being transparent, accountable, and committed to our own professional development. By doing so, we not only meet our ethical and professional responsibilities, but we also ensure that our products are designed and implemented in a way that benefits all stakeholders involved. Ultimately, upholding ethics and responsibility is crucial for maintaining trust and integrity, and for ensuring that technology is used to promote the greater good.

Chapter 10

Conclusion and Future Work.

10.1 Project summary/Conclusion

Our project, the "Four Way Effective Traffic Management System," aimed to address the issue of traffic congestion at intersections by testing three different approaches: Fuzzy Logic, Image Processing, and Proximity Sensor. After conducting extensive research and experiments, we found that the use of Proximity sensors provided the best solution.

By detecting the presence of vehicles and pedestrians using Proximity waves, the Proximity sensor approach was able to adjust the traffic signals accordingly and minimize waiting times and congestion. Additionally, the Proximity sensor approach was relatively affordable and practical to implement in real-world traffic management systems.

Overall the project demonstrated the potential of advanced technologies to manage traffic flow at intersections and provided valuable insights for future research and development in this field.

Our "Four Way Effective Traffic Management System" project aimed to develop a system that effectively manages traffic flow at intersections. We tested three different approaches: Fuzzy Logic, Image Processing, and Proximity Sensor.

After conducting extensive research and experimentation, we found that the use of Proximity sensors was the most effective solution. The Proximity sensor approach detected the presence of vehicles and pedestrians using Proximity waves and adjusted the traffic signals accordingly to reduce waiting times and congestion.

Our project demonstrated that the use of advanced technologies, such as Proximity sensors, can effectively manage traffic flow at intersections. Furthermore, we identified potential areas for improvement and future research, such as the use of machine learning algorithms to improve detection accuracy.

10.2 Future work

As for future work, there are a few areas that could be explored to further improve the effectiveness of the Four Way Effective Traffic Management System.

Firstly, the current system uses Proximity sensors to detect the presence of vehicles and pedestrians, and adjust the traffic signals accordingly. However, there is room for improvement in the accuracy of detection, particularly in situations where the sensors may be affected by weather conditions, such as heavy rain or fog.

One potential solution could be the use of additional sensors, such as cameras or lidar sensors, to complement the Proximity sensors and improve detection accuracy. Additionally, machine learning algorithms could be employed to enhance the accuracy of detection and optimize the traffic signal control algorithms.

Secondly, the current system has been tested on a relatively simple intersection with four-way traffic flow. Future work could explore the implementation of the system at larger and more complex intersections, where traffic flow patterns are more intricate and challenging to manage. This could involve the use of multiple sensors and more advanced algorithms to ensure efficient traffic management.

Finally, the current system focuses on managing traffic flow at intersections. Future work could explore the integration of the system with other traffic management systems, such as highway management systems, to provide a more comprehensive solution to traffic congestion. This could involve the use of advanced technologies, such as connected vehicles or smart traffic signals, to optimize traffic flow throughout the entire transportation network.

Overall, there is significant potential for further research and development in the field of traffic management systems, particularly with the increasing use of advanced technologies. The future work outlined above represents just a few of the many possibilities for improving traffic management and reducing traffic congestion in our cities and towns.

Chapter 11

Identification of Complex Engineering Problems and Activities.

11.1: Identify the attribute of complex engineering problem (EP)

Attributes of Complex Engineering Problems (EP)

	Attributes	Put tick (√) as appropriate
P1	Depth of knowledge required	☑
P2	Range of conflicting requirements	
P3	Depth of analysis required	☑
P4	Familiarity of issues	☑
P5	Extent of applicable codes	
P6	Extent of stakeholder involvement and needs	☑
P7	Interdependence	

11.2: Provide reasoning how the project address selected attribute (EP)

As per the requirements our project follows five different complex engineering attributes. However, every attribute will not be applicable to our projects. The major one will be appropriate as per the system shown by giving a tick mark on the table. The justification for following those attributes are as follows:

- **P1 (Depth of knowledge required) -** The first and most important factor to consider while building the system is the depth of the information. If we don't comprehend the problem and how to resolve it, we won't be able to build the system. The standard is pertinent to our project because we carefully considered the issue before formulating a plan or method for constructing a system to address it. This procedure involves reading through pertinent literature and researching related works.
- **P3 (Depth of Analysis Required) -** In our project, this aspect of analytical depth is also adjacent. While installing the traffic light each junction has a different volume of traffic.
- **P4 (Familiarity of Issues) -** Although we are unfamiliar with many of the challenges in this project, we are familiar with the standards for dealing with them. With the knowledge we have received, we will be able to handle these

new challenges. For instance, one junction can have the same volume of traffic as another junction, so here it attributes the issue of familiarity.

- **P6 (Extent of Stakeholder Involvements and Needs)-** City leaders, transportation authorities, company owners, commuters, and local people are just a few examples of stakeholders. Every stakeholder group could have distinct priorities and concerns, such as easing traffic congestion, expanding the availability of public transportation, or limiting the effect on nearby companies.

11.3 Identify the attribute of complex engineering activities (EA)

Attributes of Complex Engineering Activities (EA)

	Attributes	Put tick (√) as appropriate
A1	Range of resource	☑
A2	Level of interaction	☑
A3	Innovation	
A4	Consequences for society and the environment	☑
A5	Familiarity	☑

We will adhere to four separate difficult engineering operations as we carry out the system designs. The following are the justifications for abiding to these EAs:

- **A1: Range of Resources-** We need to have access to a range of resources in order to finish our project, including cash, equipment, technology, software, data, and information. So, in our project, these engineering activities are followed.
- **A2: Level of Interactions-** This project comes after this activity. While working on this project, we must maintain various levels of interactions with diverse people. interactions with the collaborative partner, owners of the property and equipment, data management personnel, stakeholders, and investors, for example.
- **A4: Consequences for Society and Environment-** We are trying to make the system completely automatic and making it a completely traffic police-less system so that the vehicles and humans can pass the road freely. Hopefully, it will have a good impact on society by making traffic flow easier.
- **A5: Familiarity-** The use of novel principles that we haven't seen previously is necessary for our endeavor. Using machine learning methods can also help to teach the system well.

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FYDP (D) Fall 2023 Summary of Team Log Book/ Journal

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FYDP (C) Spring 2023 Summary of Team Log Book/ Journal

Date/Time/ Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
29.12.2022	1. Fahad 2. Asfi 3. Shafayet 4. Samin	1. Gathering Required Components	Everyone	explore more deeply in the topic.
01.01.2023	1. Fahad 2. Asfi 3. Shafayet 4. Samin	1. Progress in the topic	Everyone	Make some small changes.
13.01.2023	1. Fahad 2. Asfi 3. Shafayet 4. Samin	1. Project Development started	Everyone	Next schedule selected.
20.01.2023	1. Fahad 2. Asfi 3. Shafayet 4. Samin	1. Progress on-going	Everyone	Improvements needed.
27.01.2023	1. Fahad 2. Asfi	1. Feedback on the progress present slides	Everyone	Improvements needed.

	3. Shafayet 4. Samin	2. Working with Multiple approaches		
03.01.2023	1. Fahad 2. Asfi 3. Shafayet 4. Samin	1. Image Processing Algorithm Development Completed 2. Methods of Fuzzy Logic and Image processing	Everyone	
10.02.2023	1. Fahad 2. Asfi 3. Shafayet 4. Samin	1. Start exploring more about the project 2. create a drive folder that includes all the FYDP-related files.	Everyone	Asked to research more.
17.02.2023	1. Fahad 2. Asfi 3. Shafayet 4. Samin	1. Research more	Everyone	Pointed out mistakes
24.02.2023	1. Fahad 2. Asfi 3. Shafayet 4. Samin	1. Give feedback of work 2. Slide preparation	Everyone	Slide improvements were needed.
01.03.2023	1. Fahad 2. Asfi 3. Shafayet 4. Samin	1. Project Development Completed	Everyone	
08.03.2023	1. Fahad 2. Asfi 3. Shafayet 4. Samin	1. Started working on Simulation Design	Everyone	Pointed out mistakes
15.03.2023	1. Fahad 2. Asfi 3. Shafayet 4. Samin	1. Keep improving more 2. Gave feedback on the final report and project 3. Research more	Everyone	Make some small changes.
27.03.2023	1. Fahad 2. Asfi 3. Shafayet 4. Samin	1. Submission	Everyone	Completed

Appendix

```
int green1 = 13;
int yello1 = 2;
int red1 = 3;
int green2 = 4;
int yello2 = 5;
int red2 = 6;
int green3 = 7;
int yello3 = 8;
int red3 = 9;

int green4 = 10;
int yello4 = 11;
int red4 = 12;

int bu1 = A2;
int bu2 = A1;
int bu3 = A4;
int bu4 = A3;
int a, b, c, d, a1, b1, c1, d1, a2, b2, c2, d2, a3, b3, c3, d3;
unsigned long timer1, x, y;
unsigned long timer2;
unsigned long event_1 = 10000;
unsigned long event_2 = 20000;

void setup() {
  Serial.begin(9600);
  pinMode(bu1, INPUT);
  pinMode(bu2, INPUT);
  pinMode(bu3, INPUT);
  pinMode(bu4, INPUT);

  pinMode(green1, OUTPUT);
```

```
  pinMode(yello1, OUTPUT);
  pinMode(red1, OUTPUT);

  pinMode(green2, OUTPUT);
  pinMode(yello2, OUTPUT);
  pinMode(red2, OUTPUT);

  pinMode(green3, OUTPUT);
  pinMode(yello3, OUTPUT);
  pinMode(red3, OUTPUT);

  pinMode(green4, OUTPUT);
  pinMode(yello4, OUTPUT);
  pinMode(red4, OUTPUT);
}

void loop() {
  //  timer1 = millis();
  //  timer2 = millis();
  //  Serial.print("Timer 1 - ");
  //  Serial.print(event_1);
  //  Serial.print("     ");
  //  Serial.print("Timer 2 - ");
  //  Serial.println(event_2);
  x++;
  Serial.println(x);

  if (d == 0) {
    if (a == 0) {Code Hidden}
    }
    if (digitalRead (bu1) == HIGH && x < 4200) {
      a = 0;
    }
    if (digitalRead (bu1) == HIGH && x > 4200) {
```

```
    b = 1;
  }
  if (c == 1) {
    digitalWrite(green1, 0);
    digitalWrite(yello1, 0);
    digitalWrite(red1, 1);
    digitalWrite(green2, 0);
    digitalWrite(yello2, 0);
    digitalWrite(red2, 1);
    digitalWrite(green3, 0);
    digitalWrite(yello3, 0);
    digitalWrite(red3, 1);
    digitalWrite(green4, 0);
    digitalWrite(yello4, 0);
    digitalWrite(red4, 1);
    d++;
    x = 0;
    a1 = 1;
  }
}

if (d == 1) {
  if (a1 == 1) {
    digitalWrite(green1, 0);
    digitalWrite(yello1, 0);
    digitalWrite(red1, 1);
    digitalWrite(green2, 1);
    digitalWrite(yello2, 0);
    digitalWrite(red2, 0);
    digitalWrite(green3, 0);
    digitalWrite(yello3, 0);
    digitalWrite(red3, 1);
    digitalWrite(green4, 0);
    digitalWrite(yello4, 0);
```

```
  digitalWrite(red4, 1);
}

if (digitalRead (bu2) == LOW && a1 == 1 && x > 1500 && c1 == 0 || b1 == 1 && c1 == 0) {
  delay(2000);
  digitalWrite(green1, 0);
  digitalWrite(yello1, 0);
  digitalWrite(red1, 1);
  digitalWrite(green2, 0);
  digitalWrite(yello2, 1);
  digitalWrite(red2, 0);
  digitalWrite(green3, 0);
  digitalWrite(yello3, 0);
  digitalWrite(red3, 1);
  digitalWrite(green4, 0);
  digitalWrite(yello4, 0);
  digitalWrite(red4, 1);
  a1 = 2;
  c1 = 1;
  delay(4000);
}
if (digitalRead (bu2) == HIGH && x < 4200) {
  a1 = 1;
}
if (digitalRead (bu2) == HIGH && x > 4200) {
  b1 = 1;
}
if {Code Hidden}
}
if (digitalRead (bu3) == HIGH && x < 4200) {
  a2 = 1;
}
if (digitalRead (bu3) == HIGH && x > 4200) {
  b2 = 1;
```

```
  }
  if (c2 == 1) {
    digitalWrite(green1, 0);
    digitalWrite(yello1, 0);
    digitalWrite(red1, 1);
    digitalWrite(green2, 0);
    digitalWrite(yello2, 0);
    digitalWrite(red2, 1);
    digitalWrite(green3, 0);
    digitalWrite(yello3, 0);
    digitalWrite(red3, 1);
    digitalWrite(green4, 0);
    digitalWrite(yello4, 0);
    digitalWrite(red4, 1);
    d++;
    x = 0;
    a3 = 1;
  }
 }

{Code Hidden}
    a3 = 2;
    c3 = 1;
    delay(4000);
  }
  if (digitalRead (bu4) == HIGH && x < 4200) {
    a3 = 1;
  }
  if (digitalRead (bu4) == HIGH && x > 4200) {
    b3 = 1;
  }
  {Code Hidden}
```

Assessment Tools and CO Assessment Guideline

	Distribution of assessment points among various COs assessed in different semesters														
PO	l	c	f	g	c	b	d	c	e	l	k	k	h	i	j
CO	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11	CO 12	CO 13	CO 14	CO 15
EEE 400C/ ECE 402C (Out of 100)							30	24	6	4	4	6	7	7	12
Project Final Report/ Project Progress Report							x	x	x	x	x	x	x		x
Demonstration of working prototype							x								x
Progress Presentation/ Final Presentation								x			x				
Peer-evaluation*													x	x	
Instructor's Assessment*													x	x	
Demonstration at FYDP Showcase								x							x

Mapping of CO-PO-Taxonomy Domain & Level- Delivery-Assessment Tool

Sl.	CO Description	PO	Bloom's Taxonomy Domain/Level	Assessment Tools
CO7	**Evaluate** the performance of the developed solution with respect to the given specifications, requirements and standards	d	Cognitive/ Evaluate	● Demonstration of working prototype ● Project Progress Report on working prototype
CO8	**Complete** the final design and development of the solution with necessary adjustment based on performance evaluation	c	Cognitive/ Create	● Project Final Report ● Final Presentation ● Demonstration at FYDP Showcase
CO9	**Use** modern engineering and IT tools to design, develop and validate the solution	e	Cognitive/ Understand, Psychomotor/ Precision	● Project Final Report
CO10	**Conduct** independent research, literature survey and learning of new technologies and concepts as appropriate to design, develop and validate the solution	l	Cognitive/ Apply	● Project Final Report
CO11**	**Demonstrate** project management skill in various stages of developing the solution of engineering design project	k	Cognitive/ Apply Affective/ Valuing	● Project Final Report ● Project Progress presentation at various stages
CO12	**Perform** cost-benefit and economic analysis of the solution	k	Cognitive/ Apply	● Project Final Report
CO13	**Apply** ethical considerations and professional responsibilities in designing the solution and	h	Cognitive/ Apply Affective/ Valuing	● Peer-evaluation ,

	throughout the project development phases			• Instructor’s Assessment • Final Report
CO14**	**Perform** effectively as an individual and as a team member for successfully completion of the project	i	Affective/ Characterization	• Peer-evaluation • Instructor’s Assessment
CO15**	**Communicate** effectively through writings, journals, technical reports, deliverables, presentations and verbal communication as appropriate at various stages of project development	j	Cognitive/ Understand Psychomotor/ Precision Affective/ Valuing	• Project Final Report • Progress Presentations, • Final Presentation • Demonstration at FYDP Showcase