DENSITY BASED TRAFFIC CONTROL SYSTEM FOR A FOUR WAY INTERSECTION

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

Department of Electrical and Electronic Engineering
BRAC University
January, 2023

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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/We have acknowledged all main sources of help.

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Approval

The Final Year Design Project (FYDP) titled “Density Based Traffic Control System For a Four Way Intersection” submitted by

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of Summer, 2022 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Electrical and Electronic Engineering on 1st September, 2022..

Examining Committee:

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Ethics Statement

Plagiarism Boundary is strictly maintained. It was only 11% which is below 35%.

Abstract/ Executive Summary

Intelligent traffic system is not new to this modern world in order to mitigate traffic congestion. However, a proper management plan for a four way intersection lacks in our cities. An enhanced and optimized system is introduced in our project which in measure the density of all the vehicles plying on the road. The project is conducted on the Dhaka city where live traffic data has been collected from Shoinik Club Mor. A deep learning system is conducted where optimized YOLOv5 algorithm has been used to count the vehicles and the datasets for different vehicles are collected from COCO datasets and some datasets from BRTA (Bangladesh Road Transport Authority). After analyzing in different traffic situation for over 1260 frames at a rate of 30 FPS, we get around 88% accuracy in terms of detection. This operation sets the initial time for green signal as 16 seconds and then it changes according to the density occupied by vehicles of a particular road.

Keywords:

Artificial Intelligence; Deep Learning; YOLOv5; Datasets; IoU; Non Max Spression

Acknowledgement

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List of Acronyms

AI	Artificial Intelligence
BRTA	Bangladesh Road Transport Authority
CCTV	Closed-Circuit Television
CNN	Convolutional Neural Network
COCO	Common Objects In Context
CUDA	Compute Unified Device Architecture
DMP	Dhaka Metropolitan Police
FPS	Frame Per Rate
GDP	Gross Domestic Product
GPS	Global Positioning System
GPU	Graphics Processing Unit
IOU	Intersection Over Union
IR	Infrared Radiation
ITS	Intelligent Traffic System
LED	Light-emitting diode
LeNet	Local Area Network Emulation
ML	Machine Learning
NMS	Non Max Suppression

ONNX	Open Neural Network Exchange
OPENcv	Open Source Computer Vision Library
PANET	Path Aggregation Network
RCNN	Region-based Convolutional Neural Networks
SSD	Solid-State Drive
SVM	Support Vector Machine
TCD	Turning Circle Diameter
VSCODE	Visual Studio Code
YOLOV3	You Only Look Once Version 3
YOLOV5	You Only Look Once Version 5

Chapter 1:

1.1 Introduction

The project's objective is to create a density based traffic signal system, based on which the timing of any road of a Four way intersection's light will automatically alter based on the amount of traffic there. Traffic jams are a serious problem in the majority of cities worldwide, hence it is time to switch to a more manual or fixed timer mode automated system having the capacity to make decisions. The current system of traffic signals is time-based. Thus, if one lane is open, it can be inefficient unlike the others. Sometimes longer green durations are required because of a larger traffic density on one side of the intersection. When traffic is heavier on one side of the intersection, the typical permitted green period may need to be extended. Therefore, we here offer a device that controls the duration of the green light and the density of the red light is determined by the traffic at that moment. This is done by utilizing image processing.

This smart traffic control system that we have worked upon will fully prioritize density and work accordingly. If it is implemented the society and the nation will benefit from many aspects. Such as; it will be a great productivity increase, decrease crime rate and traffic accidents increase the health care level of the population because it will improve the transportation system of our city to another level.

1.1.1 Project Title

Density Based Traffic Control System for a Four Way Intersection Road.

1.2 Background Research and Survey

Urban regions are experiencing severe traffic congestion because of the growing population, and researchers from all over the world are working on solutions regularly. Recent research has shown that several machine learning methods can improve the recognition of automobiles in images and videos CVs (Cognitive Vehicles) are distinct from Smart Automobiles (SV). They don't just rely on sensor data, but strictly adhere to the patterns and operations that have already been externally pre-programmed. Consequently, a new method of using Global Navigation Satellite Systems (GNSS) for vehicle self-localization has been created [1]. When the system location estimations are accurate, promising results are obtained to the GPS-reported positions for comparison. The authors of [2] created a human detection system based on Gaussian YOLOv3 for intelligent surveillance in smart cities and societies. The results showed that training improves the capability of the Gaussian YOLOv3 algorithm having an overall detection accuracy of 94% to identify persons. They developed all of them based on research to create a scalable traffic management system that will help shorten travel times between points A and B. The authors suggested a method for real-time emergency vehicle detections with a deep convolutional neural network in a submission titled "Emergency Vehicle Detection on Heavy Traffic Road from CCTV Footage Using Deep Convolutional Neural Network" [3]. For feature extraction, they claimed to have tested with a variety of pre-trained model convolutional neural network variations, including VGG-16, inception-v3, and Inception Networks. A Yolo-V3 object detector that had been trained beforehand was used during the detection phase. Yolo-V3 employs a 53-layer neural network trained on ImageNet that was inspired by Google's LeNet and combines detection and classification layers. It was developed in C using a darknet framework and made use of CUDA cores for distributed GPU training. They used YOLO V3, which was trained on the COCO Common Object in Context (COCO) dataset, for vehicle detection. Instead of the 80 classes found in the pre-trained model, they implemented 2 classes (emergency as ordinary vehicles) for the classification of emergency vehicles (Roy & Rahman, 2019). Although this idea was predicated on the mobility of emergency vehicles, this paper had a significant impact on how we approached our design.

While deciding our work procedure we've been through quite a few research papers and found a lot of them. With the increased traffic this is a common problem that a lot of the cities are facing and research says developing a traffic control system that can detect and decide automatically can be a solution to this problem. The authors of a paper titled "Emergency Vehicle Detection on Heavy Traffic Road from CCTV Footage Using Deep Convolutional Neural Network" finds an approach of real time emergency vehicle detections with deep convolutional neural networks. They mentioned their experiment on several pre-trained model convolutional neural networks variants such as VGG-16, inception v3 and inception network for future extraction. A pre-trained Yolo-V3 object detector was used here for the detection process. It worked in quite an efficient manner. The system they experimented was for emergency vehicles but many more inventors around the world are working on similar ideas to implement it for regular traffic too.

There are several other techniques that are being used in the field of computer vision to detect traffic congestion. Using high-resolution aerial image sequences and Haar-like features were able to identify traffic congestion [3]. They also classified and clustered the pixels in the photos using a support vector machine (SVM). Surveillance camera-based image processing is substantially more effective than alternative methods since it visualizes a vehicle in a video. In addition, it is less expensive than other types of detection methods. However, it is impacted by various environmental elements, such as lighting, illumination, and poor weather.

Magnetic sensors were also suggested by Liepins et al. as a remedy for TCD [4]. They employ wireless non-intrusive magnet sensor networks in their work to count automobiles for sophisticated traffic control systems. The results from the suggested method are stable and reliable since magnetic sensors are not impacted by weather. To identify congestion, Gholve et al. used embedded wireless magnetic sensors. They created a prototype to send a sensor node to anode traffic congestion. By placing a sensor on the side of the road, Barbagli [5] employed Acoustic sensors to gather real-time traffic data from Dursa and Tune. The suggested method has the ability to identify all real-time traffic data at a specific moment.

Based on a video sequence gathered from an optical sensor deployed on each lane of the road, Boris et al. suggested a method for traffic congestion analysis [6]. They divide each sensor into two zones (entrance and exit), using the distance between the zones to determine the direction of the vehicles and calculate their speed. The field of computer vision currently employs a deep learning strategy to identify traffic congestion.

Some other research papers were done based on real time image processing. A real-time road traffic management strategy based on an improved YOLOv3 was presented by the authors [7]. A neural network was trained and used to carry out the suggested technique to enhance vehicle detection using publically accessible datasets. The evaluation's results showed that, when compared to the old method of vehicle traffic monitoring, the suggested system functioned satisfactorily. The suggested approach also required less gear and was less expensive. The authors of [8] provided a case study of the use of YOLOv5 to identify heavy freight vehicles throughout the winter, when it is snowing, and under polar night conditions. According to the results, a trained algorithm could confidently identify the front cabin of a large goods vehicle; however, identifying the back cabin was more challenging, especially when the car was situated distant from the camera.

Researchers [9] examines and reviews the main learning models for video-based object recognition that can be used with autonomous cars. The support vector machine (SVM) technique and the YOLO and Single-Shot Multibox Detector (SSD) approaches from deep learning were deployed by the authors in an autonomous vehicle setting. Due to SVM's poor simulation performance and slow response time, the suggested technique had these drawbacks. When quick driving decisions are necessary, however, the YOLO model and SSD perform better and have a substantial ability to recognize objects in real-time.

Over time, CNN-based YOLO offered faster processing and extremely accurate performance. Other object recognition approaches in the vehicular environment under various weather conditions and traffic monitoring in real-time scenarios are investigated. The application of YOLO in the autonomous vehicle industry for object detection, localization, and classification in images and videos is presented in.

In Another submission [10] named “A Vision Based System for Traffic Anomaly Detection using Deep Learning and Decision Trees” the authors worked on detecting traffic accidents in real time. In their paper, they proposed a deep learning powered Decision Tree-enabled approach for finding unusual traffic events that can also detect the start and end time of those particular events. The first step in the technique was to create a detection model, which was then followed by anomaly analysis. The basis for our detection model was YOLOv5. Road mask extraction, traffic scene background estimate, and adaptive thresholding are steps in the anomaly detection and analysis process. A decision tree was used to filter out and assess final anomalies from candidate anomalies. According to the experimental validation, the suggested strategy produced an F1 score of 0.8571 and an S4 score of 0.5686.

They also found A crucial area of traffic behavior modeling is the detection of anomalies with characteristic aberration in vehicle scene entities [5]. Research in the fields of video analysis and anomaly identification has increased as a result of the availability of traffic video scenes [11]. The Markov model [12], [13], Markov Random Field [14] and Sparse Reconstruction [15] have shown some success because most computer vision models evaluate broad traffic scenes and distinguish the abnormal from routine traffic events. However, the ability to detect traffic irregularities has significantly improved with the development of deep learning. As a result, deep neural networks are used in the vast majority of studies to find them. [16] Li et al. introduced a multi-granularity vehicle tracking method with modularized components. The object detection module is built using Faster R-CNN, a deep learning framework. The object detector, background modeler, mask extractor, and tracker are among its modularized elements. Their technique improved the results of anomaly prediction by using both box-level and pixel-level tracking strategies. The winning response to the 2019 AI City Challenge [17] served as the inspiration for the pixel level tracking in [16]. It goes without saying that the combination of both of these methodologies, along with the backtracking optimization methodology, enabled to place first in the 2020 NVIDIA AI City Challenge's anomaly detection track [18]. With a few exceptions that concentrate on unsupervised methods, the majority of anomaly detection methods are typically supervised. Using data from vehicle trajectories, Zhao et al. introduced an unsupervised anomaly detection framework in [28]. By using a multi-object tracker to reduce the impact of false detector detections, their strategy produced better results. A pre-trained YOLO network and feature tracker were used by Mandal et al. in [19] to identify traffic abnormalities like stopped cars and roadside incidents. A YOLO-based object detector is used in a system [20] as part of an anomaly detection system to forecast stationary cars using the nearest neighbors and K-means clustering techniques. Although training on anomalous traffic video feeds should have yielded better performances, their nearest neighbor and grouping techniques imposed onerous training requirements. With the help of the spatial temporal matrix module they used, they were able to convert their analysis of strip trajectory into a study of spatial position, which provided precise start and stop times and an improved anomaly detection score, helping them take first place in the 2019 NVIDIA AI City Challenge [31]. The authors used the cutting-edge YOLO object detection framework in the current study and concentrated on a more heuristic approach centered around post-processing modules to find abnormalities. Our suggested approach avoids the use of a tracker, in contrast to certain research that employ vehicle tracking algorithms. This is done because tracking individual vehicles would have been challenging and computationally impractical given the obvious majority of vehicles in a traffic scene. It is important to note that the majority of the winning teams from the 2018–2020 NVIDIA AI City Challenge [31–34] focused on improving vehicle identification and background image segmentation, in addition to various post processing modules. Our method offers a straightforward yet effective framework for backdrop estimation and road segmentation, which was inspired by these earlier techniques. The characterization of anomalies using data from detections on foreground and background images is also done using a decision tree approach.

1.3 Literature gap:

From our research we've found some problems that remained untouched and unsolved. The traffic irregularities that take place on our roads are still being monetized manually and the efficiency level is not up to the mark till date. Monetizing these irregularities through live images could be an end to a lot of problems that we face on our roads every day and the video evidence can also be used later for any legal issues.

Another problem that was found was the unexpected objects that we have on our roads that are being detected with the traffic congestion's live feed. Not enough datasets are available on the internet which can come in use to avoid detecting or excluding those unexpected objects. Moreover, Thermal object detection is a more accurate and efficient object detection method available till date but not enough research has been done on this process. The extremely expensive project cost might be a cause but more work needed to be done on this one since it provides far better results than the regular image processing system that is widely being used.

1.4 Relevance to Current and Future Industry

Better, safer and eco-friendly transportation is important for a sustainable future. To reach these goals, an intelligent traffic control system is one of the important key technologies.

The demand on our current transportation infrastructure will get harder to meet as a result of the rising standard of life and exponential growth in the number of automobiles. Due to expense and dwindling land supply, it is doubtful that roads and highways will be expanded significantly; therefore, intelligent systems, such as enhanced traffic control, will be essential to operating current roadway networks at full capacity. In addition, signals that are not timed properly might cost money, gasoline, and time. Approximately 40% of the fuel used by automobiles in a street network with badly timed traffic signals is used by vehicles that are stopped and idle. While developed nations like the USA, Japan, and the UK have already put ITS on their roads, several studies are still being conducted to create and improve smart traffic systems that are both more sophisticated and appropriate for developing and underdeveloped nations.

Road safety has received a lot of attention in the last 20 years as a result of an increase in the number of drivers on the road. Governments and automakers will embrace any beneficial adjustments or technical advancements since safety is and will always be the top concern. Driving time is increasing, which not only adds to the commotion but also pollutes the environment. Therefore, the creation of new smart technology has taken on significant importance for many businesses, organizations, and researchers.

1.5 Objectives, Specifications, Requirements, and Constraints

Objectives:

The fundamental purpose of this complex engineering problem is to improve the present traffic control system so that it can contribute to citizen's everyday communication more effectively. We will use an image processing system to address this complicated technical challenge. This entire technique will be more focused on the density of cars at a certain junction point, in order to perform more effectively when there are an unmatched number of vehicles at a four-way street intersection point**.**

Functional Requirements

- **Road:** A four-way intersection road is the very first need. This idea can also be employed in crossroads with fewer roads. It is currently only designed to regulate a four-way junction. 2. **Vehicles:** Vehicles of various types and models are must to evaluate the system's performance, accuracy and efficiency.

- **Timer:** Timing should be used to govern the real-time setup. The traffic control lights will turn on and off in accordance with the current time interval.
- **Object detection:** The system should be able to recognize visible objects (such as automobiles).
- **Archive Storage:** All of the data, loops, and videos acquired by the detecting system should be stored centrally in the field configuration.
- **Monitoring:** When indicated in the plans, the setup should include a central monitor that reports to the central traffic system controllers.
- **Error Reporting:** If the system encounters an error or detects an unexpected incident, it should notify the central traffic controllers.

Non-Functional Requirements

- **Data Security:** All information gathered should be kept private. Because a traffic management system will be used by the public, all data must be protected.
- **Performance:** To guarantee better traffic management, the system should have a greater performance rate even during peak hours.
- **Accuracy**: The accuracy of the system must be monitored, if the accuracy level is not up to the mark, it may cause false positive results.
- **Rate of error:** Safer traffic system should be the least error-prone. So the rate of error should be recorded and evaluated regularly.
- **Primary discussion:** Prior to constructing the entire system, stakeholders should be notified so that after effects may be quantified and handled while primary initiatives are implemented.

Specifications

Imagine a crossing between Hatirpool, Nilkhet, Shahbag, and Elephant road to showcase our proposed model. We will install cameras that will identify real-time images of automobiles on each of these four roads using open CV and feed them to a central processing system, which will calculate the density of the cars based on the picture and activate the traffic lights appropriately. Green Lights will be given first to the road with the most automobiles waiting.

Assume Hatirpool Road has the highest density of automobiles among the four roads. Our computer vision will detect this and promptly release the signal, while also halting the other three routes with red lights. Our roadside timer will project the time for the next green or red light at the same time. Our System should have the following specifications:

- Vehicle density measurement system
    a. CCTV Camera for real time images

    b. Thermal Cameras in case of alternative design
- Automated timer depended on the density of vehicles
- Computer Vision
- Roadside timer assistance

Constraints

- Obtaining the necessary funds for the procedure might be difficult and requires care. 2. This project may have difficulties in making people aware of the newly designed system.

- It will be difficult to integrate this newly designed system with the previous one since they have different specifications and the components utilized are not the same. 4. Since we are considering adopting a new traffic control system, we may have discussions with the municipal corporation on how the new system will be more efficient than the current one.
- In case of Design 1: Since we are employing IP cameras, weather and sunshine circumstances may have an impact on the central controlling system. Because IP cameras are not normally waterproof, rain might be a concern. If there isn't enough light for the cameras to identify vehicle activity at night. This is another issue that needs to be addressed and resolved.
- Thermal cameras detect more accurately than visible cameras, however they are typically used in combination with visible cameras. In this case, The cost increases. [[For Design 2]]

To identify the moving items in the streets, we have utilized the image processing technique YOLOv5 in this project. We also tested the thermal imaging technology to determine if it delivers greater performance and more accurate results. Our intelligent traffic system's program architecture was built using Python and the openCV module. We have put the designs into practice and examined the results. We evaluated the designs' accuracy, performance, cost, and error rate, and based on those findings, we recommended one over the other.

The Intelligent Traffic Control System (ITSC) is built on the straightforward tenets that "the signal remains green until the current cars have passed" and "a car may only proceed ahead if there is space for it." Traffic can be made very efficient by installing sensors at each entrance and exit to a junction and keeping track of the number of vehicles there.

This is a good use of digital signal processing. However, the full benefits of such a system won't be felt until every city intersection is under its supervision.

Chapter 2: Project Design Approach

The goal of this project was to develop a neural network based deep learning algorithm for detecting vehicles with live images in order to improve roadside safety. Considering the vehicle density of our specific city, it seemed that there would be the most benefit from having YOLOv5 applied to this problem. Hence, we've used live image processing based approach over the other probable design approach that we found possible having our purpose uncompromised.

2.1 Design 1- Image Processing based Traffic Management System

Image processing has been chosen as our initial technique. Making traffic flow smooth and efficient is a difficulty already given that traffic control and monitoring in our nation, particularly on the road we have selected, is mostly congested. Automatic traffic monitoring and surveillance are essential for managing road usage. A popular area of research has been on estimating traffic parameters. Traffic characteristics have been calculated using a variety of sensors, and traffic data is constantly updated. The most popular technology are magnetic loop detectors, but they need a lot of work to install and maintain. It's probable that upcoming ITS will not work with it. Vision-based systems are more flexible, as is well known. Image measurement, in addition to a qualitative description, helps ease traffic congestion. Using this technique, we might be able to achieve a smooth traffic flow by providing a numerical representation of traffic circumstances, including speeds and vehicle numbers [21]. On the intersection lanes, we have high definition cameras [22]. Following openCV processing often collected images, the controller will instruct the LEDs to alter their state in response to vehicle density.

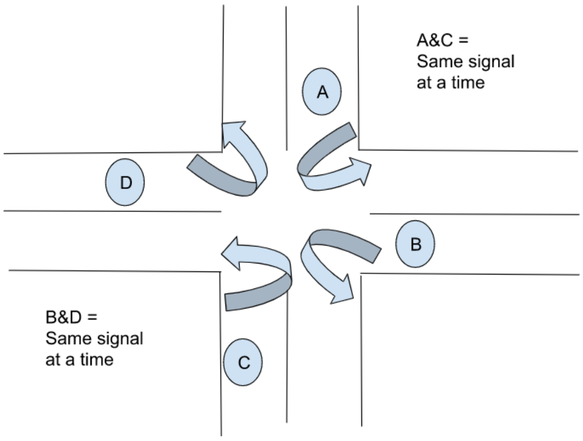

Fig 2.1: Initial Conditions for 4 way intersection

2.2 Design 2 - Thermal Image processing based Traffic Management System

While delivering detailed location and classification data, vision-based monitoring systems that employ visible (regular) video cameras can enhance or replace traditional sensors. Thermal video sensors are a new camera technology that has recently become available and has the potential to improve the performance of digitized video-based sensors. The effectiveness of thermal imaging cameras under various illumination and temperature conditions has, however, rarely been assessed in multi-modal facilities such as urban intersections, where road user classification is crucial. Although the use of infrared cameras for traffic management is still in its infancy, they have a long history in the military for perimeter detection and physical defense.

This design aims to combine existing tracking and classifier computer vision technologies for automatic data collection as well as to test the efficacy of thermal video sensors in a range of temperature and illumination conditions. The evaluation is based on the identification, categorization, and speed measurements of road users. For this, simultaneous thermal and regular video data were collected at numerous sites under a variety of conditions. The main conclusions show that the heat sensor barely surpassed the regular-video sensor in daytime circumstances. Contrarily, the heat sensor performs noticeably better in dimly light and low-visibility environments, particularly when gathering information from bicycles and pedestrians. The thermal video performs well during the day, with a miss rate of about 5%, according to Ting Fu's study, "Traffic data gathering utilizing thermal imaging camera under diverse lighting and temperature circumstances in multi-modal contexts." [4]

The same research underlines the need for the system to be retrained on thermal data and mentions a 48 percent improvement in overall accuracy. Additionally, the thermal camera's speed evaluations were consistently more accurate than the regular film during both day and night.

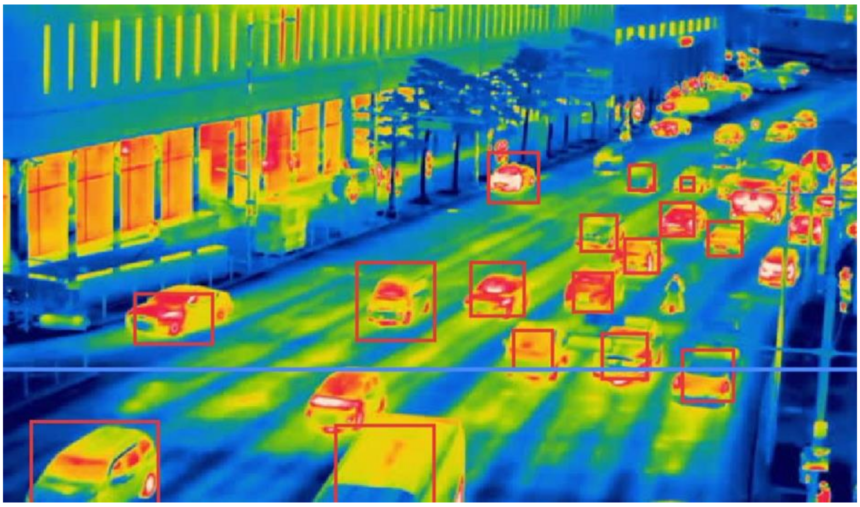

Fig 2.2: Thermal image processing

Infrared (IR) radiations are frequently referred to as heat or thermal gamma rays. Objects on Earth produce thermal radiation with wavelengths ranging from 2 meters to above 100 meters, with a wavelength maximum of about 10 meters, at an average temperature of 300 K. All objects in our environment radiate heat energy, making them all radiant. However, because to the human eye's limited wavelength response, this heat incandescence is invisible [23]. Wavelengths in the photographic infrared range from 0.75 m to 2.0 m. Since the human eye only responds to wavelengths between 0.4 and 0.75 meters, infrared radiation is indifferent to it. It can also observe, measure, and analyze highly heated objects that emit red visible light in the region of 0.65 m. The majority of heat radiation emitted by cooler objects, though, escapes undetected. Imaging systems like the human eye, as well as other sensors like photographic films, plates, and photo-emissive devices, are all limited to a long wavelength response of less than 2.5m. This information can be recorded by a thermal imager and converted into visually discernible images. Using a phased array of infrared detector elements, it creates a thermo-gram, a highly detailed temperature pattern (material sensitive to infrared radiations). In order to react to long wavelength radiation that extends beyond 3 meters, it uses camera lenses that are transparent in thermal bands. The distinction in the quantity and nature of radiation emitted by hot and cold objects is the basis of this emerging technology. If we are aware of the absolute temperature of the body and its emissivity, we can evaluate the spectral content of various objects over a spectral interval. Radiant emittance would vary even if all objects were at the same temperature due to differences in emissivity. The thermal imager used in this instance is made up of optics, a scanner, a detector, a cooler, primary electronics, a signal processor, an image processor, a display, and an eyepiece. Although the target and its surroundings are constantly shifting, a specific temperature range is always maintained. By emitting IR radiation and measuring the average temperatures of a target and its surroundings, we may determine if an object is in pseudo-color or black and white by comparing the two temperatures. The camera can create a pseudo-color image in color or a grayscale image (black and white image). Although pseudo color facilitates visual interpretation and recognition, it is significantly more challenging to convert into processable data. As a result, we simplify the system by using grayscale pictures. For this example, a grayscale image with appropriate resolution will do.

The camera's thermal image must be processed in order to provide interpretable data that may be used for traffic regulations [6]. Python is being used for the research project's implementation. Most thermographic cameras produce thermograms that show objects with normal temperatures in grayscale and objects with incredibly high temperatures in a variety of pseudo-colors. These different hues reflect intensity change (and hence temperature variation) as opposed to visible light's wavelength variation. Because no high temperature bodies (above 200 0C) are involved in traffic applications, we process the grayscale scale the camera obtained directly. This is performed using two procedures, which are both described here: binary photo conversion and production of the automobile count.

Chapter 3: Use of Modern Engineering and IT Tool

An engineering project's design process frequently involves the usage of IT and digital technologies. The software platforms aid in making the design adhere to the specifications adequately. It also offers a dynamic way to carry out the trial-and-error procedure. Engineering in the modern era focuses on the development and comprehension of technological systems and products, as well as their applications and impacts. In an increasingly digital world, engineers have access to a wide range of tools that enable them to be more inventive and creative. A project can be demonstrated in hardware or software. In this era of technology, Software is an essential part to implement different parts of a project such as designing, planning, improvements etc. Even new working methods can be developed with the correct software. Because of this, it is a vital corporate asset, and one should carefully select software to ensure that it meets the demands of the project.

Our project is to make a system which can control traffic through the density of vehicles. We are to make a program which will calculate the density based on the dataset we have acquired through the cameras. Our whole project has had different phases such as planning, designing and implementing. For planning, we have mostly depended upon Microsoft Office 365. From the initial planning, to taking key points, segmenting the work process everything was solely done with Microsoft.

Microsoft Word 2013: taking any notes, project report writing.

Microsoft Power-point: to make slides for presentation.

Google Excel: planning and making Gantt charts for observing progress

There are a lot of software platforms for designing engineering projects. Some of them are more graphical, some of them allow simulation and others have some more options. Since our project brings a real time solution for a specific situation for our roads, the design was made by us from scratch manually.

The system needed a program which would detect the density of vehicles through Pre-recorded videos/Real time videos. We have chosen python [version 3.10.6]. The sole reason for using python is that it is an excellent choice for many machine learning (ML) and artificial intelligence (AI) applications because it is so reliable, adaptable, and straightforward [24]. We don't need to declare a variable's type because Python is a dynamically typed language. It is free and contains a big selection of libraries. One of the key characteristics of Python is object-oriented [25] programming. Python is familiar with object-oriented programming and ideas like classes, encapsulation, and other similar ideas. We have used the OpenCV library. It features pre-built libraries that make image processing incredibly useful [26]

One of the most used tools for our project was GitHub. It is basically a platform for collaboration and version control. It enables remote collaboration on projects between all the group members. Since this is a year-long project that we are doing, it was extremely important to have a platform which will actually work as a repository and can be monitored by the group members online. For the project we build in GitHub Classroom, we can preconfigure an integrated programming environment (IDE) that is supported [27]. There are plenty of IDE available. We have used VSCode and with the help of it, we can create and test code simultaneously. Although it is theoretically possible to combine Sublime Text with a console, doing so requires additional physical effort, whereas Visual Studio Code offers a comprehensive solution [28].We have operated through GOOGLE Colab to run and edit the whole program so that we can contribute virtually. It was not always possible to work only on a single computer. For this project we mostly did work from home as all the group members had different locations of living. Google Colab and google drive played the most important role to pull off this whole project. Google COLAB was a platform where we mounted google drive so the files location was mounted, then the repository was directed which was GitHub (which was integrated with VSCode).

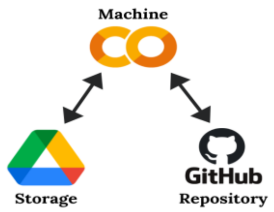

Fig 3.1: IT tools

A complex Engineering solution needs tons of tools. However, in this new age where science and technology rules every sector, Software/IT tools are a compact that one must have to complete a project.

According to us, IT tools played a huge role in our project to build and maintain the correct time frame.

Chapter 4: Optimization of Multiple Design and Finding the Optimal Solution.

We tried to come up with multiple design to fulfill our final objective. As our goal is to minimize the traffic overflow as much as possible by using intelligent system, we have compared multiple approaches which are more sustainable for us in terms of budget friendliness as well as the accuracy and effectiveness. First we intended to detect with thermal inferred image where thermal images were sent to personal computer 60 frames per second and image size of 320*240 pixels with 256 gray levels. This approach could be impactful in harsh environment. However, for this we needed thermal camera which exceeds our budget. Therefore we came up with image processing for vehicle detection by YOLOv5 and calculated the density of road.

4.1 Optimization of multiple design approach:

As we consider various approaches to achieving our goals, we develop a methodology for completing our project and determining the best solution. Thermal image processing is a system with limitless potential because it can perform in inclement weather and does not degrade in low visibility. However, this system is not cost effective, as a single middle range thermal camera costs around 300 thousand taka. In addition, there aren't enough datasets available for thermal image processing.

Therefore, we have chosen to build image processing system with '*You Only Look Once'* also known as YOLO model. In this approach 4 IP cameras are needed and with a PC or microcontroller we can detect the vehicles plying on the road. 5th version of YOLO has been used for this approach. Another advantage of this approach is YOLOv5 can easily be converted to ONNX (Open Neural Network Exchange) model [29] which is a deep learning model that allows us to interchange between various ML model and framework.

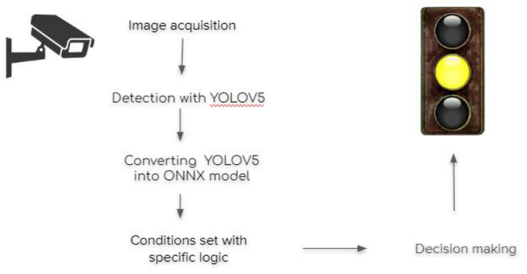

Fig 4.1: methodology of image processing

As shown in Fig 4.1 here, we collect the live image with 4 cameras and with every road we follow the detection model of YOlOv5. Datasets are collected from COCO datasets where we only classify the vehicle we need to detect. Then, s conversion takes place as we covert the YOLO model to ONNX model for merging the footage of 4 roads altogether. To run this system only one processor is needed.

Structure of YOLOv5:

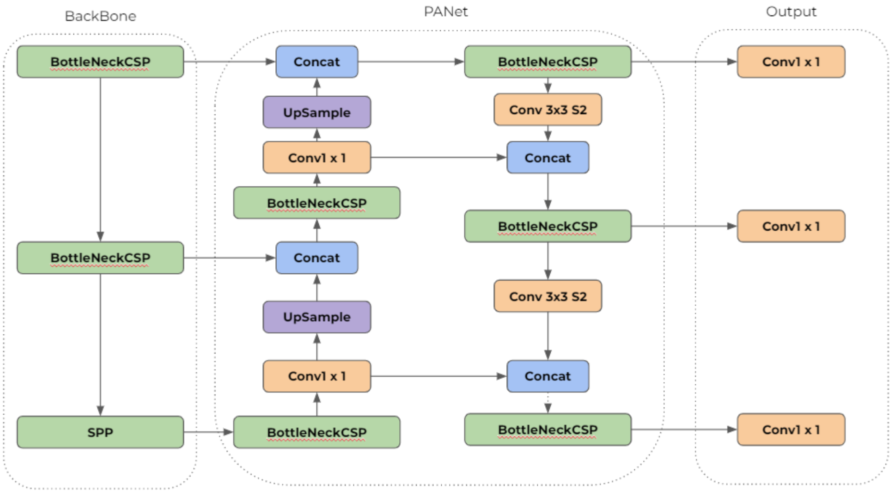

Fig 4.2: YOLOv5 Structure

In Fig 4.2 it is to be observed that YOLOv5 model has 3 parts. The BackBone, PANet and YOLOv5 Layer or output. BackBone part is consists of 2 BottleNeckCSP or CSP Darknet. The work of CSPDarknet is to generate the features and PANet works to fusion these features as well as finding the similarities in those features. In our approach PANet optimize the similarities between various vehicles in terms of their shape, color and movements. Finally the output will be presented as three 1*1 convolutional network.

There are some modifications done to make the YOLOv5 more efficient in terms of performance. As we have shown in Fig 4.3, Non Max Suppression system and mosaic data augmentation has been used. Non Max suppression is an integral part of our design. Non Max

Suppression system will be discussed later. However the mosaic data augmentation is used of the better detection of the objects with fewer datasets and also for the tiny sized objects.

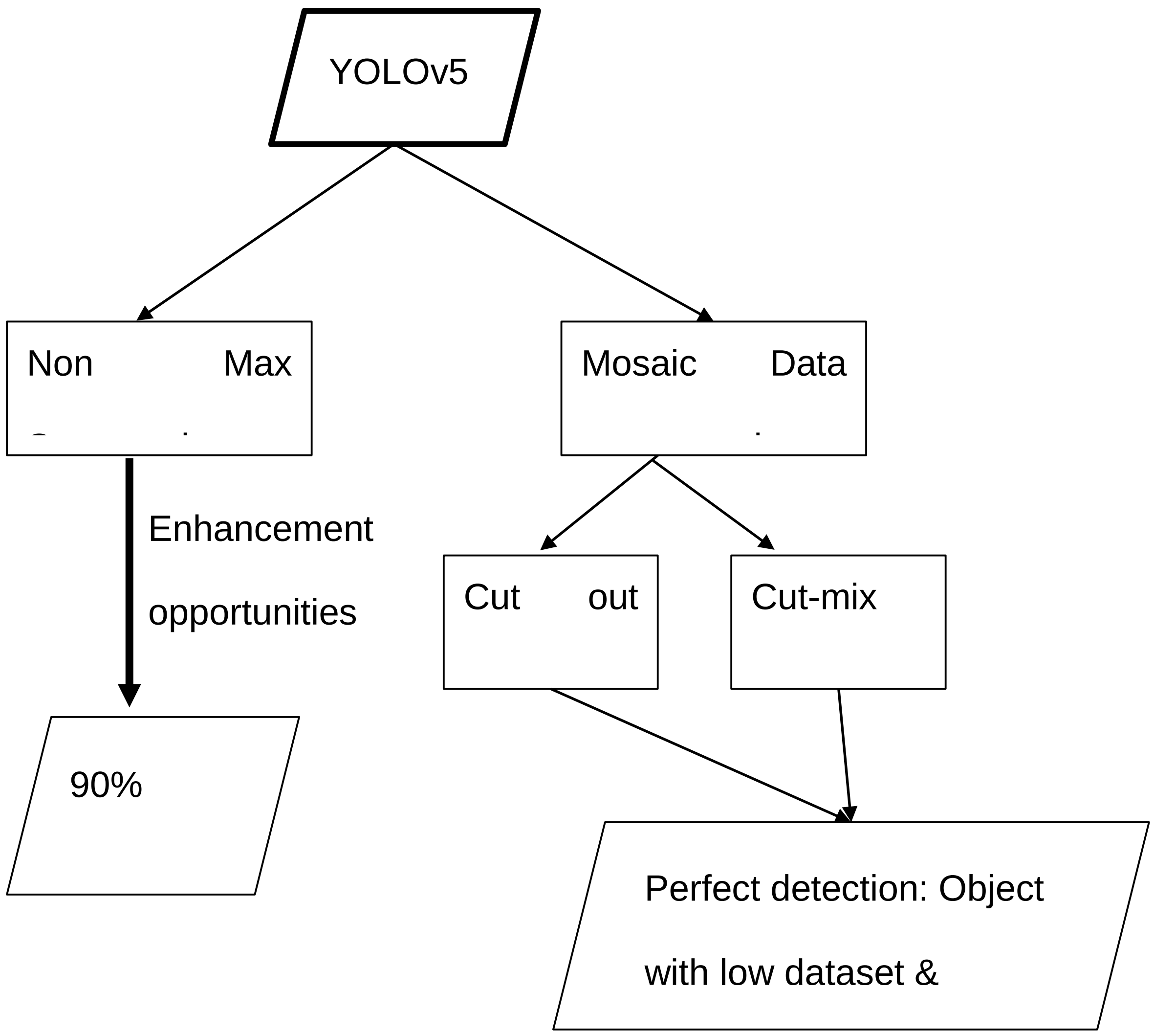

Fig 4.3: YOLOv5 Enhancement

Also, by applying this method, we were able to detect a object with minimum dept. The convolutional network of Backbone and Neck modules. By reducing the noise and by the enhancement of real-time input data the detection becomes more efficient [30].

4.2 Identifying optimal design approach:

We had to consider certain parameters that needed to be fulfilled to find the optimal design approach [31]. The criteria are given as following

- Objective
- Accuracy
- Economical Consideration
- Advancement/ Future work

We are all aware of how expensive thermal cameras are on the market, making it challenging for us to maximize their functionality. We then made the decision to deploy IP cameras, which are often used for surveillance and traffic monitoring, to obtain the real-time data as input. Additionally, we developed various methods for picture processing. First, we made an effort to align with OpenCV projects and the BackgroundsubstractorMOG [32] technique, which turns the input image into a grayscale image and removes certain regions that follow a different particle's color scheme. However, this approach could be effective for still image, not for real time data as it detects other objects of the road too. But we needed to detect only the vehicles and also count that data.

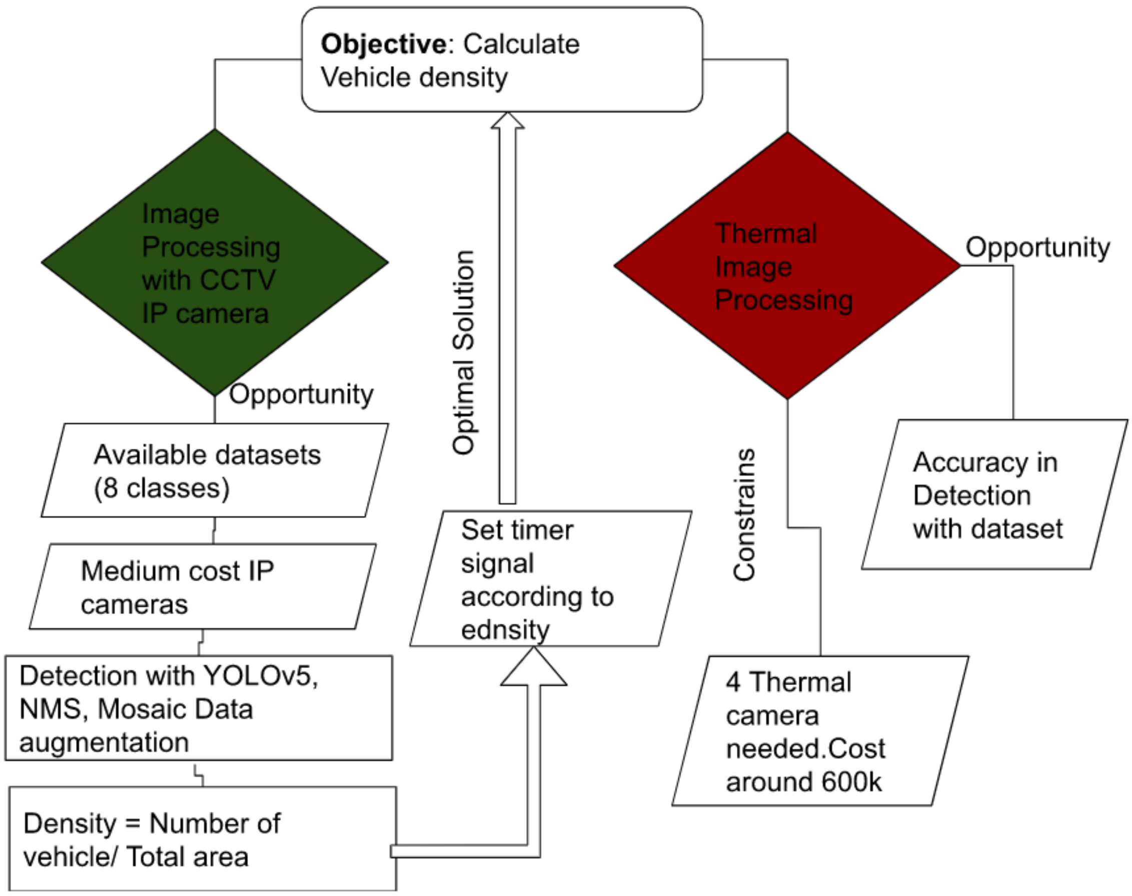

Fig 4.4: Identification of optimal solution

Initially, the plan was implement this system with Conventional Opencv project that substract the background and detect the object by making grayscaleconversion. However, in that case the system was detecting every object shown in each frame wherese we only needs to detect the conventional vehicle on the streets. Therefore, image processing with YOlOv5 has been used to obtain the detection model. Here, COCO datasets and also some datasets BRTA[33] has been imported where classification of vehicle that is relevant in this particular system in terms of detection is 8. In Fig 4.5, we can notice that in the Machine Learning model the system detects vehicles such as cars, motorcycles, bus, trucks and also by-cycles and the detection result is very much satisfactory.

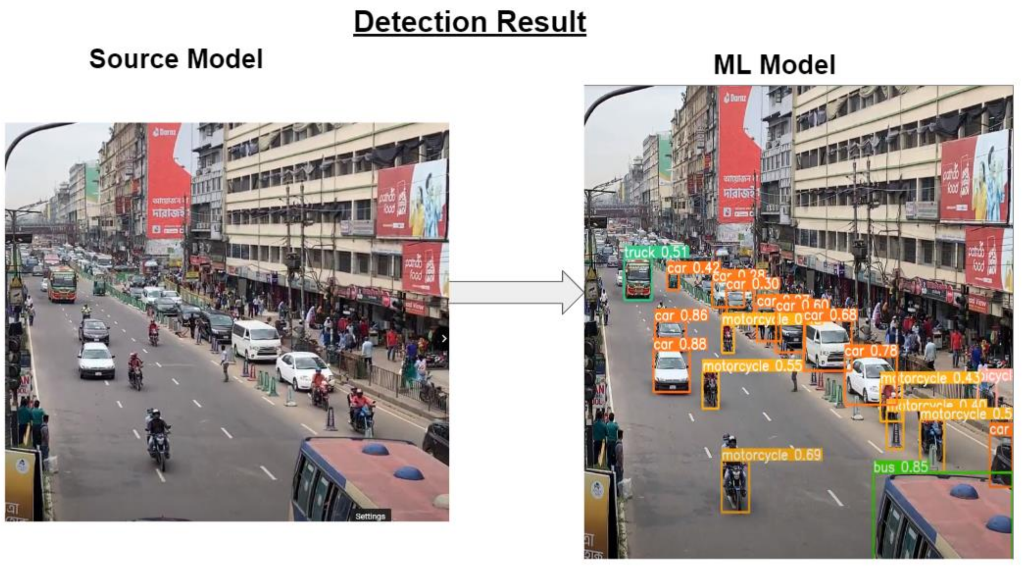

Fig 4.5: Detection result after YOLOv5

The enhancement opportunities of Non Max Suppression has shown in Fig 4.3. Also, in the Fig 4.5, we see Bounding boxes surrounds the detected vehicles with certain values above them. These bounding boxes are created with the functionalities of NMS what creates bounded box in terms of vehicles shapes given in the datasets.

These bounding boxes creates several grids in every frames and if no object is found in a grid the confidence is score is zero. This confidence score is called IoU or Intersection Over Union. In Fig 4.6, the a is intersecting bounding box and b is union bounding box.

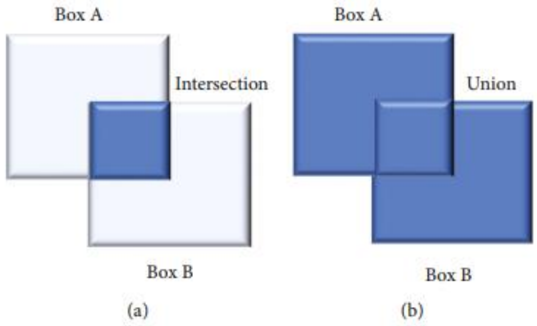

Fig 4.6 reference: https://doi.org/10.1155/2022/9444360

Since the user has personally set the ground truth boxes in this case, a higher IoU translates into a higher confidence score, which raises the algorithm's prediction accuracy. Based on the likelihood that the box contains items, those without objects are filtered out. Unwanted bounding boxes are removed via non max suppression methods, and the box with the highest probability or confidence score is retained.

$$IoU = \frac{Area\ of\ box\ A\ and\ Box\ B\ intersection}{Area\ of\ box\ A\ and\ Box\ B\ union}$$

The density is calculated the dividing the number of counted vehicles with the area of particular road.

$$Density = \frac{Total\ number\ of\ vehicle\ in\ one\ frame}{Area\ of\ the\ road}$$

4.3 Performance evaluation of developed solution:

Four different real time footages have been collected to evaluate the traffic situation. Our footages are consist of 1200 frames with a frame rate of 30 fps. With a view to better understanding, all four roads are marked as different names such as Road 1, Road 2, Road 3 and Road 4. The traffic signal is changed anti-clockwise according to the road number addressed in Fig 4.7 & Fig 4.8. Here the signal goes from the order of 1-3-4-2 and the road with the most density is given highest time for green signal.

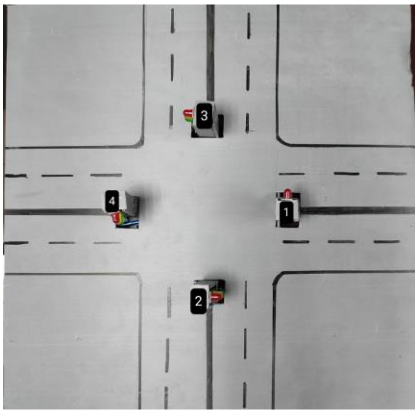

Fig 4.7: Prototype

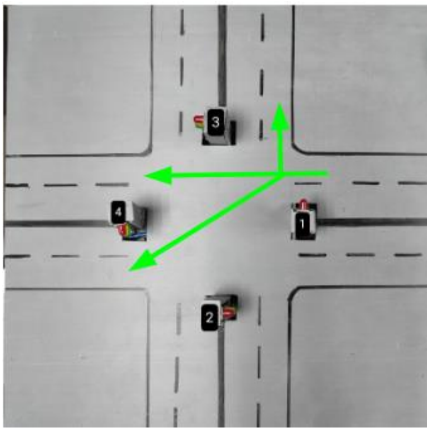

Fig 4.8: Conditions for signal

Here it can be noted that when one road has green signal other road signal must be green. As shown in Fig 4.8, road 1 in in green signal state, the vehicle from Road 1 has the access to move to the outgoing lane of road 2, 3 and 4.

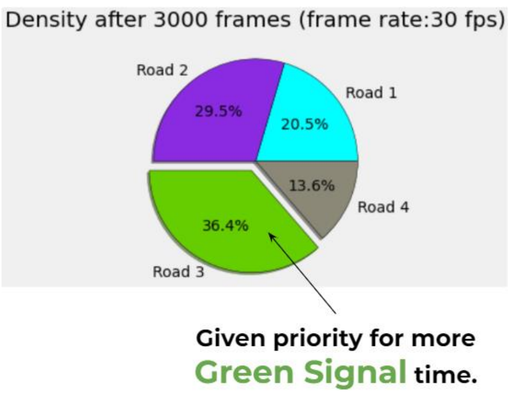

Fig 4.9: Decision making after density evaluation

From fig 4.9

- Road 1 and Road 3 are intersecting
- Road C and D are intersecting

Density in order: 3>2>1>4

Signal: Green – C & other red

Our previous plan was to immediate change the signal to green when a road have the maximum density. However, in the time of operating this system we notice that Road 4 has minimum vehicle most of the time. Hence, in that situation that was a possibility that the signal of Road 4 remain RED almost all the time. Therefore the drivers might be more irritated due to longest wait time. For that it has been decided that the signal will be changed anticlockwise direction from the road which have the highest density. The change we made is the wait time. Here the road with the highest density will have more time with green signal.

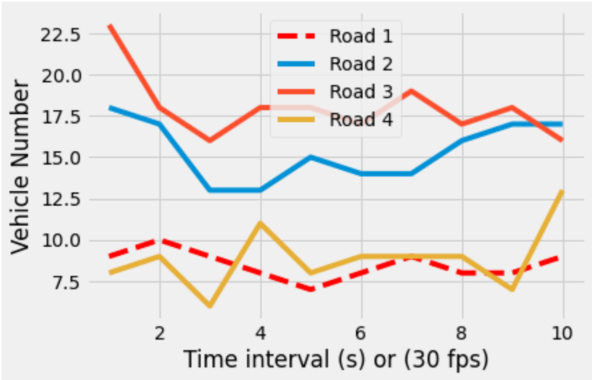

Fig 4.10: Density comparison of 4 roads

We have compared the vehicle count in four different roads and it can be noted that Road 1 density is much higher than the rest of the roads. Therefore, the green signal time for Road 1 will be higher than rest of the roads in that case. Road 1 will maintain highest time for green signal until at 9.2 s the road 2 density becomes more than Road 1. The algorithm for the timing of the signal is given below. For the visualization of all the road situation, the system output marge all four output and resize them as 1020*720.

Algorithm for Signal Time

```
standard=10 #standard duration
reward =0  #reward to be added or subtracted on the standard duration
turn = lanes.lanesTurn()

for i,lane in enumerate(lanes.getLanes()):
if(i==(len(lanes.getLanes())-1)):
reward = reward + (turn.count-lane.count)*0.2
else:
reward = reward + (turn.count-lane.count)*0.5
scheduled_time = round((standard+reward),0)
```

Therefore, if we want to change the conditions for different scenario we just need to change the standard duration of this system according to the frame counted and vehicle congestion. Evaluating the whole system it can be stated that with relevant algorithm in terms of different condition can truly minimize the traffic congestion.

Chapter 5: Completion of Final Design and Validation.

Artificial intelligent based projects are have great potential for next coming years to come. Based on current traffic conundrum, it was decided by our group to come up with image processing to measure the vehicle density in accordance with our optimal objective to minimize traffic congestion as much as possible. After trying with different methods we have come up with image processing with Yolov5 algorithm. We have compared data of two intersecting road with the datasets of 8 classes where we find a satisfactory accuracy of 90% in terms of detection. We have planned to use Raspberry pi 3 as microcontroller for processing of real time data. However After that we set different condition for traffic load on a certain road and set the signal in accordance with that condition.

5.1 Completion of final design:

Our proposed model is done after evaluating different parameters in terms of meeting the objective and analyzing accuracy. Design approaches were modified many times till the completion of final design. We were given 3 months to obtain the completion process of final design. Firstly, we collected the tested traffic videos from '*Banani Overpass'* and consider 4 tested videos as the traffic condition of 4 different roads. Then we have collected the trained dataset of 8 classes of vehicle and trained them in your Yolov5 model. The detection accuracy we got was more than satisfactory. However, our main objective was to measure the density for four way intersection and for that we needed to compare the data of four roads. As we are using Yolov5 Pt model, it was not possible to run four input data simultaneously. If we processed with that model we would need 4 IP cameras with four microprocessors and also make a web app for storing our input data as data storage [34]. However, considering the budget of this project that approach was not very convenient for our project. Therefore, we came with the idea of converting the YoloV5 PT model to ONNX (Open Neural Network Exchange) model which allows us to interchange models between various Machine Learning networks and tools.

After Converting to ONNX model:

Considering the budget, the system was converted to ONNX model where the output odf four different road can be shown is a single network. Hence, the algorithm has been set if the system is able to read frames, then it will resize the image shape to 1024*720 as a combination of the ML model of all four road.

In fig 51.1 the road of top left have highest density and therefore the runtime of green signal is higher. Furthermore in fig 5.2 the signal of the top right road is green. However, it has only 4 second time for green signal because of having less amount of vehicle compared to other roads.

fig 5.1 : final output ML model

Fig 5.2 : ML Model final output

Table 5.1: Phases of the completion of project

Phase	Modifications	Objective Criaterias		
		Detection accuracy	Density Measurement	Signal Timer
1.	Consider traffic of 4 different road as sample data. 23°47'27.6"N 90°24'01.1"E, 23°47'31.5"N 90°24'01.7"E		✓	
2.	1. Detect only the incoming vehicles to the traffic signal. 2. Mosaic data augmentation for small objects	✓	✓	
3.	1. Shift to YoloV5 onnx model from YoloV5 PT model.	✓	✓	✓

	Result: 2-2.5 times faster than onnx model			

There are always room for advanced of designed project. However, it is also important to check whether the solution meet the desired objective of not. Our core objective is to mitigate the traffic congestion to any road as much as possible and for that our approach was to calculate the vehicle density of four different roads as well as integrate them all together to get a priority based timing for four intersecting road. As, we are counting vehicle density in our approach through image processing, detection becomes the most important part of our evaluation of this approach. For getting the accuracy, 1000 frames are tested for accuracy evaluation.

$$\frac{\sum_{i=0}^{1000} M \quad \times 100\%}{\sum_{i=0}^{1000} Y}$$

M= Summation of all vehicle counts manually.

Y= Summation of all vehicle counts After the ML model through YoloV5 Detection.

I= Iteration number (done with 1000 iteration / 1000 frames

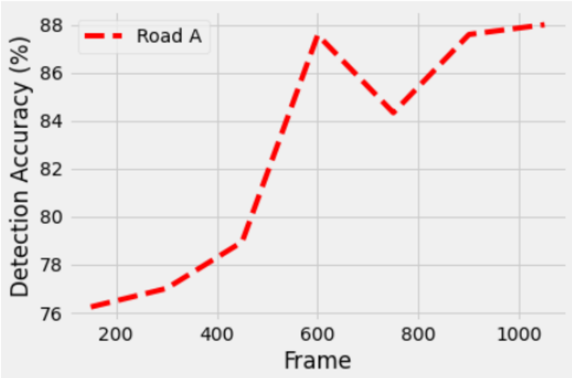

Fig 5.3: Detection accuracy

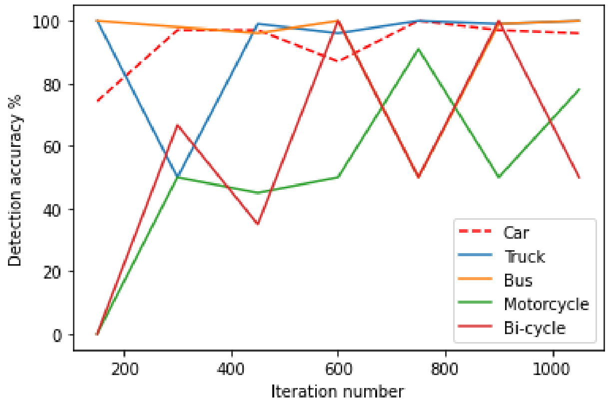

Fig 5.4: Accuracy in different vehicle

From Fig 5.2, it can be observed that the accuracy in terms of detection is being increased almost after every iteration and like most other AI models [35] accuracy keeps increasing after every iterations, our design is no different from that. After 900 frames the accuracy becomes more than 88% and acquires a stable rate.

Chapter 6: Impact Analysis and Project Sustainability.

Because of the tremendous traffic congestion that urban areas are suffering due to population growth, academics from all over the world are always working on solutions. Smart traffic control systems are one of them. It helps to regulate the flow of vehicles by using CCTV cameras and other sensors in order to detect the presence or absence of a vehicle in a given location at any time and space. This project aims to create an urban environment where people can live in comfort while enjoying the benefits of modern technologies. Our system will solely control traffic based on the density of vehicles. The impact of density based traffic control systems is very important to traffic management. This system can be used in any kind of roads and highways for both urban and rural areas.

The density-based traffic control system will be able to provide better control on the movement of vehicles in an effective manner. The societal benefits from the density based traffic control system include:

1. Lowering the number of accidents by only allowing those vehicles that are allowed t

move.

2. The ability to reduce pollution through better traffic management.
3. Better air quality due to higher volume of vehicles in a smaller area.

We have analyzed a few other impacts our complex engineering solution will bring to this society all of the impacts are categorized into different aspects.

Table 6.1: Impact analysis

Aspect	Impact
Health	1. Longer journey increases back pain and other spinal cord related issues 2. Less traffic means less environmental pollution
Lifestyle	Fast and safer traffic flow in the city
Infrastructure	No need to build or reconstruct road or bridges to reduce traffic congestion
Environmental	1. Reduction in fuel consumption 2. Reduction of air pollution
Cost	Reduction in fuel cost
Safety	Reduction in road accidents
Legal	A new set of rules added to the current traffic control system of Bangladesh.

Our way of life is significantly impacted by traffic congestion. Our weekly gatherings and everyday schedules have both been impacted. People who work 9 to 5 in our city must spend an additional 4-5 hours in traffic, which is substantial. The difficulty of daily life has been exacerbated by the traffic congestion. Everybody's life will be made simpler if the system is interconnected. Repaving or creating new roads has frequently been shown to be a successful remedy for traffic congestion. However, such a strategy is unfeasible in a densely crowded city like ours. Cities and towns experience substantial problems with smog and carbon monoxide pollution due to traffic congestion. Hazardous compounds are released into the air by traffic fumes. According to WHO, these emissions have been connected to an increase in illness and death among drivers, commuters, and inhabitants who live close to roadways (World Health Organization)[34]. The World Health Organization has said that around 70% of diseases are caused by environmental factors. The density based traffic control system is expected to reduce traffic congestion on the road thus reducing air pollution. This will also reduce back pain and other spinal cord related issues. There are many studies that have been carried out on the effect of traffic density on health but none seem to be conclusive. However, there is a growing body of evidence showing that high levels of traffic congestion increase stress levels which in turn leads to higher blood pressure. This can lead to heart attacks and other cardiovascular diseases. Studies have shown that people who live near busy roads are more likely to develop respiratory problems such as asthma or bronchitis than those living in quiet neighborhoods. They also tend to be more overweight than those living in quieter areas with a greater amount of time spent sitting in cars or buses than they do walking or cycling. The absence of density gradient can be overcome by introducing a special type of traffic control system. This system helps in controlling traffic flow by using different types of signals depending on the amount of traffic present in any particular area. For example, in our project, if there is higher density in one road of a four-way intersection, The GREEN signal will be stayed on for an extended period than it usually does, the other roads will be stayed RED till the one with heavier density is being relatively clear. With this kind of installation, it will be possible for vehicles to pass through without any delay. The main advantage of a density based traffic control system is that it can help in reducing traffic jams and thus increase the speed of vehicles on roadways. By reducing the number of cars on the road, the density-based traffic control system lowers fuel consumption. According to a study by the National Highway Traffic Safety Administration (NHTSA) in the United States, fuel usage decreases by 2% for every 10% drop in traffic. This is due to the fact that fewer automobiles on the road result in less damage to other infrastructure and vehicles [[23]-[36]]. This traffic control system can reduce the fuel consumption of vehicles by providing safe and smooth traffic flow. Thus, it is possible to use less fuel to travel on a road. While at the same time, it will also reduce the emission of carbon dioxide which is harmful to human health. Emissions of carbon dioxide (CO2), sulfur dioxide (SO2), oxides of nitrogen (NOx), particulate matter (PM), and particulate matter with solids (PMSS) are decreased as a result of decreased vehicle movements (PM10). The decrease in CO2 emissions is brought on by the fact that an average automobile releases 90% more CO2 while traveling over 18 miles per hour than when traveling below 15 miles per hour. By accelerating travel times and enhancing vehicle fuel economy, reducing traffic congestion also contributes to a reduction in CO2 emissions [37], [38]. The ability of the traffic control system to be combined with other technologies, such as sensor networks, GIS, CCTV cameras, etc., is a key strength. By regulating the flow of cars using smart sensors deployed in various sections of the city, this enables authorities to notice and avoid any accidents more easily. In general, we can say that if there is smooth traffic flow in the city or where our system is being installed and new rules are followed by every commuter, the number of road accidents will significantly come down [39], [40] . A project will be sustainable if and only if the need for a particular solution will improve the long-term economic, social and environmental performance of a system. In order to meet the need, one needs to understand what impacts the solution brings to the table. Sustainable solutions could be used to address problems associated with air pollution due to traffic congestion, heavy fuel consumption. Future generations' demands must be satisfied through sustainable solutions. We must take into account all dimensions of sustainability in order to accomplish this. The economic component, which consists of cost and profit, is the first aspect. We believe that our project, if implemented, can play a huge role in the economy of the country. The key to making a profit is to raise output while holding expenses steady or even declining. The second factor is social. The standard of living for residents of the locations where such projects will be carried out is also considered. The third factor is environmental, which covers improving environmental quality (reduce air and other pollution due to traffic), resource preservation etc. Sustainable solutions may involve adapting existing technology or implementing new methods that were previously not considered viable options due to cost or environmental concerns. In our case, the system can be implemented in any roads and can be developed with extremely helpful features which will have a great impact for our roads. From all aspects, this solution will be sustainable if installed and maintained correctly.

Chapter 7: Engineering Project Management.

The discipline of project management has several facets and numerous subspecialties. In fact, the subject is covered in depth by entire degree programs. Particularly with regard to larger projects, some people view project management as their profession rather than technical expertise. We can anticipate and handle the next issues with the help of this clear and useful Engineering project management. People will grasp the project management life cycle, the knowledge domains, and how project management has evolved into a science. We can also learn how to create a project plan. To stand out in today's fiercely competitive world, it is essential to be able to deliver projects on time, within budget, and in alignment with corporate necessary objectives. Due to this, it is crucial that we have a thorough understanding of project management, ranging from the fundamentals to substantial expertise. As our project is to build an Intelligent Traffic Control System for a four-way intersection point. In this case we divided our project works in few steps among our group members.

As our Project is an Intelligent Traffic Control System for a four-way intersection point, at first we selected two approaches. First one was CCTV footage based Traffic Control System and the second one was thermal imaging system for Traffic control. We selected our first approach as it was more optimal and effective. For our first method, we selected Image Processing for traffic control and monitoring in our country, especially on the road we have chosen (Katabon-Elephant Road) is mostly heavily packed, it is already a challenge to make traffic flow smooth and effective. Regarding road usage and management, automatic traffic monitoring and surveillance are critical. Estimating traffic parameters has been a hot topic of study. Sensors of various types have been used to calculate traffic parameters and traffic information is being updated. Detectors of magnetic loops are the most widely utilized technologies, although Installation and upkeep are time consuming and inconvenient. It's possible that future ITS will be incompatible with it. It is well known that vision-based systems are more adaptable. Aside from a qualitative description, Image measurement can help with traffic congestion. A numerical description of traffic conditions, including speeds, vehicle counts, we may get a smooth traffic flow by using this technology. We are using high definition Cameras on the intersection lanes. The captured images will be processed through openCV and then the controller will send commands to the LEDs to change its state based on vehicle density. YOLO v5 is being used as an algorithm.

Besides, project management is the practice of applying knowledge, skills, tools, and techniques to carry out a project according to specific requirements. Understanding project management comes down to identifying the problem, creating a plan to solve the problem, and then executing on that plan until the problem has been solved. That may sound simple, but there is a lot that goes into it at every stage of the process.

The origins of project management can be drawn as far back as the building of the Pyramids in Giza and the Great Wall of China. Nevertheless, the modern development of project management began in the 19th century when railway companies purchased tons of raw material and employed thousands of people to work on the transcontinental railroad.

By the early 20th century, Frederick Taylor applied concepts of project management to the workday, improving strategies for working smarter and improving inefficiencies, rather than demanding laborers and resources. Henry Gantt, an associate of Taylor's, took those concepts and used bars and charts to graph when certain tasks, or a series of tasks were completed, creating a new way to visualize project management.

7.1 Simplified Project Management:

The most popular guide to project management is PMI's Project Management Body of Knowledge (PMBOK) .It breaks down a project into five chronological (roughly speaking) process groups, or phases. These will be carried out in the correct order for smaller projects, but for bigger or more challenging projects, you frequently need to, for instance, go back and do more planning.

• Initiating: approving the project and setting up the money.

• Planning: Creating the project management strategy, budget, and timeline.

• Executing: Working on the project.

• Controlling and Monitoring: Maintaining the project's progress in order to satisfy the timeline, budget, and any other requirement outlined in the project management plan.

• Closing: Creating as-built plans, concluding deals, etc.

Define:

Project charters are a crucial component of project management since they assist in outlining the fundamentals of a project and may be consulted at any time during the project's lifecycle. The official document may also demonstrate the viability and potential Return of a project, aiding in its approval.

Initiating:

In our FYDP first semester we selected our project topic which is Intelligent Traffic Control System for Four Way intersection. We took Authorizations from our respected ATC Panel members.

Planning:

Firstly we selected two approaches for traffic management, one is image processing based and another is thermal camera based. We finally went for an image processing based. As thermal cameras were way too much costlier.

Executing:

We built a prototype using CCTV camera footage, Arduino Uno, Led Signal modules. This project detects the density of vehicles on roads and according to that the signal time interval changes. Arduino UNO will detect the number of vehicles on the road after receiving an input, and all signal lights will then change while keeping a time interval. That route's signal will become green, indicating that it is one of the roads with the greatest amount of measured vehicle density. And other traffic lights will go to red. For individuals who want to utilize the left lane, all roads will always have it available so they do not have to wait for any signals. Signal timing will vary depending on the density of each road. Here, we are applying a formula to get the vehicle density. A threshold will be set at approximately 80–90 meters. That road will be considered to have a high vehicle density and the signal will turn green among the four roads that cross the threshold first. The total number of vehicles inside the threshold line will be divided by the area to determine density.

Risk Management Analysis:

The process of discovering, evaluating, and reacting to risk factors that emerge during a business's operations and operations is known as risk management. Effective risk management requires acting proactively rather than reactively in order to affect future events as much as is practical. Consequently, effective risk management has the potential to reduce both the likelihood that a risk will materialize and the severity of its possible effects.

Table 7.1: Risk Management Analysis

	Duration without fixing	**Effect**	**Weakness**	**Contingency plan**
Natural Calamities	0 days	Difficulty in Image enhancement, Edge detection and labeling the detected region.	1. Failed Camera 1. No Power backup	Shift to an effective algorithm by which the image enhancement can be done better.
Equipement (Software)	0 days	Traffic flow will not be smooth and density based as per our project.	Less accuracy in terms of detection/No vehicle Detected.	1. Immediate signal to the server if any of the camera stops working 2. In case of software bug, Fix it immediately
Cyber Security	48 Hours	Whole system will collapse		Preserve maximum and alternative resources for rejuvenate the system.

Vendor (Sourcing)	30 hours	No supplies of raw material.	Dependency upon exporters.	

As our project time period is 3 semesters. In the first semester, which is EEE400P, the topic and different approaches were selected. In the Second Semester which is EEE400D, the final approach and optimal solution with all the simulations was covered. Last semester, which is EEE400C, we developed our whole project. Our works were divided into different parts among four members of the group. Schedule of works and meetings are provided in the Gantt Charts of each semester.

Gantt Chart:

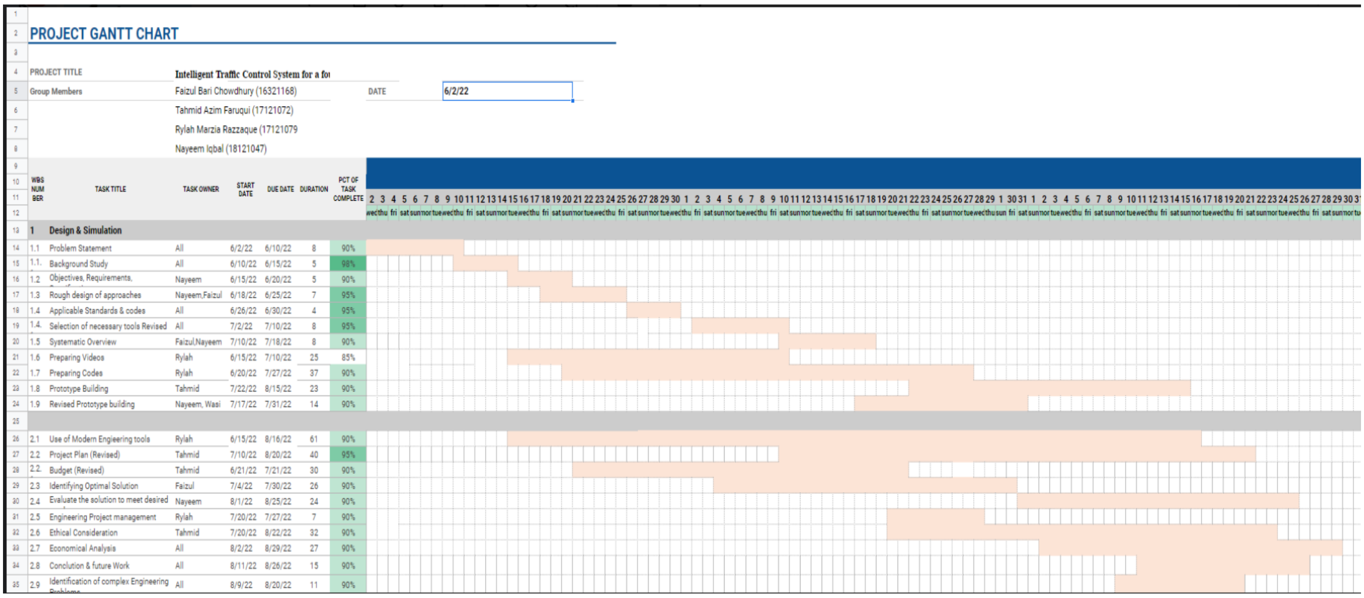

Fig 7.1: Gantt Chart

Chapter 8: Economical Analysis:

Smart Traffic Control System is a unique integrated system that unites all aspects of traffic management into one. It includes intelligent control and information/message distribution, real time traffic information, speed detection and collision avoidance, vehicle tracking and passenger monitoring, parking guidance and navigation, dynamic intersection control and security surveillance and advanced traffic signal control. In our system the traffic control will be done based on the density of traffic on a road. Many other features can be integrated into it, if developed further. In urban areas, this smart system can bring solutions to many problems. If the economical analysis is done, it will surely prove that the society will be benefited way much more than the system costs.

An economic analysis should be conducted for a technology such as this to determine if there will be any significant cost savings to the organization. Not only can direct cost savings be determined, but also indirect cost savings around maintenance and security arising from fewer accidents and no need for expensive road closures when traffic lights are out of alignment. The main objective of this research is to evaluate the economic benefits derived from implementing a smart traffic control system in an urban area. The proposed control system has been designed to detect and react to real time traffic conditions such as congestion and accidents, thereby improving the quality and reducing the cost of services on a road network. In order for this system to achieve its goal it will be necessary to create a closed feedback loop between traveling users and the Internet. Consequently, it is necessary that we develop an efficient pricing model for our proposed service. By using statistical evaluation techniques (Cost Benefit Analysis), we intend to demonstrate that it is beneficial for users, developers (manufacturers), suppliers and investors so long as they choose the safest route based on real time information provided by our proposed system [39], [41], [42]. The benefit/cost (B/C) analysis method utilized in economic research pertaining to the building or reconstruction of roads will be employed in this essay. However, the outcomes of the aforementioned approach result in significant economical choice.

8.1 Cost allocation:

If done with real time data.

1. IP Cameras
2. Microprocessor (Raspberry Pi)
3. Arduino Mega
4. Components for prototype setup

Table 8.1: The project costs If implemented on 4 Roads in an intersection

Application	**Number**	**Cost (BDT)**	**Useful life (years)**
IP Cameras	4	24000	3-5
Raspberry Pi	1	17000	7-10
Arduino	1	1500	10+
Prototype Setup & Installation	1	3000	2+
Total		45500	

8.2 Cost- Benefit Analysis:

Table 8.2: CB Analysis

Cost	**Benefit**
IP Cameras Raspberry Pi Arduino Prototype Setup & Installation Total : 45500	1. Approximately 500 meters of each road gets covered so the traffic density can be measured accurately. 2. Global cost of health damages associated with exposure to air pollution is $8.1 trillion. This system will definitely help reduce the air pollution significantly [43]. 3. Reduction in road accidents[Per year accident cost is 35000 crore [44]. 4. Depending on the size of the engine, petrol engine cars typically cost between Tk 4 and 6 (Euro 0.063) per kilometer. Reduction in fuel consumption. 5. The economy lost Tk56,000 crore ($6.5 billion) in 2020 from traffic.

The system we have used, The IP Cameras can detect the vehicles till 500 meters distance. So all the vehicles in this distance can be detected easily through our system. If the detection is done the system can control the traffic lights for a certain distance. Since the algorithm is frame based the detection will be continuous and detect the vehicles for each 500 meters simultaneously. Air pollution is a global public health concern; each year, millions of people die and many more are plagued by injuries and illnesses caused by air pollution. This publication estimates the world-wide economic cost of health damages from exposure to ambient air pollutants. Using up-to-date estimates, the estimated aggregate global cost for each country is $8.1 trillion, equivalent to 6.1% of global GDP. People living in low- and middle-income countries are most affected by mortality and morbidity from air pollution. With our system installed, the traffic will be cleared based on the density and help smooth traffic flow which will result in lesser air pollution. In 2018 the researchers at the Accident Research Institute (ARI) of Bangladesh University of Engineering and Technology (BUET) found that Dhaka traffic wastes 5 million work hours, costing the economy Tk37,000 crore ($4.35 billion) in 2020 alone. The economy loses tk56,000 crore ($6.5 billion) due to traffic accidents in 2020 according to ARI." [45], [46]

According to the information of BPC, total annual consumption of petroleum products in Bangladesh is about 3.78 million metric ton (MT) of which 2.03 million MT is for transport sector. The share of transport sector in the total consumption of petroleum products is about 54%, which is about 2.5 times higher than the agricultural sector or 18 times higher than the industrial sector (BPC, 2008). Globally motorized transport consumes more than a quarter of world’s commercial energy use [47]. Transport sector is one of the large contributing human activities that accounts about 14% of total greenhouse gas emissions. The phenomenon, global warming, is mainly attributed to the increase in atmospheric carbon dioxide due to the burning of fossil fuel. Energy sector contributes about 54% of GhG emissions [47]. Traffic congestion is a significant problem in Dhaka. It is particularly costly for businesses, as well as individuals and other individuals who have to spend time commuting from home to their jobs. Traffic congestion reduces productivity and costs billions of dollars annually. Findings in this study can inform efforts for reducing or controlling traffic congestion, by analyzing the magnitude of congestion at different times and locations, calculating its effects on productivity and costs, evaluating alternative transportation systems that can reduce or eliminate traffic delays, assessing technical assistance needs related to demand signal management strategies, and employing more effective methods of transportation pricing. According to a study done by Ahmed and Khan (2013), the total additional fuel cost due to congestion in Dhaka city is about US$ 179 million per annum. The loss of working hour during peak periods (9–10 am and 6–7 pm) in monetary terms is around Indian Khan and Islam (2013) state that the delay externality cost, which is imposed upon others, is around US$ 1050 [48].

Traffic congestion is a burning problem in Dhaka. People are moving to the city for education, job and treatment purposes. But life in this city is stuck everyday due to traffic congestion, which wastes huge amounts of time and money. Most of the commuters in the city travel more than 2 hours per day, spending even 5–10 kilometers per trip per day. They lose about one working hour per day and lose 3-4 US$ income due to traffic congestion. Commuters have to spend 1 hour per month and 10 days per year losing income due to traffic congestion among surveyed respondents. Combining elements of traffic congestion as well as cost of traffic congestion, average loss of working hours and income due to traffic congestion is estimated at US$ 421 daily from commuting by taxi drivers working part-time or full-time. If we compare the cost of this project with its benefit, we will surely get a higher monetary value of the benefit. For now we still cannot get the correct estimation of the monetary value of the benefits due to the huge impacts of this traffic problem. If we analyze correctly, this is evident that if the traffic can be controlled sensing its density, the benefit we get will severely help in our economy and recover the losses.

Chapter 9: Ethics and Professional Responsibilities

9.1 Ethics and professional responsibilities:

Ethics is the study of decisions, policies and values that are morally desirable in engineering practice and research. The ethical responsibilities of engineers are not just to society, but also to colleagues, employers and clients. Engineers should be aware of the ethical issues surrounding their work and act in a way that is consistent with professional standards. As we started working on this project, Professional responsibilities we took as a team member were initially based on the ethics that we share and ethics that should be maintained in our work area.

The practice of engineering is a profession that requires the use of technical knowledge and skills, as well as a broad understanding of ethical and social issues. The profession's ethical standards are set forth by codes of ethics, codes of professional conduct, professional societies and other organizations. The personal and professional responsibilities of engineers are significant because they impact on the public safety, health, welfare and economic well-being of society. Engineers create answers to a variety of significant societal issues using their technological expertise and knowledge. An engineer must establish an ethical basis based on the guidelines provided by the Institute of Electrical and Electronics Engineers (IEEE) code of ethics in order to be successful in this position. The IEEE code was created by IEEE members for use by its members as a standard for ethical behavior. It is meant to serve as advice on ethical conduct for individuals who operate within IEEE's sphere of activity but does not have the force of law. IEEE publications, such as Recommended Practice E1-2001: Safety Program Management and Recommended Practice C22-2002: Guide for providing, include the generally recognized techniques employed by engineers. One must be aware of their own personal values and ethics when evaluating technical problems as well as when they are making decisions about how to solve them [49]. For example, we decided to work on our project because we truly believe in the particular solution. In the last 5 years the traffic congestion of our roads have only increased. As a nation we suffer from economical loss, less productivity rate, worsened environment etc. If our system can be implemented, as we have visioned, it will solve a lot of difficult problems that we face on a daily basis. From our ethical point of view, we have researched thoroughly and made sure that no values of the nation are being harmed or violated.

Before starting a project, one must have a basic understanding of the principles of ethics and professional conduct. This includes knowing what constitutes acceptable behavior, being aware of professional codes of conduct, and being able to judge whether an action would be considered ethical or unethical. The ethical responsibilities of engineers are not just to society, but also to colleagues, employers and clients. Engineers should be aware of the ethical issues surrounding their work and act in a way that is consistent with professional standards. There are a few ethical issues listed below:

Integrity:

Integrity is a major concern in the development of any smart traffic control system. There should be complete transparency of the results and decision-making process, as well as ethical behavior by both the stakeholders and the team members of this project

i. To have strong morals and working in a truthful manner.

ii. Always making public statements/ proposals to stakeholders or ATC committees with honesty.[50]

iii. Avoiding deceptive acts

Competence:

Competence is a person skill capable of realizing one's potential. The ability to perform services only in the area in which one specializes ensures that the services provided are competent, reliable and appropriate as per our stake-holders requirements.

i. Perform services only in area of one’s competence

ii. Not working under a specialization if that is out of one’s ability [51].

Fidelity & Confidentiality:

To keep information private, safeguard confidentiality and to avoid any conflict of interest and possible bias. Even when we are facing conflict within any parties be it the team members or the faculties, we are to keep maximum confidentiality and stay true to the project work for what is best for the public.

i. Not disclosing any information from the stakeholders or any other parties regarding the process

ii. Stay true to our stakeholders, be trusted by the team members.

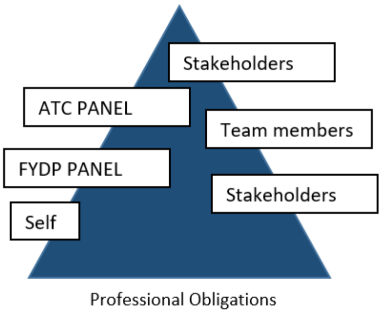

Fig 9.1: Processional Obligation

Professional Responsibilities:

As a professional one needs to be aware of the rights, moral and ethical responsibilities that are required in relation to the project. We are not only obligated to one person but our team members, ATC members, stakeholders, society etc.

This project aims to bring the team members' knowledge and understanding of professional ethics as well as ethical issues that are associated with the project, by providing an opportunity for reflection, discussion and critical thinking. We have a responsibility to complete the project on time, on the other hand we have to remember this is a team effort. We have to cooperate with our team members and work accordingly. Some other professional responsibilities that we have maintained throughout the process:

1. Being empathetic towards the group members and communicating effectively.

2. Taking deadlines seriously and working accordingly.

3. Taking part in active decision making

4. Ensure Stakeholder Satisfaction

5. Take full accountability.

Professional ethics requires that the project team members must be committed to high levels of integrity, professionalism. As a team, we have tried our best to work as per the stakeholder’s need and maintain utmost professionalism. A good team is essential to success in any project. We are responsible to ensure the quality of the work, time schedule and budget requirement. With the ethical values that we share as a group this project has been done throughout the three trimesters.

Chapter 10: Conclusion and Future Work.

10.1 Future work:

A better traffic system in a country can change citizens' and authorities' attitudes toward rules and regulations, as well as road safety. Our project is intended to reduce traffic congestion, and only vehicle counting is required to achieve this goal.

However, it should be noted that the detection accuracy of smaller vehicles such as motorcycles and bicycles is significantly lower than that of conventional vehicles.

There is a huge scope for future works of this system as we have used YoloV5 model to detect and other variables of traffic system can also be monitored by this model.

Over Speeding Control:

There should be a threshold value of speed limit and if the vehicle movement by be monitored frame by frame by using vector quantity, speed can be measured [52] as we have the frame rate and pixel quantity.

Drunk Driver detection:

Every year, drunk driving causes the premature deaths of a number of drivers. A drunk driver won't be caught until after he commits an illegal act. However, using a deep learning method, a drunk driver can be identified. We require a faster convolution neural network of mosaic data augmentation for drunk driver detection [53]. Both datasets from people who have consumed alcohol and datasets from people who are sober must be gathered in large quantities by the system. This allowed for a thorough comparison of the body language and eye position of a sober and drunk driver.

Emergency lane creation:

Often emergency vehicles get ignored in time of gridlock situation and ironically it becomes impossible to pass the vehicle through. In that scenario the system needs to detect and intrgate two input signals. One is vehicle detection using video footage and other is specific audio frequency. The YOLOv5 model can be used as emergency vehicle detection and for audio detection we could use VGGnet (Visual Geometry Group) architecture [54] with Linear classifier model for audio detection.

10.2 Conclusion:

This project was created for a four-way intersection. In this project, the traffic situation is examined using four separate real-time traffic footages. The YoloV5 model was used to process images and later it was changed to the ONNX model since we wanted to use just one microcontroller for practical reasons. Our system can identify vehicles such as cars, trucks, buses, motorcycles, bicycles, rickshaws, ambulances, and fire brigades. Following detection, the densities of each of the 4 roads are measured, and the time of the traffic light is managed in accordance with the densities. As a result, the road with the most traffic is given preference for having the longest green signal. For that, we have been able to mitigate the traffic congestion of a particular road. We are getting the accuracy rate of more 88% with this system.

Chapter 11: Identification of Complex Engineering Problems and Activities.

Having a depth of understanding in fields like machine learning and data science is necessary for the implementation of this project (P1). Additionally, we are knowledgeable with the diverse needs and analyses needed for different situations (P2 & P3). A wide range of stakeholders will participate in this endeavor. The most important stakeholders are, first and foremost, all commuters and users. Then, law enforcement organizations like the DMP and the traffic police will keep an eye on this. The Dhaka City Corporation's approval will also be required for the project's actual execution. There are particular guidelines set forth by the traffic regulating body as well as other restrictions with regard to the implementation of this project, which satisfies P5. Other norms and particular rules are established by the organization in charge of regulating traffic. We hope to make this project a solution to a challenging engineering problem by fulfilling these conditions.

11.1 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	√

Note: Project must have P1, and some or all from P2-P7

11.2 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	√

Note: Project must have some or all of the characteristics from attributes A1 to A5

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Appendix

Logbook:

	Final Year Design Project (C) SUMMER 2022		
Student Details	**NAME & ID**	**EMAIL ADDRESS**	**PHONE**
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ATC Details:			
ATC 4			
Chair	**Dr. Mohammed Belal Hossain Bhuian**		
Member 1	**Md. Mahmudul Islam**		
Member 2	**Abdullah Hil Kafi**		

General Notes:

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
02.06.2022 07.06.2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem 1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	1. Discussing project plan 2.Capturing videos Finding necessary Softwares	Task : Nayeem Rylah Tahmid Wasi Task: Nayeem Rylah Tahmid Wasi	
09.06.2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	Meeting with ATC	Task 1: All	Selection of modern Engineering tools
16.06.2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	Research about simulations	Task : Nayeem Faizul	
22.06.2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	Updating Codes	Task : All	
27.06.2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	Meeting with ATC	Task: Nayeem	Few changes need to be applied.
07.07.2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	selection of necessary tools	Task1: All	
14.07.2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	Selection of necessary tools Revised	Task 1: All	
17.07..2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	Test and Run Codes	Task1: All	
21.07.22	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	Specifications Expected impacts Preparing progress Presentation	Task : All	
04.08.2022	1.Faizul 2.Tahmid	Prototype Building Budget making	Task 1: Nayeem Task2 : Tahmid	

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
02.06.2022 07.06.2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem 1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	1. Discussing project plan 2.Capturing videos Finding necessary Softwares	Task : Nayeem Rylah Tahmid Wasi Task: Nayeem Rylah Tahmid Wasi	
	3.Rylah 4.Nayeem			
11.08.2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	Working on logic and algorithms.	Task1 : Tahmid Task 2: Rylah Task 3 : Nayeem	
18.08.2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	In person meeting with ATC members.	Task 1: All	Need to work on density more clearly.
21.08.2022	1. Faizul 2.Tahmid	Final simulation test run	Task 1: All	
24.08.2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	Preparing slides of Final presentation	Task 1: All	
25.08.2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	Final Budget making (revised) Project plan update	Task :Tahmid	
28.08.2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	Preparing Gantt Chart Preparing Slides	Task: Rylah Nayeem Tahmid Wasi	
29.08.2022	1.Faizul 2.Tahmid 3.Rylah 4.Nayeem	1.Work on ethical Consideration 2.Preparing the project plan 3. Working on Design 01	Task1:Nayeem Task2: Tahmid Task 3 : Rylah	
30.08.2022	1. Nayeem 2.Faizul	1. Updating Background Research 2. Determining Ethical Consideration 3. Work on updated proposal report	Task 1 & 2 : Nayeem Task 3 & 4 : Faizul	

Assessment Guideline for Faculty

[The following assessment guideline is for faculty ONLY. **This portion is not applicable for students**.]

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

Note: The star (*) marked deliverables/skills will be evaluated at various stages of the project.

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 throughout the project development phases	h	Cognitive/ Apply Affective/ Valuing	• Peer-evaluation, • 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

Note: The double star (**) marked CO will be assessed at various stages of the project through indirect deliverables.

Code for vehicle detection: (Multiple road Simultaneously & lane Detection)

```
import sys
import pathlib
# sys.path.insert(1, str(pathlib.Path.cwd().parents[0])+"/common")
import utilities as util
import multi_vehicle_detect as mvd
import numpy as np
import time
import cv2
import argparse

from os.path import join
from multi_vehicle_detect import detect_fun
def main():
# read image from each lanes video source
# vs = cv2.VideoCapture(
#     str(pathlib.Path.cwd().parents[0])+"/datas/"+sources[0])
# vs2 = cv2.VideoCapture(
#     str(pathlib.Path.cwd().parents[0])+"/datas/"+sources[1])
# vs3 = cv2.VideoCapture(
#     str(pathlib.Path.cwd().parents[0])+"/datas/"+sources[2])
# vs4 = cv2.VideoCapture(
#     str(pathlib.Path.cwd().parents[0])+"/datas/"+sources[3])
# main_dir = r"C:\Users\ranas\OneDrive\Desktop\Personal\AI-based-Traffic-Control-System--\datas"
# vs = cv2.VideoCapture(join(main_dir, "video1.mp4"))
# vs2 = cv2.VideoCapture(join(main_dir, "video2.mp4"))
# vs3 = cv2.VideoCapture(join(main_dir, "video3.mp4"))
# vs4 = cv2.VideoCapture(join(main_dir, "video5.mp4"))
main_dir = r"C:\Users\ranas\OneDrive\Desktop\Personal\AI-based-Traffic-Control-System--\data_dhaka"
vs = cv2.VideoCapture(join(main_dir, "1.MOV"))
vs2 = cv2.VideoCapture(join(main_dir, "IMG_9879.MOV"))
vs3 = cv2.VideoCapture(join(main_dir, "3.mp4"))
vs4 = cv2.VideoCapture(join(main_dir, "4.MOV"))

print("okay")
```

```
# creates a network given yolov5s model
# net = cv2.dnn.readNet(
#     str(pathlib.Path.cwd().parents[0])+"/models/yolov5s.onnx")
# net.setPreferableBackend(cv2.dnn.DNN_BACKEND_CUDA)
# net.setPreferableTarget(cv2.dnn.DNN_TARGET_CUDA)
# ln = net.getUnconnectedOutLayersNames()  # returns the name of output layer

# initial configuration of each lanes order
lanes = util.Lanes([util.Lane("", "", 1), util.Lane(
"", "", 3), util.Lane("", "", 4), util.Lane("", "", 2), ])
wait_time = 0

while True:

# read the next frame from the
(success, frame) = vs.read()
print(success)
(success, frame2) = vs2.read()
print(success)
(success, frame3) = vs3.read()
print(success)
(success, frame4) = vs4.read()
# if the frame was not successfuly captured, then we have reached the end
# of the stream or there is disconnection

print(success)
if not success:
break
# assigns each lane its corresponding frame
for i, lane in enumerate(lanes.getLanes()):
if (lane.lane_number == 1):
lane.frame = frame
elif (lane.lane_number == 2):
lane.frame = frame2
elif (lane.lane_number == 3):
lane.frame = frame3
elif (lane.lane_number == 4):
lane.frame = frame4
```

```
start = time.time()
# print(lanes)
# lanes = util.final_output(net, ln, lanes)
lanes = mvd.detect_fun(lanes)
end = time.time()
print("total processing:"+str(end-start))
if wait_time <= 0:
images_transition = util.display_result(wait_time, lanes)
final_image = cv2.resize(images_transition, (1020, 720))
cv2.imshow("f", final_image)
cv2.waitKey(100)

# returns waiting duration of each lane
wait_time = util.schedule(lanes)
images_scheduled = util.display_result(wait_time, lanes)
final_image = cv2.resize(images_scheduled, (1020, 720))
cv2.imshow("f", final_image)
cv2.waitKey(1)
wait_time = wait_time-1


if __name__ == "__main__":

main()
```

```
import torch
import cv2
# Model


model_dir = r"C:\Users\ranas\OneDrive\Desktop\Personal\AI-based-Traffic-Control-System--\models\yolov5s.pt"


model = torch.hub.load('ultralytics/yolov5', 'yolov5s')  # or yolov5n - yolov5x6, custom
```

```
# model = torch.load(model_dir)
# Images
# img = 'https://ultralytics.com/images/zidane.jpg'  # or file, Path, PIL, OpenCV, numpy, list

video_dir = r"C:\Users\ranas\OneDrive\Desktop\Personal\AI-based-Traffic-Control-System--\datas\video2.mp4"

video_tr = cv2.VideoCapture(video_dir)



vehicle_list = [  "bicycle", "car", "motorcycle", "airplane", "bus", "train", "truck", "boat" ]
# Inference

def drawPred(frame, classId, conf, left, top, right, bottom):
# Draw a bounding box.
cv2.rectangle(frame, (left, top), (right, bottom), (255, 0, 0), thickness=2)

return frame

while True:
(success, frame) = video_tr.read()
if not success:
break
results = model(frame)
vehicle_count = 0
for obj in results.crop():
if obj['label'].split(" ")[0] in vehicle_list:
x1,y1, x2, y2 = int(obj['box'][0].item()), int(obj['box'][1].item()), int(obj['box'][2].item()), int(obj['box'][3].item())
conf = obj['conf'].item()
cls_id = obj['cls'].item()
frame = drawPred(frame, cls_id, conf, x1, y1, x2, y2)
vehicle_count += 1

cv2.imshow("f", frame)

print(results)
```

Results

Related code/theory:

All the codes and simulation files as well as datasets can be found in the following drive link:

https://drive.google.com/drive/folders/1bPJoXYiZdJmrrCx17WQhYutxOOw8dWDE?usp=sharing