A

Project Report

on

Rescue Route

submitted for partial fulfillment for the award of

BACHELOR OF TECHNOLOGY

DEGREE

in

Computer Science

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DECLARATION

I/We hereby declare that this submission is our own work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

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CERTIFICATE

This is to certify that Project Report entitled **“Rescue Route”** which is submitted by **Kashish Gupta, Khushi Vaish and Nikita Sharma** in partial fulfillment of the requirement for the award of degree B. Tech. in Department of Computer Science of Dr. A.P.J. Abdul Kalam Technical University, Lucknow is a record of the candidates own work carried out by them under my supervision. The matter embodied in this report is original and has not been submitted for the award of any other degree.

Date:

Supervisor Signature:

Ms. Akanksha

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ABSTRACT

In today's world we have been facing problem due to increasing traffic on roads. This causes a lot of waste of time and increases stress level. As many emergency vehicles are also stuck in traffic for hours leads to losing life of people. So, this requires development of a system to handle traffic in a smart way by automatically adjusting its timing based on traffic density provide passage for ambulances using RCNN(Region-based Convolutional Neural Network), webcam, NodeMCU controller, LEDs. The core idea revolves around traffic management through the assessment of traffic volume on each side of the road, with the aim of implementing smart traffic signal control based on this density information. The webcam captures images of the vehicles on the road and send images to the NodeMCU microcontroller and then we apply RCNN algorithm and OpenCV to detect and count number of vehicles on the lane and set traffic timing accordingly. If ambulance is detected traffic light turns green on that side and other side are turn red to provide passage for emergency vehicles.

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LIST OF ABBREVIATIONS

V2V	Vechile-to-Vechile
RCNN	Region Based Convolutional Neural Networks
MCU	Micro-controller
LED	Light Emitting Diode
RFID	Radio Frequency IDentification
IR	Infrared

CHAPTER 1

INTRODUCTION

1.1 Introduction to Project

One of the pressing issues exacerbated by the world's growing inhabitants and the swift increase in the count of automobiles is traffic blockage. In countries like India, the estimate of expanding lane infrastructure lags far behind the rate of vehicle growth[1].Traffic jams give rise to numerous critical problems that have a direct impact on people's daily lives and, in some cases, even lead to loss of life[2]. For instance, when an emergency vehicle such as an ambulance is transporting a critically ill patient, being trapped in a heavy traffic jam significantly reduces the chances of the patient reaching the hospital in a timely manner.

Therefore, it is imperative to develop an intelligent traffic management system that can effectively regulate traffic to prevent accidents, collisions, and traffic gridlocks, with a special focus on ensuring the swift passage of emergency vehicles like ambulances[3]. These challenges can be mitigated through the application of emerging technologies, specifically Machine Learning (ML). By establishing connections between a range of software packages and hardware devices, whether through wireless or wired means, a system can be created to efficiently regulate traffic. This system operates by automatically adjusting signal timings in accordance with traffic density and also facilitates the unobstructed passage ofemergency vehicles, such as ambulances, utilizing RCNN (Region-based Convolutional Neural Network), webcams, NodeMCU controllers, and LEDs.

1.2 Project Category

Industry automation refers to the use of control systems, such as computers or robots, and information technologies for handling different processes and machinery in an industry to replace human involvement. In the context of the smart traffic management system you are developing, industry automation plays a crucial role in optimizing traffic flow and providing efficient passage for emergency vehicles.

The system utilizes various technologies, including RCNN (Region-based Convolutional Neural Network), webcam, NodeMCU controller, LEDs, and OpenCV, to automate traffic signal control based on real-time traffic density information. This automation reduces the need for manual intervention in adjusting traffic signal timings, making the system more efficient and responsive to changing traffic conditions.

By automating the detection and counting of vehicles on each lane using RCNN and OpenCV, the system can accurately assess traffic volume and adjust traffic signal timings accordingly. This not only improves traffic flow but also reduces congestion and travel time for commuters.

Moreover, the system's ability to detect and prioritize emergency vehicles, such as ambulances, by automatically turning traffic lights green on their route, demonstrates how industry automation can significantly improve emergency response times and potentially save lives.Overall, the smart traffic management system exemplifies how industry automation can be applied to solve real-world problems, making processes more efficient, reliable, and responsive to changing conditions.

1.3 Objectives

- **Optimize Traffic Flow:** Develop a system that adapts traffic signal timings based on real-time traffic density data to alleviate congestion, reduce travel times, and enhance overall transportation efficiency.

- **Increase Ambulance Response Efficiency:** Establish a priority mechanism to grant ambulances a red-light-free pathway, ensuring swift response to emergencies and enhancing public safety.
- **Reduce Environmental Impact:** By minimizing traffic congestion and idling, contribute to lower emissions and reduced environmental pollution, thereby promoting a healthier urban environment.
- **Enhance Public Safety:** Improve the safety of the public by expediting ambulance responses and minimizing the risk of delays during critical medical emergencies.
- **Improve Urban Transportation Infrastructure:** Implement an innovative solution that enhances the functionality of urban traffic management systems, ultimately benefiting the quality of life and transportation experience for residents.

1.4 Structure of Report

The project report has been divided into multiple chapters with each chapters getting divided into multiple sections and sub-sections.

Chapter 1 contains the introduction where a brief introduction of the project is stated. It also contains the category to which the project belongs to.

Chapter 2, we have discussed the previous research work that has happened in this field as well as the problem statement. Apart from this, we have also mentioned the number of objectives that the system proposes to achieve.

Chapter 3 contains the detailed discussion of the project, its functionalities and the methodology used to create the proposed system. The various unique features of the project that differentiates this project with the existing ones, are also mentioned in the designated section.

Chapter 4, we have performed the feasibility study and mentioned the various parameters and evaluated the system's technical, economical and operational feasibility. Along with this, we have also included the software requirement specification document that contains data requirement, functional requirement, performance requirement, maintainability requirement as well as security requirement. This chapter also explains the Software Development Life Cycle (SDLC) model that has been used. It also illustrates the various diagrams like System Design using DFD Level 0 and Level 1, Use Case Diagram and ER Diagram.

Chapter 5 includes the implementation details of the proposed system. It mentions the languages, tools and technologies that have been used to create the system whereas

Chapter 6 is dedicated to the testing and maintenance of the project.

Chapter 7, the results and discussion is done that contains the user interface representation, description of various modules of the project and snapshots of the system.The final **chapter 8** is dedicated to the conclusion and future scope of the system.

The project report concludes with the references section and research paper and proof of patent publication.

CHAPTER 2

LITERATURE REVIEW

2.1 Literature Review

A. Real-time traffic density count using image processing.

In [1] Abbas, et al. present a method for assessing lane-specific traffic density through the application of image processing. This approach offers distinct advantages, primarily obviating the need for costly aerial imagery and intricate sensor-based systems, thus rendering it a cost-effective solution. Notably, our system does not necessitate the installation of additional devices like RFIDs. Future improvements can include the incorporation of an emergency vehicle identification system, affording priority to such vehicles, and the integration of Vehicular Ad-hoc Networks (VANETs) to enhance road safety and contribute to the development of intelligent transportation systems.

B. Smart traffic control system using image processing.

In [2] Jadhav, Prashant, et al. introduces a novel approach to estimate traffic, employing image processing on captured highway camera footage to count vehicles, issue warnings for heavy traffic if thresholds are exceeded, and offers cost-effectiveness, ease of implementation, and notable accuracy and speed compared to traditional sensor-based systems. It is executed using MATLAB and image processing, aims to alleviate heavy traffic congestion. It involves the utilization of web cameras positioned in traffic lanes to capture road images, which are then meticulously processed to gauge traffic density

C. Density Based Traffic Control System with Smart Sensing Of Emergency Vehicles

In [3] D. M. Varadharaj employs switches, rather than magnetic sensors, to assess traffic density and modulate green signal durations based on this information, leading to the desired outcomes. Future project developments involve extending the system to manage all four lanes at a traffic signal by employing efficient PIC interfacing techniques. Furthermore, the system will incorporate the capability to detect emergency and government vehicles through the use of RF transmitter and receiver components, known collectively as an RF transceiver. The primary goal of the project is to optimize traffic flow by effectively utilizing green signal durations. In this system, the traffic density in a specific lane is determined by the count of magnetic sensors placed at the roadside, which generate output signals corresponding to the traffic density.

D. Vehicles Density Based Traffic Control and Ambulance Detection using RFID reader & IR Sensors”

In [4], Vivekanand Thakare present a deep learning-based, decentralized smart traffic management system that optimizes traffic on the roadways and use intelligent algorithms to better correctly control all traffic scenarios. Through the use of an IR sensor, an object identification algorithm, and sensor data, the system receives the density of cars in traffic as input and outputs multiple vehicles for signal management. To lessen traffic congestion, an algorithm in an IR sensor is utilized to forecast the number of vehicles in traffic in the future. In addition, by installing RFID Reader in emergency vehicles such as ambulances and police cars, among others, RFID Reader is also used to prioritize emergency vehicles.

The traffic system receives data from IR sensors and digital cameras that are abstracted from digital image processing techniques to determine the density of cars. It then uses this information to produce outputs such as signal management. The time will either decrease or rise depending on the density of vehicles. Time will be added to the lane when there is a lower vehicle density than in the other. To reduce traffic congestion, an algorithm is employed to forecast the future traffic density.

The traffic density of the cars is sent into the system by cameras, which are decoupled from RFID readers. and the data from IR sensors, which are then provided as an output for signal management. The purpose of the IR sensor is to control signal timing based on congestion in traffic.

For signal control in the traffic management system, use the AT Mega 328 P. The traffic system's goal is to control traffic flow and decrease stoppage time by introducing sensors to control traffic lights.

Vehicle Detection: When there are more cars on one road than on another during traffic, a light will open on that road. An infrared sensor is used to identify vehicles. in order for it to clear the route more quickly than the prior available traffic signal. Detection of Vehicles with IR Sensor Identifying Ambulance: Because a certain lane has a time limit, there are a lot of cars in traffic. Emergency vehicles have been experiencing delays and issues. Here, if there is an ambulance in the traffic, the RFID reader will identify it. Traffic system design uses Arduino, Express PCB, Proteus software, RFID reader for ambulance detection, and coding and circuit design.

E. Real Time Traffic Density Measurement using Computer Vision and Dynamic Traffic Control

In [5], propose a dynamic traffic control system that uses image processing and real-time video feeds to measure the traffic density at intersections. After gathering a video sample, a combination of Gaussian algorithms was applied to foreground detection and background subtraction in order to maintain track of the number of cars in each lane. By using their line of centroid, the vehicles are identified. A vehicle is confirmed by centroid movement. The traffic conditions detected from the video feeds will be used to dynamically adjust the traffic lights at the intersections.

F. Smart Ambulance Traffic Control System

The Smart Ambulance Traffic Control System (SATCS)[6], an integrated system for managing traffic signals in emergency ambulance scenarios, is presented in this paper. By using Radio-Frequency Identification (RFID) technology, SATCS makes it possible for ambulances and traffic lights to communicate with one another. The RFID system makes sure that the traffic lights turn green when an emergency ambulance approaches a junction, giving it priority passage. Because of RFID technology, SATCS provides server-less deployment, offline support, and cost-effectiveness in contrast to other systems like the Intelligent Traffic Control System for Smart Ambulance, Smart Ambulance Guiding System, Smart Ambulance System, and Smart Ambulance with Traffic Control Ability. The prototype uses Intel Upsquared and RFID technology, and it has been successfully tested without internet access. The authors advise real-world testing despite the proof of concept, taking into account variables like varying ambulance speeds.

G. Toward Reliable and Scalable Internet of Vehicles: Performance Analysis and Resource Management

In [7] , reliable and scalable wireless transmissions for Internet of Vehicles (IoV) are technically challenging. Each vehicle, from driver-assisted to automated one, will generate a flood of information, up to thousands of times of that by a person. Vehicle density may change drastically over time and location. Emergency messages and real-time cooperative control messages have stringent delay constraints while infotainment applications may tolerate a certain degree of latency. On a congested road, thousands of vehicles need to exchange information badly, only to find that service is limited due to the scarcity of wireless spectrum. Considering the service requirements of heterogeneous IoV applications, service guarantee relies on an in-depth understanding of network performance and innovations in wireless resource management leveraging the mobility of vehicles, which are addressed in this article. For single-hop transmissions, we study and compare the performance of vehicle-to-vehicle (V2V) beacon broadcasting using random access-based (IEEE 802.11p) and resource allocation-based (cellular vehicle-to-everything) protocols, and the enhancement strategies using distributed congestion control. For messages propagated in IoV using multihop V2V relay transmissions, the fundamental network connectivity property of 1-D and 2-D roads is given. To have a message delivered farther away in a sparse, disconnected V2V network, vehicles can carry and forward the message, with the help of infrastructure if possible. The optimal locations to deploy different types of roadside infrastructures, including storage-only devices and roadside units with Internet connections, are analyzed.

H. A Review paper on Traffic Load Computation for Real Time Traffic Signal Control

In [8] ,traffic load computation for real time traffic signal control system has become a challenging problem as well as them need of hour to make road traffic decent, safe, less time and fuel consuming. CCTV Cameras can prove to be a robust and sufficient solution in this direction. Images of the traffic captured with the help of CCTV Camera, can be processed to retrieve the required output about current traffic. This presents a model to count the traffic load by some parameters such as edge detection, histogram equalization, labeling and removing the noise with the help of median filter. The load computed can then be used to control the traffic signals. The main purpose of the developed algorithm is to compute total traffic load at a particular junction, which is then further used for real time traffic control by generating green light timing of the traffic signal. For computing traffic load, two data source images have to be input, one is blank road image and the other is its corresponding road image with vehicles. The two images are compared to count the number of vehicles present in the traffic load image. The load computed will then be used to control the traffic signals.

I. Design of an Intelligent Traffic Light Control System

Today[9], the number of cars is rapidly increasing which creates a real traffic control problem. While the conventional traffic control systems are inconvenient to provide fast and fair solutions for the congestion problem.This research addresses the traffic control problem and hence proposes an intelligent traffic light control system. In particular, the proposed system senses the presence or absence of cars on each lane, and then estimates the time to open each lane, which is proportional to the number of cars on that lane. Practically, the system circuit has been printed on a board with three main components: namely pressure sensors, microcontroller, and traffic lights. Then a C program has been developed to enable the microcontroller for receiving inputs from sensors, calculating the times to open lanes and sending appropriate logic decisions to traffic light. The obtained results prove the accuracy and reliability of the system. In addition to the practical test, the intelligent traffic light control system has been successfully simulated, where the simulation results are found to be the same as the calculated ones.

J. Deep Learning for Intelligent Transportation Systems: A Survey of Emerging Trends

In[10] , Wang Y. operate in a domain that is anything but simple. Many exhibit both spatial and temporal characteristics, at varying scales, under varying conditions brought on by external sources such as social events, holidays, and the weather. Yet, modeling the interplay of factors, devising generalized representations, and subsequently using them to solve a particular problem can be a challenging task. These situations represent only a fraction of the difficulties faced by modern intelligent transportation systems (ITS). In this paper, we present a survey that highlights the role modeling techniques within the realm of deep learning have played within ITS. We focus on how practitioners have formulated problems to address these various challenges, and outline both architectural and problem-specific considerations used to develop solutions. We hope this survey can help to serve as a bridge between the machine learning and transportation communities, shedding light on new domains and considerations in the future.

K. Image analysis and rule-based reasoning for a traffic monitoring system

The paper presents [11] an approach for detecting vehicles in urban traffic scenes by means of rule-based reasoning on visual data. The strength of the approach is its formal separation between the low-level image processing modules and the high-level module, which provides a general-purpose knowledge-based framework for tracking vehicles in the scene. The image-processing modules extract visual data from the scene by spatial-temporal analysis during daytime, and by morphological analysis of headlights at night. The high-level module is designed as a forward chaining production rule system, working on symbolic data, i.e., vehicles and their attributes (area, pattern, direction, and others) and exploiting a set of heuristic rules tuned to urban traffic conditions. The synergy between the artificial intelligence techniques of the high-level and the low-level image analysis techniques provides the system with flexibility and robustness. Advances in information and signal processing technologies have a significant impact on autonomous driving (AD), improving driving safety while minimizing the efforts of human drivers with the help of advanced artificial intelligence (AI) techniques. Recently, deep learning (DL) approaches have solved several real-world problems of complex nature. However, their strengths in terms of control processes for AD have not been deeply investigated and highlighted yet. This survey highlights the power of DL architectures in terms of reliability and efficient real-time performance and overviews state-of-the-art strategies for safe AD, with their major achievements and limitations. Furthermore, it covers major embodiments of DL along the AD pipeline including measurement, analysis, and execution, with a focus on road, lane, vehicle, pedestrian, drowsiness detection, collision avoidance, and traffic sign detection through sensing and vision-based DL methods. In addition, we discuss on the performance of several reviewed methods by using different evaluation metrics, with critics on their pros and cons. Finally, this survey highlights the current issues of safe DL-based AD with a prospect of recommendations for future research, rounding up a reference material for newcomers and researchers willing to join this vibrant area of Intelligent Transportation Systems.

L. Smart traffic light control system

Traffic light control systems are widely used to monitor and control the flow of automobiles through the junction of many roads. In [12] , Bilal Ghazal aim to realize smooth motion of cars in the transportation routes. However, the synchronization of multiple traffic light systems at adjacent intersections is a complicated problem given the various parameters involved. Conventional systems do not handle variable flows approaching the junctions. In addition, the mutual interference between adjacent traffic light systems, the disparity of cars flow with time, the accidents, the passage of emergency vehicles, and the pedestrian crossing are not implemented in the existing traffic system. This leads to traffic jam and congestion. We propose a system based on PIC microcontroller that evaluates the traffic density using IR sensors and accomplishes dynamic timing slots with different levels. Moreover, a portable controller device is designed to solve the problem of emergency vehicles stuck in the overcrowded roads.

M. Adaptive traffic signal control for smart cities using reinforcement learning

The self-adaptive traffic signal control system serves as an effective measure for relieving urban traffic congestion. The system is capable of adjusting the signal timing parameters in real time according to the seasonal changes and short-term fluctuation of traffic demand, resulting in improvement of the efficiency of traffic operation on urban road networks. The development of information technologies on computing science, autonomous driving, vehicle-to-vehicle, and mobile Internet has created a sufficient abundance of acquisition means for traffic data. Great improvements for data acquisition include the increase of available amount of holographic data, available data types, and accuracy. The article investigates the development of commonly used self- adaptive signal control systems in the world, their technical characteristics, the current research status of self-adaptive control methods, and the signal control methods for heterogeneous traffic flow composed of connected vehicles and autonomous vehicles. Finally, the article concluded that signal control based on multi agent reinforcement learning is a kind of closed-loop feedback adaptive control method, which outperforms many counterparts in terms of real-time characteristic, accuracy, and self-learning and therefore will be an important research focus of control method in future due to the property of “model-free” and “self-learning” that well accommodates the abundance of traffic information data. Besides, it will also provide an entry point and technical support for the development of Vehicle-to-X systems, Internet of vehicles, and autonomous driving industries. Therefore, the related achievements of the adaptive control system for the future traffic environment have extremely broad application prospects.

N. Image analysis and rule-based reasoning for a traffic monitoring system

The paper [14] presents an approach for detecting vehicles in urban traffic scenes by means of rule-based reasoning on visual data. The strength of the approach is its formal separation between the low-level image processing modules and the high-level module, which provides a general-purpose knowledge-based framework for tracking vehicles in the scene. The image-processing modules extract visual data from the scene by spatio-temporal analysis during daytime, and by morphological analysis of headlights at night. The high-level module is designed as a forward chaining production rule system, working on symbolic data, i.e., vehicles and their attributes (area, pattern, direction, and others) and exploiting a set of heuristic rules tuned to urban traffic conditions. The synergy between the artificial intelligence techniques of the high-level and the low-level image analysis techniques provides the system with flexibility and robustness . Advances in information and signal processing technologies have a significant impact on autonomous driving (AD), improving driving safety while minimizing the efforts of human drivers with the help of advanced artificial intelligence (AI) techniques. Recently, deep learning (DL) approaches have solved several real-world problems of complex nature. However, their strengths in terms of control processes for AD have not been deeply investigated and highlighted yet. This survey highlights the power of DL architectures in terms of reliability and efficient real-time performance and overviews state-of-the-art strategies for safe AD, with their major achievements and limitations. Furthermore, it covers major embodiments of DL along the AD pipeline including measurement, analysis, and execution, with a focus on road, lane, vehicle, pedestrian, drowsiness detection, collision avoidance, and traffic sign detection through sensing and vision-based DL methods. In addition, we discuss on the performance of several reviewed methods by using different evaluation metrics, with critics on their pros and cons. Finally, this survey highlights the current issues of safe DL-based AD with a prospect of recommendations for future research, rounding up a reference material for newcomers and researchers willing to join this vibrant area of Intelligent Transportation Systems.

O. IoT based traffic light control system using Raspberry Pi

Congestion in traffic is a serious issue. In [15] existing system signal timings are fixed and they are independent of traffic density. Large red light delays leads to traffic congestion. In this paper, IoT based traffic control system is implemented in which signal timings are updated based on the vehicle counting. This system consists of WI-FI transceiver module it transmits the vehicle count of the current system to the next traffic signal. Based on traffic density of previous signal it controls the signals of the next signal. The system is based on raspberry-pi and Arduino. Image processing of traffic video is done in MATLAB with simulink support. The whole vehicle counting is performed by raspberry pi.Traffic congestion is a critical issue, particularly when existing traffic signal systems have fixed timings that do not account for real-time traffic density. Prolonged red light delays can exacerbate traffic jams, leading to significant disruptions. To address this problem, an IoT-based traffic control system can be implemented where signal timings are dynamically updated based on vehicle counts. Finally, this survey highlights the current issues of safe DL-based AD with a prospect of recommendations for future research, rounding up a reference material for newcomers and researchers willing to join this vibrant area of Intelligent Transportation Systems.

P. Real-time estimation of vehicle-count within signalized links

The number of vehicles included in a metered motorway ramp or an urban signalized link at any time is valuable information for real-time control. A Kalman-Filter is employed to produce reliable estimates of this quantity based on real-time measurements of flow and occupancy provided by (at least) three loop detectors. The resulting vehicle-count estimator is tested via microscopic simulation for a variety of metered ramp scenarios and traffic conditions. Several related fundamental issues are addressed: the effects of loop density, update period, downstream signal cycle, vehicle length and link length. The simulation investigations indicate a robust estimation performance with low calibration effort needed, which facilitates easy applicability of the method.

Q. Automatic vehicle counting using Raspberry pi and background subtractions method in the Stoll road

Traffic density can be controlled by acquiring and managing the volume data of the vehicle on the highway. Currently, the vehicle density calculating still use mechanical equipment or assign some people to calculate the vehicle, which passes the highway. However, the equipment is costly and requires many operators for manual counting. Therefore It is needed equipment that can calculate the traffic density precisely and adequately but also not expensive. This research made a simple system by using a raspberry pi, OpenCV, and Background Subtraction Method. This experiment also used real conditions in the Sidoarjo Toll Road. The experiment found that the accuracy of counting highest in the morning with an accuracy of 92.3%. Therefore the lowest accuracy result found in the afternoon counting process with accuracy 77.3%.

R. Smart Density Based Traffic Light System

In [18] today's life we have to face many problems, one of which being traffic congestion and it's becoming more serious day after day. Conventional traffic system does not have proper monitoring system and often requires manual handing at traffic junction. This not only causes mental stress in passengers but also lot of fuel goes wasted due to delay at traffic junction. This requires development of a system to handle traffic in a smart way by automatically adjusting its timing based on traffic density using Arduino Uno ATMega 328. In this, traffic is sense using digital IR Sensors and IR Sensors detect vehicles further based on the signal reflected from them. Sensors placed adjacent to the road to control the traffic density by changing traffic signal appropriately. All IR Sensors are interfaced with Arduino Uno and it reads data from IR Sensors. Traffic Signal for the system is designed using LEDs and each signal consist two LEDs for each lane. Using this system development at traffic junction we need not to worry about handing the traffic manually and also consumes less time as compared to the conventional traffic system.

2.2 Research Gaps

Table 2.1 Research Gaps

Name	**Research Gaps**
Abbas et al. (2013)	Focuses solely on lane-specific traffic density assessment, lacking real-time traffic

	management and emergency vehicle prioritization features
Firdous et al.	Lacking the accuracy and versatility of image processing-based methods.
Vigos et al.	Focuses solely on vehicle count estimation within signalized links using loop detectors
Basil and Sawant	It does not utilize advanced technologies like RCNN, OpenCV, and NodeMCU controller.
Cucchiara et al.	Focuses on vehicle detection and tracking using rule-based reasoning, which may not be as adaptable or scalable as the deep learning-based approach
Jadhav et al.	Reliance on web cameras for traffic monitoring, which may not provide real-time data or the same level of accuracy as the proposed system using RCNN, OpenCV, and NodeMCU controller.
Thakare et al.	Lacking the real-time

	monitoring and accuracy of image processing-based methods like RCNN and OpenCV in your research
Chowdhury et al.	Focuses on traffic density measurement at intersections using image processing but lacks real-time traffic management or emergency vehicle prioritization features, as proposed in your research
Ni et al.	Focuses on wireless transmissions and resource management for Internet of Vehicles without specific emphasis on real-time traffic management
Kanojia	Lacking the comprehensive approach of using advanced image processing techniques like RCNN, OpenCV, and NodeMCU controller for real-time traffic management.

2.3 Problem Formulation

The problem formulation for the project could be stated as follows:

"Increasing traffic congestion on roads leads to significant time wastage and stress for commuters, while also posing challenges for emergency vehicles trying to navigate through traffic. This project aims to develop a smart traffic management system that uses RCNN (Region-based Convolutional Neural Network), webcam, NodeMCU controller, LEDs, and OpenCV to automate traffic signal control based on real-time traffic density information. The system will detect and count vehicles on each lane using RCNN and OpenCV, adjust traffic signal timings accordingly to optimize traffic flow, and provide a green light for emergency vehicles detected in the vicinity to ensure their timely passage. By addressing these issues, the system aims to improve overall traffic efficiency and emergency response times, ultimately enhancing road safety and reducing travel time for commuters.

CHAPTER 3

PROPOSED SYSTEM

3.1 Proposed System

The goal of traffic management is to minimize other effects of the current road network while maximizing efficiency of the traffic structure without any issues. The system is improving upon the shortcomings of earlier traffic management frameworks. The mechanism uses automobiles' traffic density as determined by camera input, which is separated from pictures of cars. We have issues in the modern world because of the rise in traffic on the roads. This raises stress levels and results in significant time waste. Many emergency vehicles get caught in traffic for hours at a time, which results in fatalities. This calls for the creation of a system that uses RCNNs (Region based Convolutional Neural Networks), webcams, NodeMCU controllers, and LEDs to handle traffic in an intelligent manner by automatically adjusting its timing based on traffic density and provide passage for ambulances . The NodeMCU microcontroller receives images from the webcam that show the cars on the road. We then use the RCNN algorithm and OpenCV to count the number of cars in each lane and adjust traffic timing accordingly. If an ambulance is seen in the road. When an ambulance is spotted, the traffic light on that side turns green, and the other side turns red to allow emergency vehicles to pass. Emergency vehicles, like ambulances, often get stuck in traffic, leading to potentially fatal delays. To address these challenges, the proposed system employs RCNNs (Region-based Convolutional Neural Networks), webcams, NodeMCU controllers, and LEDs to intelligently manage traffic. The NodeMCU microcontroller receives images from webcams that capture real-time footage of the road. Using RCNN and OpenCV, the system analyzes these images to count the number of cars in each lane and adjust traffic signal timings accordingly. Additionally, when an ambulance is detected, the system prioritizes its movement by turning the traffic light green on its side and red on others, ensuring that emergency vehicles can pass through without delay. This system aims to improve upon the shortcomings of earlier traffic management frameworks by using real-time traffic density data obtained from camera inputs.

The flow chart as shown in figure 1 above is described in the following steps:

STEP 1: Start

STEP 2: Camera capturing real-time images of vehicles as shown in Fig 2. Sending theseimages to NodeMCUController.

STEP 3: If an ambulance is detected then green that lane and the other three lanes keep reduntil it passes otherwise go to step 4.

STEP 4: Count incremented.

STEP 5: Check if the previous lane is green then go to the next step otherwise go to step 4.

STEP 6: Stop count calculates time delay depends on vehicle count and value is store in thememory.

STEP 7: Assign delay value to green light and clear the count value and go to step 2.

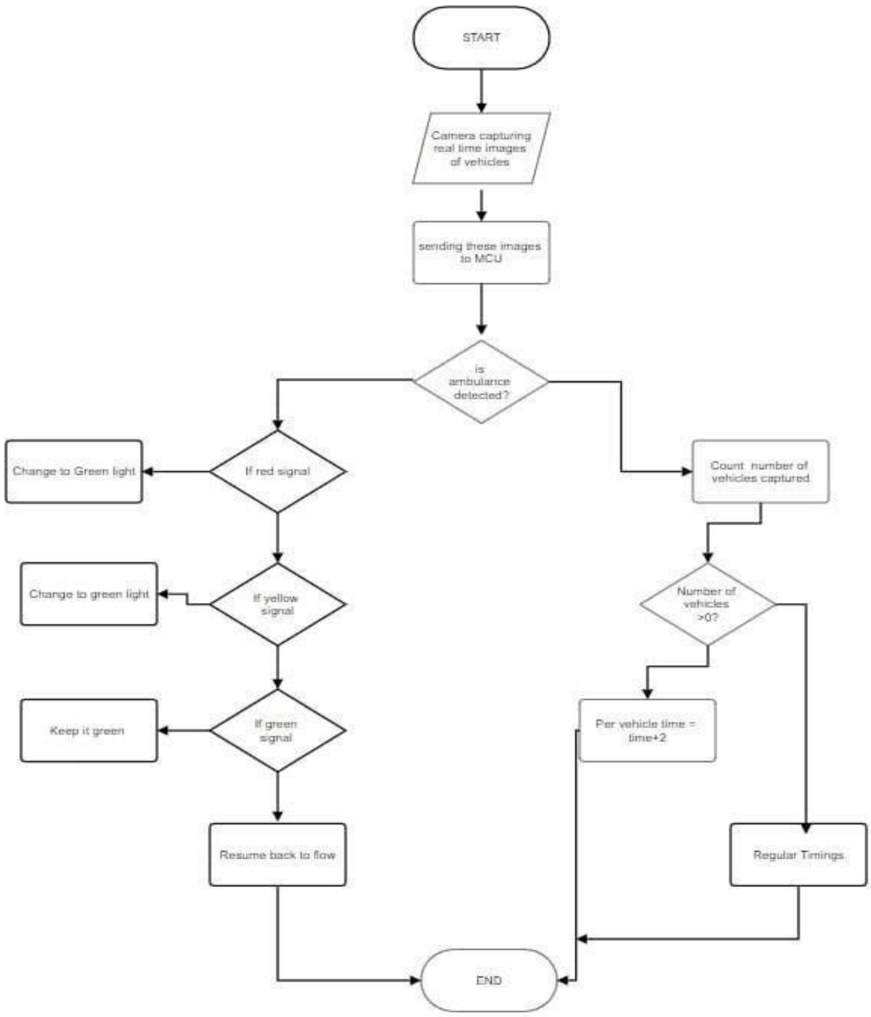

Figure3.1:Flowchart

3.2 Unique Features of The System

In response to the pressing challenges posed by escalating traffic congestion, this abstract presents a novel approach to traffic management that stands out for its innovative features. Our system harnesses the power of RCNN (Region-based Convolutional Neural Network), webcam technology, and NodeMCU controllers, augmented by LED signaling, to create an intelligent traffic management solution. What sets our system apart are its unique capabilities. By dynamically assessing traffic volume in real-time and employing advanced algorithms, our system autonomously adjusts signal timings to optimize traffic flow. Moreover, a standout feature lies in its ability to prioritize emergency vehicle passage. Upon detection of an ambulance, the system promptly transitions the traffic signal to green on the corresponding lane while halting traffic on other lanes, ensuring swift and unhindered passage for emergency vehicles.

This proactive approach not only enhances safety and efficiency but also addresses the critical need to reduce response times for emergency services. By seamlessly integrating cutting-edge technologies, our system represents a significant advancement in mitigating the adverse effects of urban traffic congestion and improving overall traffic management strategies.

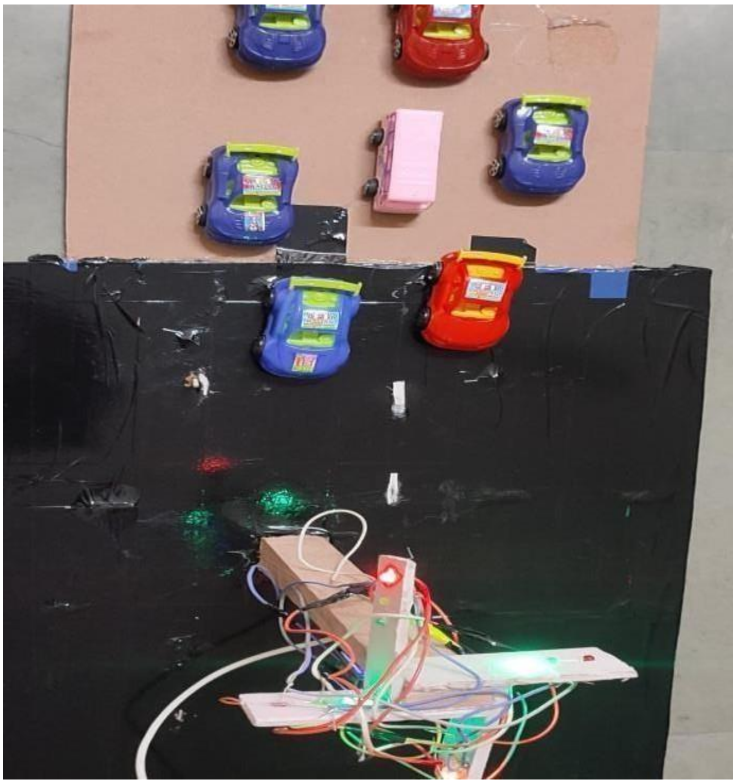

Figure 3.2: Proposed System

Table 3.1 Unique Features (Comparison Table)

Metrics System	RFID Reader	Arduino Uno	Node Mcu Controller	RCNN	Cost	Power Consumption
Smart Ambulance Traffic Control System	Yes	No	No	No	High	High
Density Based Traffic Control System with smart Sensing of Emergency Vehicle	Yes	No	No	No	High	High
Smart Traffic Control with Ambulance Detection	No	Yes	No	No	High	High
Smart Density Based Traffic Light System	No	Yes	No	No	High	High
Proposed System	No	No	Yes	Yes	Low	Low

CHAPTER 4

REQUIREMENT ANALYSIS AND SYSTEM SPECIFICATION

4.1 Feasibility Study (Technical, Economical, Operational)

The feasibility study for the smart traffic management system evaluates its technical, economical, and operational aspects to determine its viability and potential success.

A. Technical Feasibility:

Hardware Compatibility: Ensure that the system components (e.g., webcam, NodeMCU controller) are compatible and capable of performing the required tasks.

Software Compatibility: Verify that the software components (e.g., OpenCV, TensorFlow) can be integrated and function as intended.

Scalability: Determine if the system can scale to handle increased traffic and additional lanes or intersections.

Reliability: Assess the system's reliability in accurately detecting vehicles, adjusting traffic signals, and providing priority passage for emergency vehicles.

B. Economical Feasibility:

Cost-Benefit Analysis: Evaluate the costs associated with developing, implementing, and maintaining the system against the potential benefits, such as reduced traffic congestion and improved emergency vehicle response times.

Return on Investment (ROI): Determine if the system's benefits outweigh its costs over the long term.

Budget Considerations: Ensure that the project fits within the allocated budget and financial constraints.

C. Operational Feasibility:

User Acceptance: Assess the willingness of users (e.g., traffic authorities, commuters) to adopt and use the system.

Training Requirements: Determine the training needs for operating and maintaining the system.

Legal and Regulatory Compliance: Ensure that the system complies with relevant laws and regulations governing traffic management and data privacy.

4.2 Software Requirement Specification

4.2.1 Data Requirement

Developing an intelligent traffic management system necessitates a detailed understanding of its diverse data requirements, each playing a crucial role in its effective operation.

First and foremost, real-time traffic data forms the backbone of the system. This includes information such as vehicle counts, speed, lane occupancy, and classifications, sourced from sensors, cameras, and other monitoring devices strategically placed at intersections and along roadways. These data points provide invaluable insights into current traffic conditions, enabling the system to dynamically adjust signal timings and optimize traffic flow in response to changing demand.

Complementing real-time traffic data is the information related to emergency vehicles. This includes the real-time location of emergency vehicles, such as ambulances, as well as their priority status. By integrating this data, the system can ensure the swift and unobstructed passage of emergency vehicles through intersections, potentially saving lives during critical medical emergencies.

Geographical information is also essential for the system to function effectively. This includes detailed maps of road networks, intersection layouts, and traffic signal locations. With this geographical data, the system can accurately determine optimal routes for emergency vehicles, as well as strategically adjust traffic signal timings to alleviate congestion and improve overall traffic flow.

Furthermore, historical traffic patterns offer valuable insights into past traffic trends and congestion levels. By analyzing historical data, the system can identify recurring congestion hotspots, predict traffic patterns during peak hours, and make informed decisions about signal timing adjustments and traffic management strategies.

Machine learning plays a pivotal role in vehicle detection and classification within the system. Training data for machine learning models, such as the RCNN, consists of annotated datasets containing images or videos of traffic scenes labeled with vehicle positions, types, and counts. This training data is essential for accurately detecting and classifying vehicles in real-time, enabling the system to make data-driven decisions about traffic signal adjustments and emergency vehicle prioritization.

Additionally, traffic signal configuration data provides the system with crucial information about signal timings, phases, and sequences. Emergency vehicle priority rules dictate how the system should prioritize emergency vehicles at intersections, ensuring that they receive expedited passage through traffic signals when necessary.Environmental data, including weather conditions and air quality metrics, further informs the system's decision-making process. By considering environmental factors, the system can assess the impact of traffic congestion on air quality and public health, and adjust traffic management strategies accordingly.

Finally, performance metrics and user feedback play a vital role in continuously refining and optimizing the system. Performance metrics, such as traffic flow efficiency and average response times for emergency vehicles, provide valuable insights into the system's effectiveness and reliability. User feedback, obtained through surveys, feedback forms, and system logs, helps identify areas for improvement and informs future enhancements to the system's functionality and user experience.

By integrating these diverse data requirements into the intelligent traffic management system, it can effectively mitigate congestion, prioritize emergency response, and enhance overall traffic management efficiency, ultimately improving the safety and efficiency of urban transportation systems.

4.2.2 Functional Requirements

- **Description:** The system shall detect and count vehicles, adjust traffic signals based on traffic density, and prioritize emergency vehicles.

- **Use Case Scenarios:** User observes traffic flow on the user interface and system detects an emergency vehicle and prioritizes its passage.

- **User Interaction and Interfaces:** The system will have a user interface for monitoring traffic conditions and controlling traffic signals.

- **Input and Output Requirements:** Input will be from webcams and user interface. Output will be traffic signal control commands.

- **Error Handling and Recovery:** The system shall handle errors such as lost connection to webcams and recover graceful.

4.2.3 Performance Requirements

The performance requirements for the intelligent traffic management system encompass several critical benchmarks that ensure its efficacy and reliability in addressing traffic congestion and facilitating emergency vehicle passage. Foremost, the system must exhibit swift real-time processing, analyzing incoming traffic data and emergency vehicle information with minimal latency, ideally within milliseconds. Additionally, the accuracy of vehicle detection and classification by machine learning models is paramount, necessitating a minimum accuracy rate of 95%. Responsiveness in dynamically adjusting traffic signal timings is crucial, with signal adjustments expected within seconds of detecting changes in traffic density to optimize flow and alleviate congestion. Emergency vehicle priority response time is equally vital, mandating that these vehicles receive a green-light pathway within 5 seconds of approaching an intersection, thereby minimizing response times during emergencies. System availability and reliability are foundational, requiring a minimum uptime of 99.9% to ensure uninterrupted operation. Scalability is also imperative, with the system capable of supporting at least 1000 intersections without performance degradation. Furthermore, the system should contribute to reducing environmental impact by decreasing overall traffic congestion and idling times by at least 20%, thereby reducing emissions and pollution. The user interface should be responsive and intuitive, with interactions having a response time of less than 1 second to enhance user experience. Adaptability to changing conditions, compliance with regulatory standards, and continuous improvement are additional pillars underpinning the system's performance requirements. Through meeting and exceeding these benchmarks, the intelligent traffic management system can effectively optimize traffic flow, prioritize emergency response, and enhance overall transportation efficiency, fostering safer and more efficient urban environments.

4.2.4 Maintainability Requirements

Maintainability requirements outline the criteria and processes necessary to ensure that the intelligent traffic management system can be effectively maintained, updated, and enhanced over its operational lifecycle. Here's a paragraph detailing maintainability requirements:

The maintainability of the intelligent traffic management system is essential to ensure its long-term functionality and adaptability to evolving needs. A key requirement is the establishment of clear documentation, including system architecture, codebase, and operational procedures, to facilitate ease of understanding and modification by maintenance personnel. Additionally, the system should be designed with modularity and encapsulation principles, allowing for isolated updates or replacements of components without disrupting the entire system. Regular maintenance schedules and protocols should be established to address hardware and software updates, bug fixes, and security patches promptly. Furthermore, the system should incorporate automated testing suites to validate changes and ensure system integrity post-maintenance. In the event of system failures or issues, robust logging and monitoring mechanisms should be in place to aid in troubleshooting and diagnosis. Finally, a dedicated support and training program should be provided to maintenance personnel to ensure proficiency in system operation and maintenance tasks. By adhering to these maintainability requirements, the intelligent traffic management system can remain agile, resilient, and responsive to the changing demands of urban transportation environments.

4.2.5 Security Requirements

The Smart Traffic Management System incorporates several security measures to protect against unauthorized access and ensure the safety of traffic data. Access control is enforced through strict measures to prevent unauthorized access to sensitive data and system functionalities. All data transmitted and stored by the system is encrypted to protect it from unauthorized access. Secure communication protocols are used to ensure that data exchanged between system components is not intercepted or tampered with. Users and system components are authenticated and authorized before accessing sensitive data or performing critical operations. Data stored by the system is stored securely to prevent unauthorized access or data breaches. The system maintains logs of all user and system activities for auditing and monitoring purposes. Backup and recovery mechanisms are in place to protect data in case of system failures or disasters. The system receives regular security updates to protect against new vulnerabilities and threats. Users of the system receive training on security best practices to prevent security breaches. Physical access to system components is restricted to prevent unauthorized access. These security measures ensure the integrity and confidentiality of traffic data and the overall security of the system.

4.3 SDLC Model to Be Used

The Smart Traffic Management System will follow the Agile software development methodology. Agile is chosen for its iterative and incremental approach, allowing for flexibility and adaptability to changing requirements. This model will enable the development team to deliver a functional product quickly and incrementally, while also incorporating feedback from stakeholders throughout the development process. The Agile methodology's emphasis on collaboration and customer involvement aligns well with the dynamic nature of the project, ensuring that the final product meets the needs and expectations of its users.

4.4 System Design

4.4.1 System Design Using DFD Level 0 and Level 1

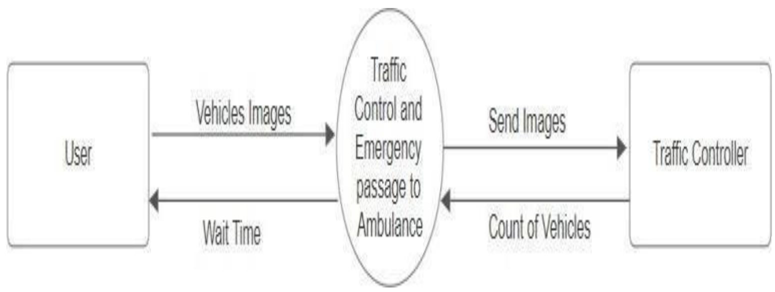

Figure 4.1: DFD Level 0

The Level 0 Data Flow Diagram (DFD) provides a high-level overview of the primary processes and data flows between the system and external entities. The system includes several key components: traffic cameras, traffic signals, emergency vehicles, and the Traffic Management Center (TMC). Traffic cameras continuously capture real-time video feeds of the intersection and send these feeds to the system for processing.

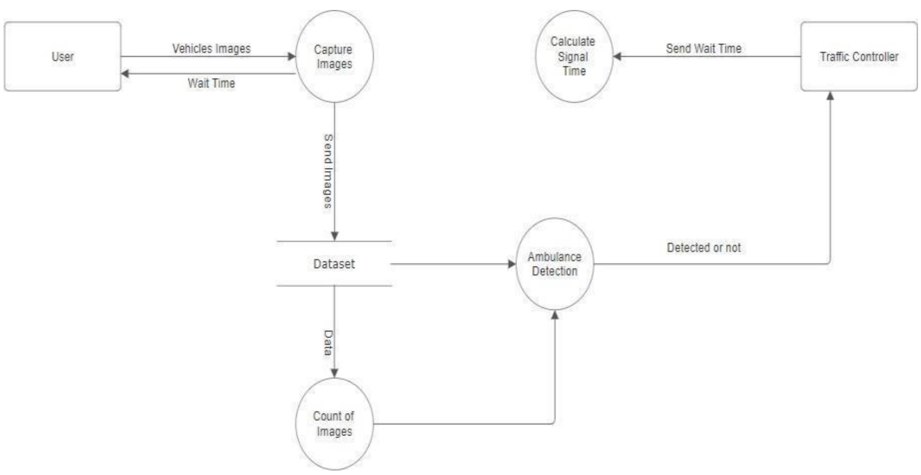

Figure 4.2: DFD Level 1

The Level 1 Data Flow Diagram (DFD) expands on the processes outlined in the Level 0 DFD, providing a more detailed view of how the system captures and processes video feeds, detects ambulances, generates alerts, and controls traffic signals.

Firstly, traffic cameras capture real-time video feeds, which are then sent to the Preprocess Video Feed module. Here, the video feeds are enhanced and prepared for further processing. The preprocessed video is then fed into the Detect Ambulance (RCNN) module, which utilizes the RCNN algorithm to analyze the frames and identify ambulances.

If an ambulance is detected, the process continues to the Generate Alert module, which sends an alert to the Traffic Management Center (TMC), informing them of the ambulance's presence and location. Simultaneously, the Control Traffic Signals module dynamically adjusts the traffic signals at the intersection. This adjustment involves turning the traffic light green on the side where the ambulance is detected and setting all other directions to red, ensuring a clear path for the ambulance to pass through the intersection safely.

Data stored by the system is stored securely to prevent unauthorized access or data breaches. The system maintains logs of all user and system activities for auditing and monitoring purposes. Backup and recovery mechanisms are in place to protect data in case of system failures or disasters. The system receives regular security updates to protect against new vulnerabilities and threats. Users of the system receive training on security best practices to prevent security breaches. Physical access to system components is restricted to prevent unauthorized access. These security measures ensure the integrity and confidentiality of traffic data and the overall security of the system.

4.4.2 Use Case Diagram

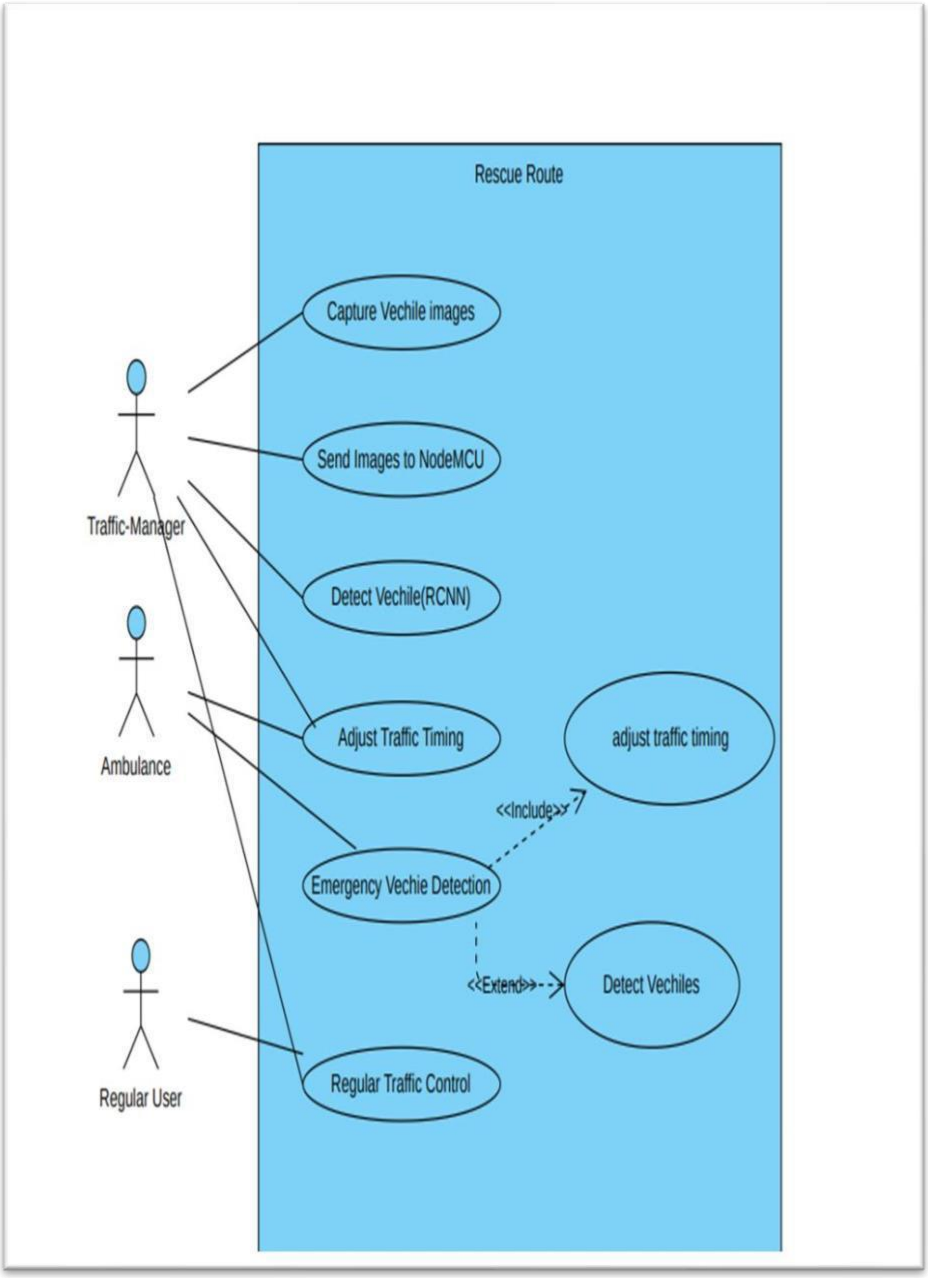

Figure 4.3 : Use Case Diagram

The Use Case Diagram for the emergency vehicle detection and traffic signal control system depicts interactions between system actors and functionalities.It outlines how users, such as emergency vechiles and traffic signals, engage with the system to facilitate efficient traffic management and prioritize emergency response.

4.4.4 ER Diagram

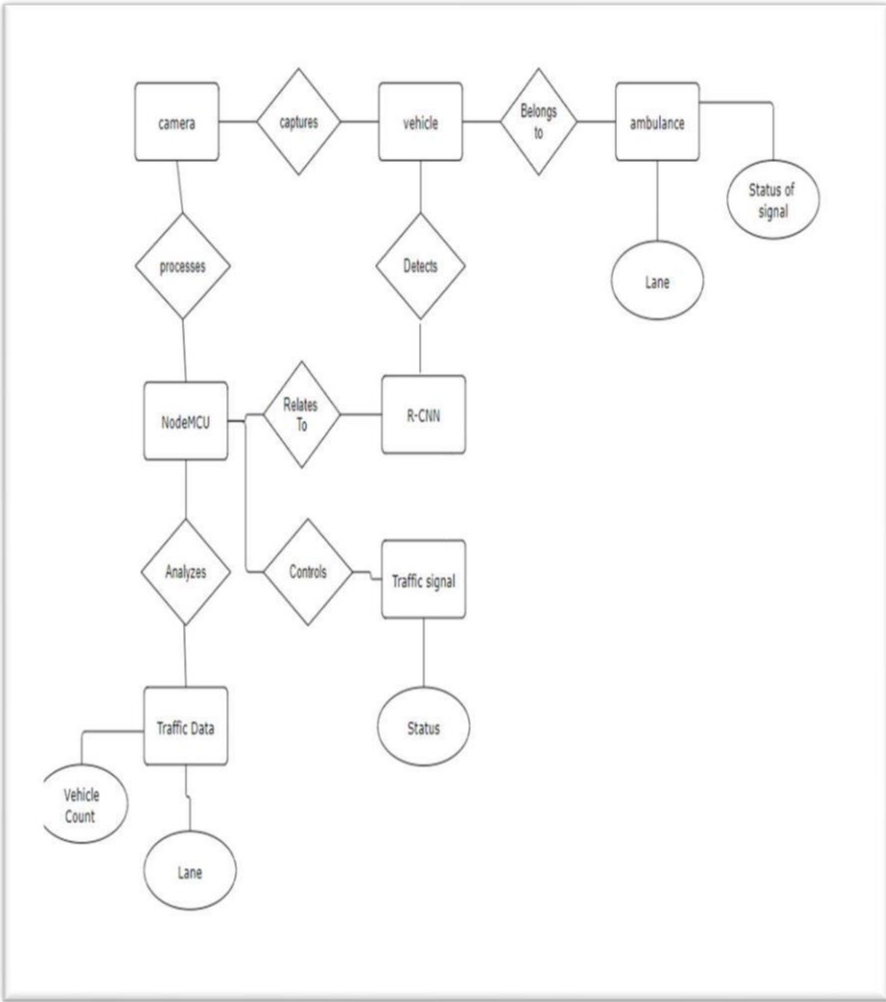

Figure 4.4: ER Diagram

An Entity-Relationship (ER) Diagram visually illustrates system and their relationships, crucial for designing database structures. It serves to identify core components and their interconnections, aiding in database modeling. By depicting entities as tables and relationships as lines between them, it showcases how data entities relate to each other, whether through associations, dependencies, or contraints.ER diagrams provide a blueprint for database design, highlighting entity attributes and their cardinality in relationships. This graphical representation facilitates understanding and communication.

CHAPTER 5

IMPLEMENTATION

5.1 Introduction to Languages, Tools and Technologies Used for Implementation.

The smart traffic management system utilizes a combination of languages, tools, and technologies to achieve its goals:

A,Programming Languages:

- **Python:** Used for implementing the RCNN (Region-based Convolutional Neural Network) algorithm and for image processing tasks using OpenCV.
- **C/C++:** Used for programming the NodeMCU controller to control the traffic signals and interface with the webcam and LEDs.

B. Tools and Libraries:

- **OpenCV:** An open-source computer vision and machine learning software library used for image processing tasks such as vehicle detection and counting.
- **TensorFlow or PyTorch:** Deep learning frameworks that can be used to implement the RCNN algorithm for vehicle detection.
- **Arduino IDE:** Used for programming the NodeMCU controller, which is based on the ESP8266 chip, to control the traffic signals and interface with other components.

C. Technologies:

- **RCNN (Region-based Convolutional Neural Network):** A deep learning algorithm used for object detection, in this case, for detecting vehicles in images captured by the webcam.

- **NodeMCU Controller:** A low-cost open-source IoT platform based on the ESP8266 Wi-Fi module, used for controlling the traffic signals and communicating with other components of the system.
- **Webcam:** Used for capturing images of the traffic flow, which are then processed to detect vehicles and assess traffic density.
- **LEDs:** Used as the traffic signals to control the flow of vehicles based on the decisions made by the system.

D. Networking:

- **Wi-Fi:** The NodeMCU controller communicates with the webcam and other components over a Wi-Fi network, enabling real-time data transfer and control.

E. Software Development:

- **Integrated Development Environments (IDEs):** Used for writing and debugging code, such as PyCharm or Visual Studio Code for Python, and Arduino IDE for programming the NodeMCU controller.

F. Image Processing Techniques:

- **Background Subtraction**: A technique used to distinguish moving vehicles from the static background in the traffic video feeds. This helps in accurately counting the number of vehicles passing through an intersection.
- **Object Detection:** Algorithms such as RCNN (Region-based Convolutional Neural Network) are employed to detect and classify vehicles in the video frames. These advanced machine learning models provide high accuracy in identifying different types of vehicles.

CHAPTER 6

TESTING AND MAINTENANCE

6.1 TESTING TECHNIQUES AND TEST CASES USED

Testing techniques and test cases are crucial for ensuring the effectiveness and reliability of the smart traffic management system. Here are some testing techniques and test cases that could be used:

A.**Functional Testing:**

Test Case: Verify that the system can detect vehicles in images captured by the webcam.

Test Case: Ensure that the traffic lights change according to the detected traffic density.

B. Performance Testing:

Test Case: Evaluate the system's response time in detecting vehicles and adjusting traffic lights.

Test Case: Measure the system's ability to handle a high volume of traffic data.

C. Integration Testing:

Test Case: Verify that the NodeMCU controller can communicate with the webcam and other components.

Test Case: Ensure that the RCNN algorithm integrates correctly with the overall system.

D. Usability Testing: Test Case: Evaluate the system's user interface for ease of use and understandability.

E. Reliability Testing: Test Case: Test the system's ability to operate consistently over an extended period.

F. Security Testing: Test Case: Ensure that the system is protected against unauthorized access and data breaches.

Table 6.1. Test Cases

TEST CASE	EXPECTED RESULT	OUTCOME
Normal Traffic Handling	Smooth traffic flow	Pass
Heavy Traffic Handling	Longer green time for the side with heavy traffic.	Pass
No Traffic Detection	Traffic lights follow a preset timing schedule.	Pass
Ambulance Detection	Traffic light on the side with the ambulance turns green.	Pass
Ambulance Detection Priority	Prioritize the ambulance over regular vehicles.	Pass
Ambulance Detection with Obstacles	Detect the ambulance and provide it with a green light.	Fail
Vehicle similar to ambulance	Not detect it as ambulance	Fail

Network Connectivity	Handle the situation gracefully without crashing.	Pass
False Positives	Implement a mechanism to filter out false positives.	Pass
System Recovery	Recover and resume normal operation.	Fail
Communication Failures	Handle communication errors gracefully	Pass
Vehicle count	Time delay according to traffic density	Pass
Overlapping Vehicles	Accurately count each vehicle, even if they overlap partially.	Fail
Environmental Disturbances	Adapt and maintain accurate vehicle counting.	Fail

CHAPTER 7

RESULTS AND DISCUSSIONS

7.1 Representation of Results

This work's primary goal is to manage traffic sensibly both in regular and emergency situations by following the architecture as shown in Fig 7.1. Thus, the system is constructed. At the end, the right results are obtained for the particular condition. The test cases are displayed beneath.

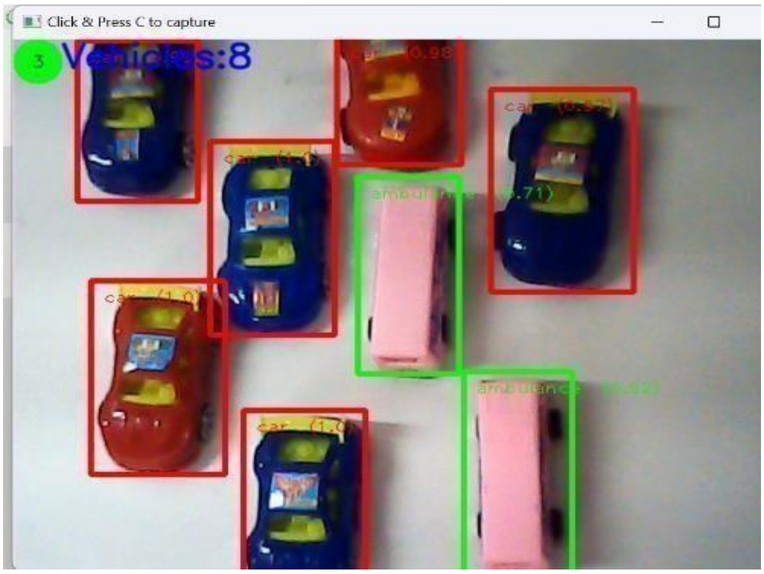

Figure 7.1 : Trained Models

A. If there is Heavy Traffic Jam

If there is heavy traffic then using RCNN(Object Detection Algorithm) tally the number of automobiles based on the vehicle’s count green light is delayed by two seconds for each vehicle by the microcontroller. Ifthere is no vehicle on the road the traffic light will be set to 15 seconds for each side. Ifthere is no vehicle on the road the traffic light will be set to 15 seconds for each side. The traffic light on the side where the ambulance is detected is turned green, while all other directions are set to red, ensuring a clear path for the ambulance. This priority adjustment remains in effect until the system confirms that the ambulance has safely passed the intersection. Continuous monitoring ensures that the ambulance's progress is tracked through subsequent frames.

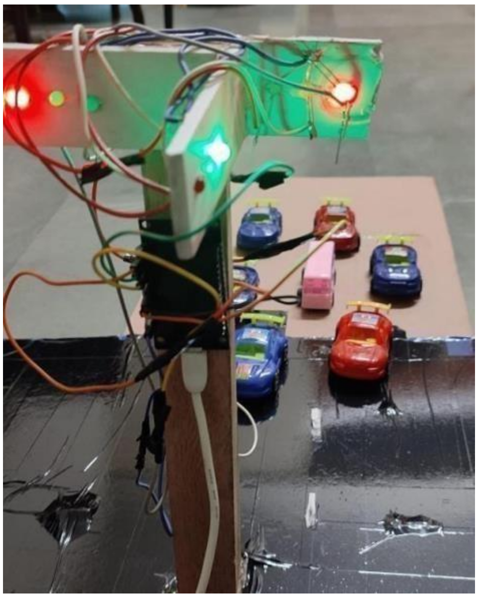

Figure 7.2. Proposed System

B. If Ambulance Arrives

The detection process begins with real-time video feeds captured by traffic cameras installed at intersections. Each frame of the video feed is preprocessed to enhance image quality, preparing it for object detection. An RCNN (Region-based Convolutional Neural Network) processes these frames to identify ambulances. The RCNN is trained to recognize specific features unique to ambulances, such as shape, color, and markings. Once an ambulance is detected, the system generates an alert, indicating the presence and location of the emergency vehicle. Upon detection, the system immediately interrupts the current traffic signal cycle, overriding normal operation. The traffic light on the side where the ambulance is detected is turned green, while all other directions are set to red, ensuring a clear path for the ambulance. This priority adjustment remains in effect until the system confirms that the ambulance has safely passed the intersection. Continuous monitoring ensures that the ambulance's progress is tracked through subsequent frames. Once the ambulance has passed, the system resumes its normal operating mode, reinstating the predefined traffic signal schedule and dynamic adjustments based on real-time traffic density. This approach not only facilitates the swift passage of emergency vehicles but also minimizes disruption to regular traffic flow, enhancing overall traffic management efficiency and safety.

7.2 Performance Evaluation

Table 7.1. Comaparison Table

Metrics System	**RFID Reader**	**Arduino Uno**	**Node Mcu Controller**	**RCNN**	**Cost**	**Power Consu mption**
Smart Ambulance Traffic Control System	Yes	No	No	No	High	High
Density Based Traffic Control System with smart Sensing of Emergency Vehicle	Yes	No	No	No	High	High
Smart Traffic Control with Ambulance Detection	No	Yes	No	N	High	High
Smart Density Based Traffic Light System	No	Yes	No	No	High	High
Proposed System	No	No	Yes	Yes	Low	Low

7.3 Key Findings

Traffic congestion is a significant problem exacerbated by population growth and increasing vehicle numbers, leading to wasted time and stress for commuters, and hindering emergency vehicle response times.

The paper proposes an intelligent traffic management system utilizing RCNN, OpenCV, and NodeMCU controllers to dynamically adjust traffic signal timings based on real-time traffic density and prioritize emergency vehicle passage.

Components used in the system include NodeMCU controllers, LEDs for traffic signal indication, and RCNN for vehicle detection and counting, enabling real-time traffic monitoring and management.

A literature survey highlights existing approaches to intelligent traffic management, informing the development of the proposed system and identifying areas for innovation.

The methodology involves integrating RCNN and OpenCV for vehicle detection, NodeMCU controllers for data processing and signal control, and LEDs for traffic signal indication, as depicted in the flowchart diagram. Results demonstrate the system's effectiveness in managing traffic flow under different conditions, including heavy congestion and emergency vehicle arrival, leading to improved road safety and efficiency.The paper concludes that the proposed system offers a cost-effective and efficient solution to traffic congestion and emergency vehicle prioritization, contributing to the field of intelligent transportation systems.Components used in the system include NodeMCU controllers, LEDs for traffic signal indication, and RCNN for vehicle detection and counting, enabling real-time traffic monitoring and management. To tackle these issues, the system utilizes advanced technologies such as RCNN, OpenCV, and NodeMCU controllers. RCNN is employed for vehicle detection and counting, providing accurate real-time traffic density information. OpenCV is used for image processing tasks, enhancing the system's ability to detect vehicles and analyze traffic patterns. NodeMCU controllers are responsible for data processing and traffic signal control, enabling the system to dynamically adjust signal timings based on the traffic conditions detected by RCNN and OpenCV.

The system's methodology involves integrating these technologies to create a seamless traffic management solution. RCNN and OpenCV work together to detect vehicles and analyze traffic flow, while NodeMCU controllers process this information and control the traffic signals accordingly. LEDs are used for traffic signal indication, providing clear signals to drivers and pedestrians.

CHAPTER 8

CONCLUSION AND FUTURE SCOPE

In conclusion, the smart traffic management system presented in this project offers a promising solution for optimizing traffic flow and improving emergency vehicle response times. By leveraging technologies such as RCNN, webcam, NodeMCU controller, LEDs, and OpenCV, the system automates traffic signal control based on real-time traffic density information. This automation reduces the need for manual intervention, making the system more efficient and responsive to changing traffic conditions. The system's ability to detect and prioritize emergency vehicles, such as ambulances, by automatically adjusting traffic signals demonstrates its potential to save lives. Furthermore, its cost-effectiveness, simple installation, and balance of accuracy and speed make it a viable solution for urban traffic management.

In future Scope we can expand the smart traffic management system to encompass all four lanes presents an exciting array of future opportunities for enhancing traffic efficiency and safety. Implementing lane-specific traffic management capabilities would allow for tailored strategies on each lane, potentially reducing congestion and improving overall flow. Advanced vehicle detection technology could further enhance the system's ability to differentiate between vehicle types, enabling more nuanced traffic management strategies. Additionally, integrating speed sensors and variable speed limit signs could dynamically adjust speed limits based on real-time traffic conditions, promoting smoother traffic flow and reducing the likelihood of accidents.

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GITHUB LINK : https://github.com/KIET-Github/CS-2024-B/tree/main/PCS24-40-KhushiVaish

Research Paper (Acceptance Proof)

(Paper id : 173) Acceptance of paper for 4th International Conference on Computational Methods in Science and Technology ICCMST 2024

Inbox

Microsoft CMT Mar 28

to me

Dear Dr./Mr./Ms. Akanksha Chaudhary,

Congratulations!!!

As per reviewer's comment, on behalf of the ICCMST 2024 program committee and technical committee, we are very pleased to inform you that Submission id : 173 with Title:- Enhancing Urban Mobility and Providing Way for Ambulance Using Machine Learning has been accepted with minor revisions as a REGULAR paper for presentation at the 4th International Conference on Computational Methods in Science and Technology dated 2nd - 3rd May 2024.

Comments
1. Reference citation in literature is not as per format of Taylor and Francis.
2. Cite reference in dataset section from where dataset is collected as per format of Taylor and Francis.
3. Add proposed model if any.
4. Remove third party images if any.
5. Cite all the figures, tables, equations.

Research Paper (Certificate)

ICCMST

CHANDIGARH GROUP OF COLLEGES

NAAC GRADE A+

Cert id: CEC/ICCMST/2024/754

Certificate

This is to certify that ***Akanksha*** from ***KIET Group of Institutions, Delhi-NCR, Ghaziabad*** has presented paper titled ***Enhancing Urban Mobility and Providing Way for Ambulance Using Machine Learning*** in the 4th International Conference on Computational Methods in Science & Technology *(ICCMST-2024)* held on 2nd and 3rd May 2024 at Chandigarh Engineering College - CGC Landran, Mohali.

Dr. Amanpreet Kaur *General Co-Chair*	**Dr. Sukhpreet Kaur** *General Co-Chair*	**Dr. Rajdeep Singh** *Executive Chair*

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Certificate

This is to certify that ***Kashish Gupta*** from ***KIET Group of Institutions, Delhi-NCR, Ghaziabad*** has presented paper titled ***Enhancing Urban Mobility and Providing Way for Ambulance Using Machine Learning*** in the 4th International Conference on Computational Methods in Science & Technology *(ICCMST-2024)* held on 2nd and 3rd May 2024 at Chandigarh Engineering College - CGC Landran, Mohali.

Dr. Amanpreet Kaur *General Co-Chair*	**Dr. Sukhpreet Kaur** *General Co-Chair*	**Dr. Rajdeep Singh** *Executive Chair*

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Enhancing Urban Mobility and Providing Way for AmbulanceUsing Machine Learning

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Abstract - In today's world we have been facing problems due to increasing traffic on roads. This causes a lot of waste of time and increases stress level. So, this leads for creating a system which can intelligently handle traffic by itself modifying its timing in response to traffic density provide passage for ambulances using RCNN(Region-based Convolutional Neural Network), webcam, NodeMCU controller, LEDs. The core idea revolves around traffic management through the assessment of traffic volume on each side of the road, with the aim of implementing smart traffic signal control based on this density information. The webcam captures real-time images of the

automobiles on the road and send images to the NodeMCU microcontroller and then we apply RCNN algorithm and OpenCV to recognize and tally the count of automobiles on the lane and set traffic timing accordingly. If ambulance is detected traffic light turns green on that side and other side are turn red to provide passage for emergency vehicle

Keyword* – *Traffic Light System, RCNN, OpenCV, NodeMCU controller, Ambulance, SaveLive

I.INTRODUCTION

One of the pressing issues exacerbated by the world's growing inhabitants and the swift increase in the count of automobiles is traffic blockage. In countries like India, the estimate of expanding lane infrastructure lags far behind the rate of vehicle growth[1]. Traffic jams give rise to numerous critical problems that have a direct impact on people's daily lives and, in some cases, even lead to loss of life[2]. For instance, when an emergency vehicle such as an ambulance is transporting a critically ill patient, being trapped in a heavy traffic jam significantly reduces the chances of the patient reaching the hospital in a timely manner.

Therefore, it is imperative to develop an intelligent traffic management system that can effectively regulate traffic to prevent accidents, collisions, and traffic gridlocks, with a special focus on ensuring the swift passage of emergency vehicles like ambulances[3]. These challenges can be mitigated through the application of emerging technologies, specifically Machine Learning (ML). By establishing connections between a range of software packages and hardware devices, whether through wireless or wired means, a system can be created to efficiently regulate traffic. This system operates by automatically adjusting signal timings in accordance with traffic density and also facilitates the unobstructed passage of emergency vehicles, such as ambulances, utilizing RCNN (Region-based Convolutional Neural Network), webcams, NodeMCU controllers, and LEDs.

The problems that exists in traditional traffic handling system are as follows:

A. High Traffic

As the number and diversity of automobiles on the road continue to grow, major cities are experiencing a significant rise in heavy traffic congestion. This congestion is particularly pronounced at intersections, especially both throughout the working day and in the evenings when commuters are heading home from work. The primary consequence of this situation is the prolonged time wasted by individuals while on the road. To address this issue, a potential solution involves implementing a novel program with distinct delay settings tailored to various intersections.

B. Have to wait, even if there is no traffic

At certain intersections, even when traffic is not excessively congested, individuals often find themselves waiting. This is due to the fixed timing of traffic signals, requiring road users to wait until the lights change from red to green. Violating this rule incurs fines.. Additionally, coordination of signal timings at different intersections is essential.

Traffic congestion is widely recognized as a significant problem in urban areas, and it is expected to worsen with the growing population. Currently, traffic signal lights operate on fixed time schedules, following a predetermined cycle. This can lead to inefficient traffic flow, with one lane being overly congested while others remain vacant. In cases where traffic density varies at different sides of an intersection, a mechanism is proposed to adapt red and green light durations based on the solidity of traffic. In instances of long bottlenecks where automobiles come to a complete stop, drivers and passengers can experience considerable mental stress. This can escalate into road rage, underscoring the severity of the traffic congestion problem. Therefore,there is a pressing need for intelligent solutions to address this issue.

II. LITERATURE SURVERY

In [4] Abbas, et al. presents a method for assessing lane-specific traffic density through the application of image processing. This approach offers distinct advantages, primarily obviating the need for costly aerial imagery and intricate sensor-based systems, thus rendering it a cost-effective solution. Notably, our system does not necessitate the putting in of additional systems like RFIDs. Future improvements can include the incorporation of an emergency vehicle identification system, affording priority to such vehicles, and the integration of Vehicular Ad-hoc Networks (VANETs) to enhance road safety and contribute to the development of intelligent transportation systems.

In [5], Jadhav et al. introduce a novel approach to estimate traffic, employing image processing on captured highway camera footage to count vehicles, issue warnings for heavy traffic if thresholds are exceeded, and offer cost-effectiveness, ease of implementation, and notable accuracy and speed compared to traditional sensor-based systems. It is executed using MATLAB and image processing and aims to alleviate heavy traffic congestion. It involves the utilization of web cameras positioned in traffic lanes to capture road images, which are then meticulously.

In D. M. [6] employs switches, rather than magnetic sensors, to assess traffic density and modulate green signal durations based on this information, leading to the desired outcomes. Future project development involves extending the system to manage all four lanes at a traffic signal by employing efficient PIC interfacing techniques. The primary goal of the project is to optimize traffic flow by effectively utilizing green signal durations. In this system, the traffic density in a specific lane is determined by the count of magnetic sensors placed at the roadside, which generate output signals corresponding to the traffic volume.

In, [7] et al. propose a dynamic traffic control system that uses image processing and real-time video feeds to measure the traffic density at intersections. After gathering a video sample, a combination of Gaussian algorithms was applied to foreground detection and background subtraction in order to maintain track of the count of cars in each lane. By using their line of centroid, the vehicles are identified. A vehicle is confirmed by centroid movement. The traffic conditions detected from the video feeds will be used to dynamically adjust the traffic lights at the intersections.

In[8] , the research team created a basic system using Raspberry Pi, OpenCV, and the Background Subtraction Method, that could identify and tally cars on the Sidoarjo Toll Road in real-world scenarios. For four minutes each, experiments were run in the morning, afternoon, and evening. 92.31% was the highest accuracy recorded in the morning, and 77.27% was the lowest in the afternoon. 91% of the time, the background Subtraction using the GMM method produced accurate results. Variations in accuracy were ascribed to environmental factors, including illumination, vehicle motion, and environmental stability. In order to predict object movement, the primary steps in the process were background subtraction, object tracking,and video capture. It was discovered that the best position for the camera to detect and count vehicles was at a height of ± 6 meters. The Arduino Uno is interfaced with every infrared sensor, and it receives data from the sensors. The system's traffic signals are made of LEDs, with two LEDs for each lane in each signal. The authors have created a smart traffic system that uses IR sensor processed to gauge traffic density. Based on the data analysis conducted through environmental stability. In order to predict object movement, the primary steps in the process were background subtraction, object tracking,and video capture. It was discovered that the best position for the camera to detect and count vehicles was at a height of ± 6 meters. In [9], Anam Firdous et al. proposed a system that uses Arduino Uno ATMega 328 tomanage traffic density. In this, digital infrared sensors are used to sense traffic, and infrared sensors further identify vehicles based on the signal that is reflected from them. sensors positioned next to the lane to regulate traffic volume through suitable traffic signal changes. The Arduino Uno is interfaced with every infrared sensor, and it receives data from the sensors. The system's traffic signals are made of LEDs, with two LEDs for each lane in each signal. The authors have created a smart traffic system that uses IR sensors and Arduino to manage traffic in an efficient manner, reducing delays and utilizing renewable energy sources. We had to somewhat reduce the likelihood of traffic jams by putting this system into place, and the outcome was achieved. Additionally, we power the Arduino Uno using renewable energy by using a solar panels, which *also requires very little power*. In[10] proposed a system in order tooptimize traffic flow, this study suggests a decentralized smart traffic management system that makes use of intelligent algorithms and deep learning. To determine the density of cars and control traffic signals, the system makes use of infrared sensors, object recognition algorithms, and digital cameras. Future traffic density is predicted by an infrared sensor, and emergency vehicles such as police cars and ambulances are given priority by RFID readers. The AT Mega 328 P is used by the system to regulate signal timing. In [18] Liu, Y et al. states that his study proposes a TSC system to maximize the number of vehicles crossing an intersection and balances the signals between roads by using Q-learning (QL). In [12] Pratishtha Gupta et al. states that the main purpose of the developed algorithm is to compute total traffic load at a particular junction, which is then further used for real time traffic control by generating green light timing of the traffic signal.In [13] Sabhya Sachi Kanaojia states that in this system we are using Canny edge detection. In [15] Liu, Y The system is endowed with robust and efficient detection techniques, which main features are the statistical and knowledge-based background update and the use of HSV color information for shadow suppression. In [14] Wang Y. states that reinforcement learning plays an important role in traffic congestion system.In [16] Elizabeth Basil states that this system consists of WI-FI transceiver module it transmits the vehicle count of the current system to the next traffic signal. In [17] Bilal Khan states that we propose a system based on PIC microcontroller that evaluates the traffic density using IR sensors and accomplishes dynamic timing slots with different levels

III. PROPOSED WORK

The goal of traffic management is to minimize other effects of the current road network while maximizing the efficiency [11] of the traffic structure without any issues. The system is improving upon the shortcomings of earlier traffic management frameworks. The mechanism uses automobiles' traffic density as determined by camera input, which is separated from picturesof cars. We have issues in the modern world because of the rise in traffic on the roads. This raises stress levels and results in significant time waste. Many emergency vehicles get caught in traffic for hours at a time, which results in fatalities. The NodeMCU microcontroller receives images from the webcam that show the cars on the road. We then use the RCNN algorithm and OpenCV to count the number of cars in each lane and adjust traffic timing accordingly. If an ambulance is seen in the road. When an ambulance is spotted, the traffic light on that side turns green, and the other side turns red to allow emergency vehicles to pass.

Following are the components used:

A. NodeMCU Controller

There are open source prototyping board designs available for the NodeMCU firmware. "Node" and "MCU" (micro-controller unit) are combined to form the term "NodeMCU". The firmware itself is referred to as "NodeMCU" strictly speaking, not the related development kits. The designs for the prototyping board and firmware are both available for free. The scripting language Lua is used by the firmware. The firmware was developed using the Espress if Non-OS SDK for ESP8266 and is based on the project.

B. LEDs(Light emitting Diode)

Light is released from a light-emitted diode (LED), when current flows through it. The recombination of electrons and electron holes in the semiconductor releases photons. The colorof light is connected to photon energy and is determined by the energy required for electronsto pass the band gap of the semiconductor. White light can be produced by using numerous semiconductors or by coating the semiconductor device with a layer of light-emitting phosphor.

C. RCNN(Region-Based Convolutional Neural Network)

In computer vision, region-based convolutional neural networks, or RCNNs, are essential object detection algorithms. The task is split into two phases: producing region suggestions in an imagewhere objects could be present, and then categorizing these regions and fine-tuning their borders. Using selective search, RCNN creates region proposals, from which a convolutional neural network that has been trained to extract features is used. After that it uses a support vector machine algorithm to categorize objects inside these regions and fine-tunes the bounding box coordinates for accurate localization. While RCNN was revolutionary, later models such as Fast R-CNN and Faster R-CNN enhanced its performance by combining deep learning with region proposal techniques, resulting in object detection systems that operate more quickly and accurately in real-world scenarios.

The flow chart as shown in figure 1 above is described in the following steps:

STEP 1- Start

STEP 2- Camera capturing real-time images of vehicles as shown in Fig 2. Sending theseimages to NodeMCUController.

STEP 3- If an ambulance is detected then green that lane and the other three lanes keep reduntil it passes otherwise go to step 4.

STEP 4-Count incremented.

STEP 5- Check if the previous lane is green then go to the next step otherwise go to step 4.

STEP 6- Stop count calculates time delay depends on vehicle count and value is store in thememory.

STEP 7- Assign delay value to green light and clear the count value and go to step 2.

IV. RESULTS

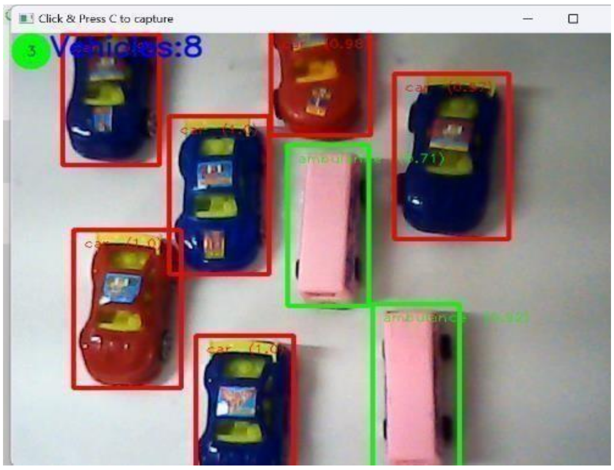

Figure 2. Detecting Vehicles

This work's primary goal is to manage traffic sensibly both in regular and emergency situations by following the architecture as shown in Fig 1. Thus, the system is constructed. At the end, the right results are obtained for the particular condition. The test cases are displayed beneath.

A. If there is heavy traffic jam

If there is heavy traffic then using RCNN(Object Detection Algorithm) tally the number of automobiles based on the vehicle's count green light is delayed by two seconds for each vehicle by the microcontroller. If there is no vehicle on the road the traffic light will be set to 15 seconds for each side.

B. If the ambulance arrives

When traffic signal was operating on normal mode and suddenly an ambulance arrival is detected using RCNN(Object Detection Algorithm). Then it will stop its current work and turn the light green on the side where ambulance is detected and others make red until it passes the signals shown in Fig 3. When ambulance is passed it goes to the normal working.

V. CONCLUSION

The system under consideration here effectively oversees traffic in real-time, leading to areduction in accident rates and the preservation of valuable time spent waiting at traffic signals. This foundational approach paves the way for automation in traffic signal control systems. Granting priority to ambulances equipped with emergency tags ensures quicker hospitalization for patients, ultimately contributing to saving lives. This novel approach offers several advantages, including the utilization of image processing instead of sensors, cost-effectiveness, simple installation, and a balance of both accuracy and speed. The authors created this project as a proof of concept because it is a final year project and because of constraints. Since the active webcam range is only about 10 meters, future research can concentrate on utilizing cloud computing to test it at various distances between the ambulance and oncoming traffic, as well as in real traffic lights, as well as for various ambulance speeds.

A comparison is shown between the existing system and our proposed system as shown in Table 1.

Metrics System	RFID Reader	Arduino Uno	Node Mcu Controller	RCNN	Cost	Power Consumption
Smart Ambulance Traffic Control System	Yes	No	No	No	High	High
Density Based Traffic Control System with smart Sensing of Emergency Vehicle	Yes	No	No	No	High	High
Smart Traffic	No	Yes	No	No	High	High

Control with Ambulance Detection						
Smart Density Based Traffic Light System	No	Yes	No	No	High	High
Proposed System	No	No	Yes	Yes	Low	Low

Table 1. Comparison Table

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