Intelligent Traffic Management for Emergency Vehicles using Convolutional Neural Network

S.Deepajothi
Department of CSE,
Guru Nanak Institute of Technology, Hyderabad
phddeepajothis@gmail.com

D.Palanival Rajan
Department of CSE
CMR Engineering College
Hyderabad, india
palanivelrajan.d@gmail.com

P.Karthikeyan
Department of CSE,
Parul University
Gujarat, india
nrmkarthi@gmail.com

S.Velliangiri
Department of CSE,
CMR Institute of Technology
Hyderabad, india
velliangiris@gmail.com

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***Abstract*—The structure of the road network and the rapid growth of urbanization are becoming increasingly complex. The intersection delay is the main factor that affects the productivity of urban road traffic as the bottleneck of traffic growth. A fair signal control system could help relieve congestion on the highways. Suppose the privilege of preference for the emergency is not assured. In that case, the delay in traffic at the collision may increase, which could hardly indicate the reliable, safe and rapid output as a priority of public transport or any emergency vehicle. We have proposed the Convolutional neural network (CNN) based traffic management for emergency vehicles. CNN model is deployed in the Raspberry-Pi. CNN model will accept the video from the traffic road and take quick decision to allow the emergency vehicles. The proposed method improves accuracy over traditional image processing algorithm and reduces cost.**

***Keywords*—Deep learning, Convolutional neural network, IoT, Raspberry-Pi, Image processing**

I. Introduction

The regulation of traffic lights plays a crucial role in every smart traffic management system. The two main factors to be taken into account in traffic light management are the green light series and the period of green light. Most traffic lights feature set sequences and light length period in many nations. Specified control techniques are, even then, just appropriate for steady and consistent traffic, but never for emotional traffic situations. Considering the current state of things, its flashing green light sequence has been assessed without considering emergency vehicles' possible existence [1]. Emergency vehicles such as police cars, fire engines, ambulance, etc., must wait in traffic at an intersection as depicted. They delay their arrival at their destination, causing loss of life and property. In India, daily an average of 3500 fatalities was reported every year due to late ambulance reactions [2].

In the recent year, many deep learning-based models presented for the traffic management system because it gives better accuracy in object detection than the traditional machine learning algorithm like support vector machine and image processing algorithm. The activity of the convolution is one of the establishments of CNN. From the Latin word convolve, "to convolve" signifies to roll together. For numerical purposes, convolution is the fundamental estimating how much two capacities cover as one ignores the other. Consider a convolution a method of blending two capacities by increasing them. CNN's main advantage is that weight sharing, for example, if the model is having ten filters of size 4x4. We can compute parameters of, it would be 4*4*10 weights and ten biases, i.e. 4* 4*10 + 10 = 160 parameters. However, suppose you use a traditional deep neural network for image classification. In that case, the total number of parameters used in the network depends upon the image size. Unseen image CNN is the best choice for image detections. We can easily extract the features from the already trained CNN with its trained weights by feeding your data on each level and tune the CNN a bit for the specific task. One more benefit of this pre-training is that we can evade CNN's training and save memory, time [3][4].

This paper proposed to resolve the emergency vehicles during the traffic timings by using a convolutional neural network. The results were evaluated through the simulation, and it has successfully examined the performance. Moreover, the proposed system has controlled the overall traffic during the peak time without delaying emergency vehicles. The rest of the paper is organized as follows. Section 2 discusses the related work, section 3 we have discussed prosed, and concludes in section 4.

II. Related Work

Extensive work has been applied to traffic management using the intelligent method. The most utilize traffic data to decide green light groupings. Recently used methods are summarized in table 1.

TABLE I. Emergency Vehicle Detection Based on Siren Sounds

Ref. No	Method	Main contributions
[5]	The optimum method for signal timing based on priority.	It can diminish the per capita defer and improve administration levels. It was utilizing Modular to mimic the planning plan.
[6]	Smart Vehicular Traffic Management	It also improves road safety and enables a clear path. The shrewd route also empowers the ideal traffic burden method in every imaginable way and improves street security.
[7]	IoT based network cognition and intelligent traffic system	The research work's main motto is to design an IoT for public traffic adaptive detection system and proficient.

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[8]	STMS	The method's motivation is to propose brilliant traffic the executive's Framework utilizing the IoT and a decentralized way to deal with advanced traffic on the streets and shrewd method to deal with all traffic circumstances all the more precisely.
[9]	Intelligent Forecasting System	This method takes Shenzhen Fustian's extensive transportation intersection as the case and investigation on spatial and fleeting dissemination of raveller stream under various methods for transportation and administration limit of intersection from multi-dimensional space-time viewpoints.
[10]	Intelligent traffic using computer vision	It can likewise identify vehicle conditions on the street and auto-alter the Framework as indicated by the changing street conditions, making the framework savvy. The structured Framework can assist in taking care of dealing with issues in active urban communities.
[11]	IoT based traffic signal for emergency vehicles	The ambulance, fire unit vehicles, and police vehicles in criticalness need to rapidly arrive at a specific goal. It gets unsafe for the individuals needing a quick guide, administrations, or help.
[12] [13]	An intelligent system for the only ambulance	The whole Framework is mechanized. In this way, it requires less human intercession. "Savvy Traffic Signals Control System for Ambulance" increment the chance of sparing lives.

III. Proposed Methodology

In this section, we present Intelligent traffic management using a Convolutional neural network. The proposed system can be extended to clear the traffic for emergency vehicles like ambulances and fire engines. The existing traffic system has not been serving its actual purpose because it cannot judge the situation and timing, creating chaos in the daily city traffic, causing bigger jams. This issue requires a smarter way to be looked into and a smarter way to fix it. This proposed system can thus fix the top part of this issue. By using the smart traffic system, most importantly, the emergency vehicles will reach their destination on time and, of course, save many lives and help the reason for them going to their destination get less harmful.

In our proposed system, the camera notes incoming vehicles towards the signal and detects the ambulance. An ambulance is learnt by the camera using image processing. These signals, which have the 'congestion' mark, will indicate the Raspberry-Pi processor installed inside the signal. The Raspberry-Pi instructs the traffic controller to show the

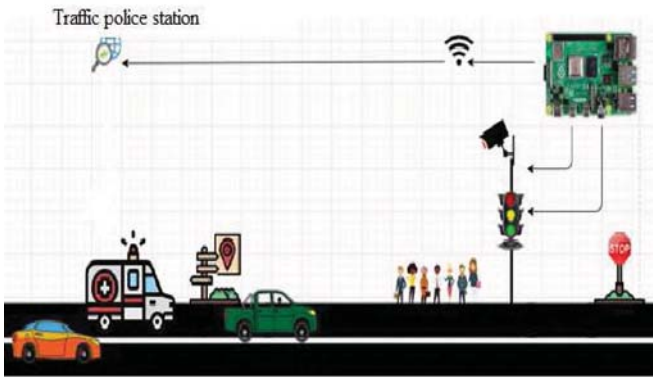

Fig. 1. 2D model of the traffic management system

appropriate signals based on the denseness of the traffic. The data signal given to the traffic light will be as: The congested side will be given more 'green light' (i.e., the timer in the congested side is given more seconds than the other) to the side and vice versa. The message is saying the ambulance is passed. It will be sent to the traffic service station, ensuring that this is an emergency vehicle or emergency circumstance. The traffic light had turned into whatsoever colour. This is to result is clearing traffic in critical situations even faster. Figure 1 below depicts the Rapid Traffic Management System for Emergency Vehicles.

This plan will most impact surrounding residents in the facilities while providing safe, direct, vehicular access to new facilities. Generally, include smooth and safe traffic flow for ingress and egress to the facilities given the existing Right of Way infrastructure leading to the property. Detail will be studied in more specificity upon the creation of a land-use plan. When a specific land-use proposal is known, traffic impact information will be shared and coordinated with the affected Towns that the traffic changes may affect. Here are a few objectives that will support our observation. Figure 2 shows the 2dimesnionsal model of our system.

Traffic flow: Improved management of the flow of traffic through bottlenecks to minimize track occupancy times. This will be addressed through improved timetabling techniques and real-time traffic management.

People's safety: To provide customers with passenger and freight services with reliable and accurate information that is updated as new traffic management decisions are taken, particularly in the event of disruptions.

Updating information: To provide a means of updating and notifying the changes promptly and to timescales that allow them to use the information effectively while travelling on roads.

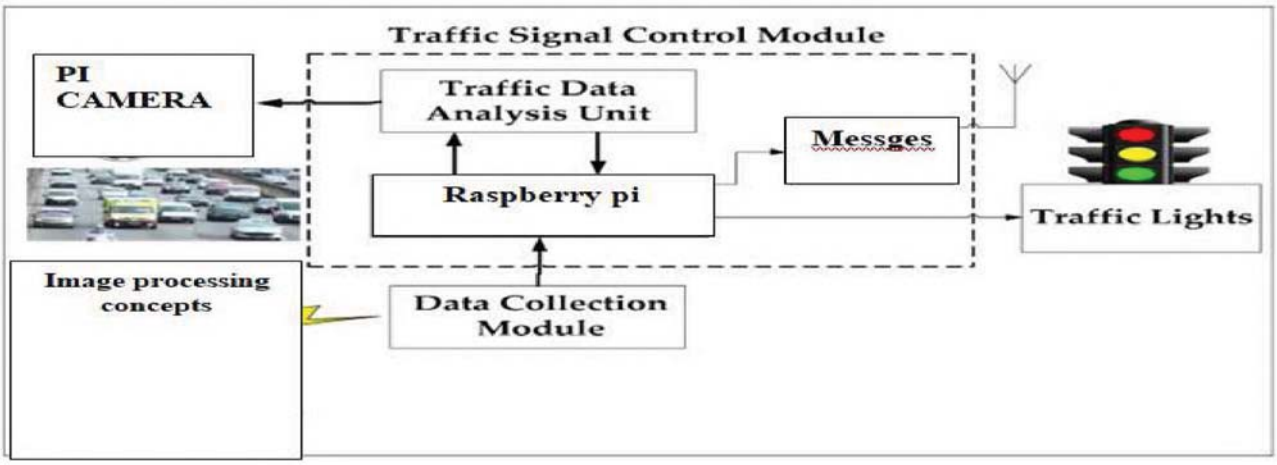

Fig. 2. System Architecture

A. *System Architecture*

A process framework that describes the way, behaviour, vision and knowledge of how the project works. Characterization of the architecture is a concise overview and recognition of both the structure that has been coordinated in such a way as to promote the rationale of the project for the implementation and required to work principle of the design process.

Figure 3 shows the technical model drawn that show how accurate our project flows. It allows the understanding of each component that has been used for a different purpose. We can observe that the raspberry pi board's inputs are camera image captured and the primary power supply. The code inserted into raspberry pi for manual functioning and image detection and processing. The traffic lights will switch according to the raspberry pi's function, and at the end, the message is sent to the nearby traffic station. These modules work as output functions.

Figure 4 clearly explains how the captures raw data has been processed and convert to understand computer language. The operation of data is carried out mostly by a computer to retrieve, transform or classify information. Then the contextual image is classified into pattern recognition in computer vision.

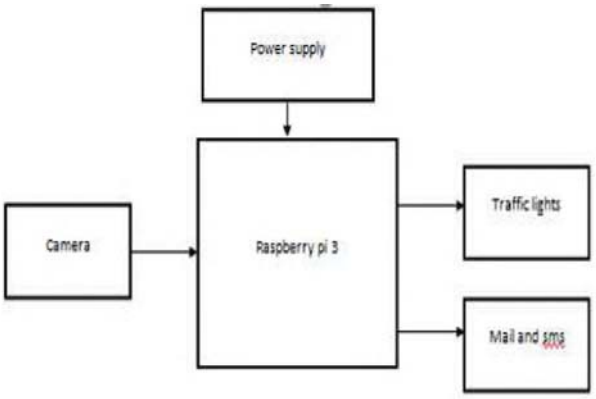

Fig. 3. Basic blueprint or workflow diagram

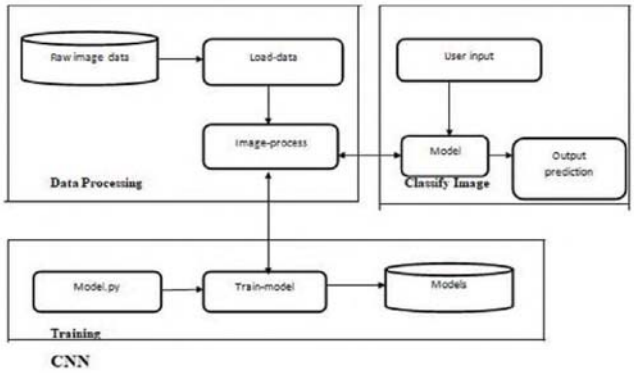

Fig. 4. Processing, Classifying and Training the data using CNN

This is an approach of classifying the image based on some content, and output is predicted. Now at the end, CNN has an image of a vehicle that first needs to learn. Once the activation pattern is built with fully connected layers, image identification and recognition will be done and sent to a raspberry pi.

In Figure 5, we can see the arrangement of traffic signals that are connected on a breadboard. Resistors have a job to resist the flow of electricity where and how fast it can flow.

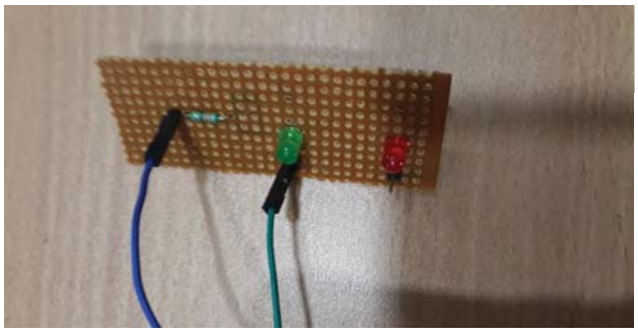

Fig. 5. Traffic lights (LED's) connections on the breadboard

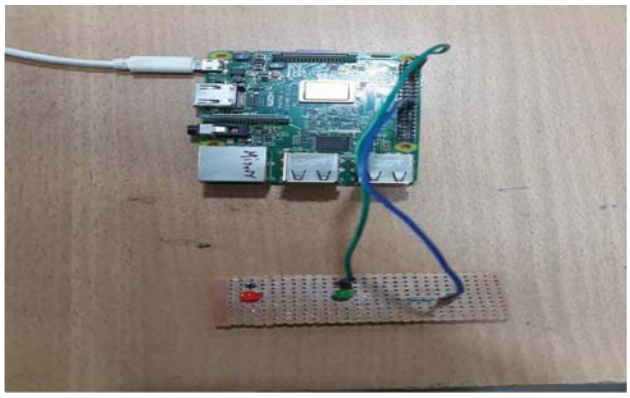

Fig. 6. Raspberry pi connected to the traffic lights circuit

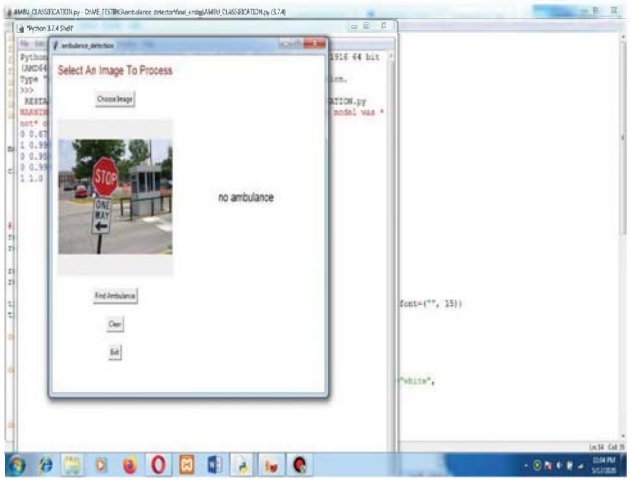

Fig. 7. Output screen of no ambulance

The figure 6 Raspberry pi board has a parallel connection to the fully built traffic lights circuit. The appropriate code is written to function the traffic lights according to the project idea.

The figure 7 s shown that there is no ambulance present. With the absence of an ambulance, the signal will change its lights accordingly.

In the figure, 8the light continues to be in red if initially, it was in red because the image that had been processed had no ambulance. However, this applies whether the light is in red, yellow or green. It is concluded that there is no requirement for the signal to turn green in the absence of emergency vehicles. Hence the light remains what it initially was without any changes.

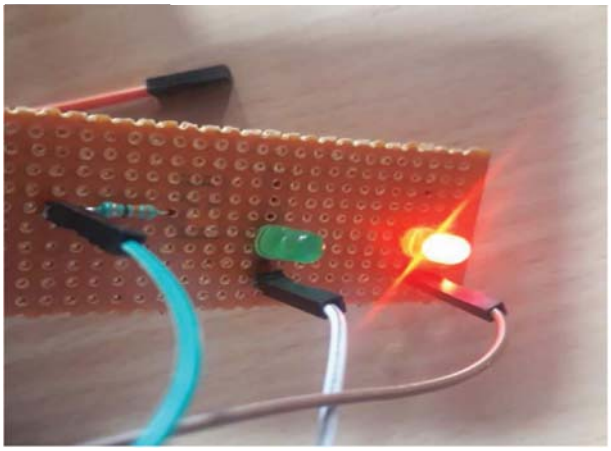

Fig. 8. Output of Red LED blinking because there is no ambulance present in the lane

In figure 9 image has been processed, and it is shown that there is an ambulance present. With the presence of an ambulance, the signal turns green. This helps the traffic to get cleared.

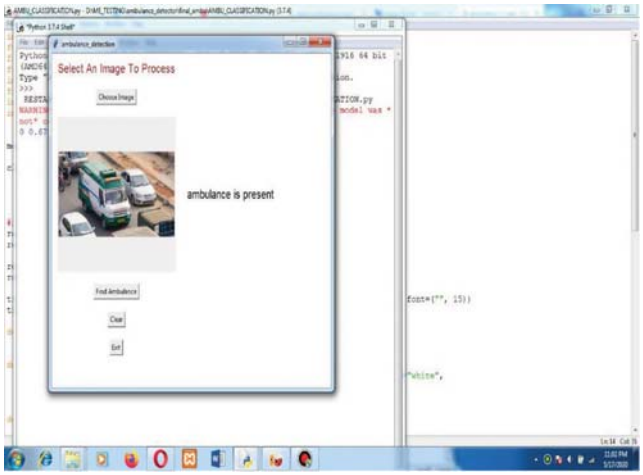

Fig. 9. Output screen of an ambulance present

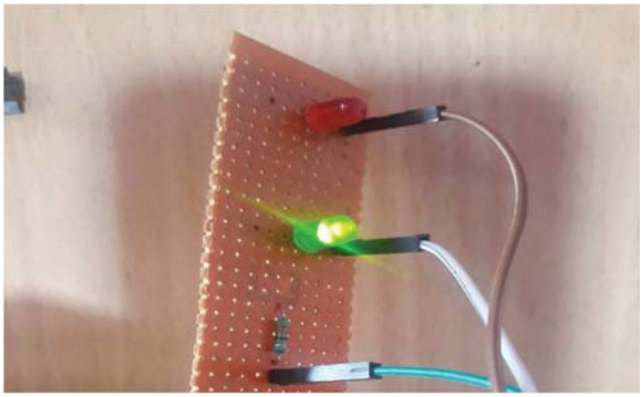

Fig. 10. Output of Green LED blinking because there is an ambulance present in the lane and indicating vehicles to move

In figure 10, it is seen that the traffic light has turned green. This is because the camera detected an ambulance or ambulances with image processing. Once the light has turned green, it is the message for an ambulance to start moving along with other vehicles resulting in clearance if traffic and henceforth helping the ambulance reach their destination on time. Once the ambulance has passed the signal, a message is sent to the nearest traffic station that the ambulance has passed.

IV. CONCLUSION

The CNN-based Traffic Management system is automated traffic management. It makes it more efficient while also focusing on making emergency service vehicles more easily accessible. The simulated traffic management system allows us to coordinate between multiple intersections connected to ensure smooth traffic flow. This is possible by fixing this system in all junctions. It also facilitates the prioritization of emergency vehicles in significant traffic snarls by ensuring the roads get cleared when the emergency vehicle is recognized to be approaching. There are many smart traffic systems but can be affected by snow, fog, and other weather conditions. However, this CNN based traffic management system will not be affected by weather conditions and function in all. Other advantages of this system also exist. Since we have a camera fixed, it can also capture images when the rules are violated, like when a vehicle is spotted skipping the signal. It will be captured for other purposes. It was not troublesome for the traffic police.

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