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TRAFFIC VIOLATION ADMINISTRATOR

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Abstract— It has been noted by experience that traffic signals in the city, Bengaluru, have been broken at will by the ones whose safety and convenience is the primary objective of these traffic signals. This has caused accidents incidentally, thereby leading to loss of life and property and causing huge traffic disturbance. Moreover, inefficient management can lead to traffic snarls in cities of developing countries like India. Manual discernment of traffic violations is a daunting task with many of the violations going unrecognized. An automated traffic management system, is therefore, an efficient alternative. The project at hand will aid to control these issues and further avoid these accidents by means of automated fine system. The system has a cognitive computer vision, a convolution neural network, supported by strong network of IOT devices and is called the Traffic Violation Administrator (TVA). In order to reduce this congestion and set up a functional system of traffic management and to minimize emergency vehicles waiting time, the TVA, which uses image processing and a scheduling algorithm, automatically manages the duration of traffic signals based on the number of vehicles, length of the queue and the average lane speed. The management of signals to prioritize emergency vehicles such as ambulances or fire brigades is by ensuring green signals in their specified routes with aid of GPS and maps. This project is aimed to be developed for the Traffic monitoring agencies in various parts of the country to replace the traditional monitoring with increased efficiency.

Keywords—automated traffic management system, computer vision, internet of things,

I. INTRODUCTION

The future unfolds before our eyes, but is it always beyond our grasps? What was once the province of the Gods has now come more clearly into view, through mathematics and data. From the decisions about weather, business optimizations, fortifying healthcare and detecting crime, to conquering spam and optimizing social networks, to winning elections, everyday mathematics, data and computing combine to help us envision what might be. This is the power of computing, a technology that helps us capture minute details and process them at unbelievable speeds to make precise decisions and perform automated surveillance at unprecedented efficiency. “Implementation of automated enforcement programs for traffic signals is increasing “ [1]. “The use of video cameras (many of which are already installed to survey road networks) coupled with computer vision techniques, offers an attractive alternative to traditional traffic management.” [2]. The applications of a fully developed system for video analysis in traffic application are numerous, from simple traffic observation (traffic counting, speed measurement or incident detection) to long term studies (example road use behavior, entry/exit statistics, journey times or cause of collisions and impact of the automated system), while installation and maintenance may be performed without disruption of traffic flow.

According to the World Health Organization " there is thus an urgent need to recognize the worsening situation in road deaths and injuries and to take appropriate action. Road traffic injury prevention and mitigation should be given the same attention and scale of resources that is currently paid to other prominent health issues if increasing human loss and injury on the roads, with their devastating human impact and large economic cost to society, are to be averted." [3]. These reports suggest that there is a need for a traffic management system that can solve the road safety issue with utmost ingenuity.

•Traditional Management:

A local cop monitors the traffic rules violation and the signals in case of congestion. This cop would note down the number of any vehicle which he observes of violating the rules. Practically speaking, vehicles escape many a times since a single human cannot monitor a huge traffic from all directions. Even in case of increased traffic or congestion, he will be unable to efficiently rule the steps of traffic release. This will cause loss of time and energy. It is also possible that there is no monitoring in certain parts of the day. These shortcomings definitely need to be replaced by an ingenious approach.

•Proposed Management Scheme:

To monitor the signal junctions for prevention of accidents and increased revenue to the government, a computerized traffic controller has been built. With the aid of this computerized traffic controller any vehicle violating the traffic rules will be automatically fined. In addition to this the signal timings also will be monitored based on traffic intensity. This will help the traffic regulating agencies to monitor the traffic in a safe, economic and efficient manner.

II. LITERATURE SURVEY

In this section, we articulate on some of the related works that have been carried out. The Traffic Violation Administrator, to a great extent, takes inspiration from these works.

2.1 Implementation of Automated Traffic System and Impact on Road Safety

Impacts of the systems on the safety of the transportation system are difficult to assess[1]. There are several factors that influence road safety especially at the road intersections. These include driver behavior, adherence to strict lane discipline and the signal timings. Right angle crashes happen when the driver tends to violate the signal during the 0.5 to 1 second into the red phase. Rear end collisions happen due to misunderstanding between the driver's when the vehicle ahead stops whereas, the vehicle behind miscommunicates and crashes into the first one. This is of utmost importance when signal timing optimization, that is, dynamic signal timing has to be implemented. Thus, a threshold time must be set to be used as a warning for the vehicles to stop so as to prevent the collisions.

2.2 Emergency Vehicle Clearance

In reference [4] , green wave system was discussed, which was used to provide clearance to any emergency vehicle by turning all the red lights to green on the path of the emergency vehicle, hence providing a complete green wave to the desired vehicle. A 'green wave' is the synchronization of the green phase of traffic signals. With a 'green wave' setup, a vehicle passing through a green signal will continue to receive green signals as it travels down the road. In addition to the green wave path, the system will track a stolen vehicle when it passes through a traffic light. Advantage of the system is that GPS inside the vehicle does not require additional power. The biggest disadvantage of green waves is that, when the wave is disturbed, the disturbance can cause traffic problems that can be exacerbated by the synchronization.

In reference [5], the use of Zigbee Transmitter and Receiver is made to clear the path of emergency vehicles.Here, each emergency vehicle contains ZigBee transmitter module and the ZigBee receiver will be implemented at the traffic junction. The buzzer will be switched ON when the vehicle is used for emergency purpose. This will send the signal through the ZigBee transmitter to the ZigBee receiver. It will make the traffic light to change to green. Once the ambulance passes through, the receiver nolonger receives the ZigBee signal and the traffic light is turned to red.

NEED FOR AUTOMATED TRAFFIC ADMINISTRATOR

•Reference [6], Traffic is a critical issue of transportation system in most of all the cities of Countries. This is especially true for Countries like India and China, where the population is increasing at higher rate. For example, Bangalore city, has witnessed a phenomenal growth in vehicle population in recent years.

• As a result, many of the arterial roads and intersections are operating over the capacity and average journey speeds on some of the key roads in the central areas are lower than 10 Km/h at the peak hour. In reference [7] some of the main challenges are management of more than 36,00,000 vehicles, annual growth of 7-10% in traffic, roads operating at higher capacity ranging from 1 to 4, travel speed less than 10 Km/h at some central areas in peak hours, insufficient or no parking space for vehicles, limited number of policemen.

• Reference [8], Currently a video traffic surveillance and monitoring system commissioned in Bangalore city. It involves a manual analysis of data by the traffic management team to determine the traffic light duration in each of the junction. It will communicate the same to the local police officers for the necessary actions.

III. OBJECTIVES

The Traffic Violation Administrator (TVA) has been developed to replace the limitations of the traditional traffic management. The Traffic Violation Administrator is trained to be a decision making model having cognitive computer vision to be able to interpret it's surrounding for the objectives mentioned below. Also, a reliable network of IOT devices coordinately aids the cognitive computer vision.

The proposed objectives of the TVA are:

• To automate the fine levied on the vehicles breaking the traffic signals using the Traffic Signal System and the License Plate Recognition System.

• To smartly control the traffic signal at a junction based on the traffic intensity incident to that junction from various roads to achieve highest level of optimization.

• To give room to emergencies such as ambulance, fire brigade, government officials etc. by controlling the signals with emergency and its type being given a priority using the Zigbee Transmitter and Receiver to be installed in the emergency vehicles and at the traffic junction.

IV. SYSTEM ARCHITECTURE

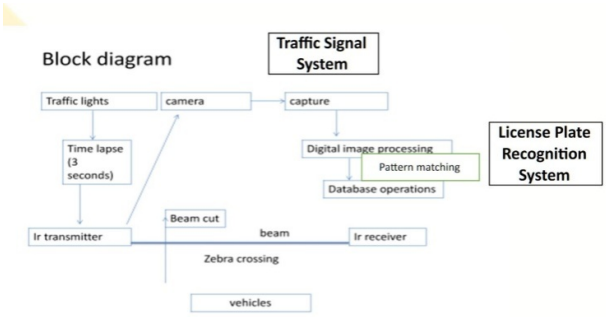


Fig. System Architecture

The block diagram, as shown in figure , shows the proposed system architecture. As shown, an Infrared(IR) transmitter and receiver is placed on either end of the the road. A camera and the red, yellow, green LEDs are placed on a certain perpendicular distance from the IR beam and are controlled by the Raspberry Pi (which has an active internet connection).

Detection of Red Traffic Signal Violation
The IR transmitter and receiver gets activated during the red phase of the signal and sends an IR beam across the road. Whenever, a vehicle interrupts the beam, a message is delivered to the camera to capture the image at that instant. This module is identified as the Traffic Signal System.
Recognition of the vehicle violating the traffic rule is performed by the License Plate Recognition(LPR) System. The captured image is sent via email to the LPR System that performs image processing to correctly recognise the registration number of that vehicle. This violation is then updated with proof in the database of the traffic monitoring agency.

V. MODULES IDENTIFIED

A. Traffic Signal System

Figure 1 shows the circuit diagram of the connections to be made for controlling the traffic signals using the Raspberry Pi.

1. The program starts execution with the green led being turned for a time period of 15 seconds.

2. Similarly for the next 5 seconds a warning yellow led will be turned to indicate the drivers to slow down and stop.

3. For the next 15 seconds the red led will be turned ON and the pir() is invoked at which the vehicles must stop mandatorily .

4. The algorithm for the pir() is given below

Switch ON PIR Sensor.

If pirSense =1

Print “violation”

Capture image

Send image via email over Wi-Fi

Else

Print “no violation”

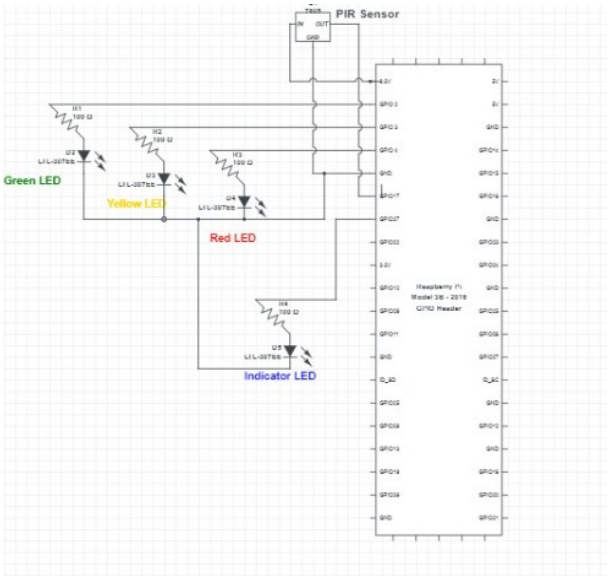


Fig 2. Circuit Diagram of Traffic Lights, Sensor and Raspberry Pi

B. Licence Plate Recognition System

License Plate Recognition System use the concept of optical character recognition to read the characters on a vehicle license plate. In other words, LPR takes the image of a vehicle as the input and outputs the characters written on its license plate.

Stage	Name	Description
1	Distance Calculation	Computes the distance between vehicles and the camera against a threshold value to ascertain traffic signal violation.
2	License Plate Detection	This is the first and probably the most important

		stage of the system. It is at this stage that the position of the license plate is determined. The input at this stage is an image of the vehicle and the output is the license plate(bounding boxes).
3	Text Recognition	It's at this stage the characters on the license plate are recognized. The input is the bounding boxes and output is recognized strings corresponding to each bounding box.
4	Pattern Matching	The extracted string is then matched against the predefined pattern for vehicle registration numbers.

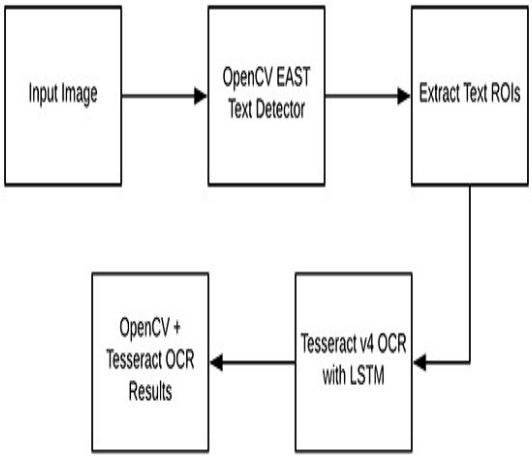


Fig. 1. Working of the LPR System using the OpenCV EAST Text Detector and Tesseract v4 OCR with LSTM.

•To start, we'll apply OpenCV's EAST text detector to detect the presence of text in an image. The EAST text detector will give us the bounding box (x, y)-coordinates of text ROIs.

•We'll extract each of these ROIs and then pass them into Tesseract v4's LSTM deep learning text recognition algorithm.

•The output of the LSTM will give us our actual OCR results.

•Finally, we'll draw the OpenCV OCR results on our output image.

Pattern Matching:

•Pattern for vehicle registration number in Karnataka:

^[(KA)(ka)][0-9]{2}/D*[A-Z a-z]{1,2}/D*[0-9]{4}$

C. Congestion Control System

The proposed system uses image processing and scheduling algorithm to set the timer value. Before a signal is turned into green a picture of the lane is taken and with the help of a scheduling algorithm the timer value is set, with number of vehicles average lane speed as parameters. Since all the traffic lights are connected it helps to achieve better synchronization with the help of synchronization algorithm considering the distance between the traffic junctions and status of other junctions as parameter. Prioritizing of emergency vehicles is done using emergency algorithm which considers the status of the nearby traffic junctions and the distance between the emergency vehicle and traffic light as parameters.

Scheduling Module

This module deals with scheduling of timer for traffic signal based on the results obtained after image processing. The iinpu, traffic lane image is processed to find the length of vehicles, number of vehicles and type of vehicle which is given as input to the scheduling algorithm which thenprocesses and sets the timer value. The results with the image are stored in database.

	Image Processing	By means of a camera, the traffic light captures the image of the traffic at the time of signal changing color to green. This image is then processed and the traffic density is determined by classifying it into categories (empty, light

		traffic, medium traffic, heavy traffic, traffic jam).
	Scheduling Algorithm	Based on the results from the image processing and considering the status of other smart traffic light from synchronization module the timer value is found and scheduled.
	Database	The results of the Scheduling algorithm along with image processing results is stored in the database for analyzing and improvising the traffic management system.

Synchronisation Module

All the traffic signals are synchronized by connecting them to the cloud. This facilitates better coordination between signals, hence allowing us to regulate the traffic much more easily. In an essence, the vehicles waiting at signal 1 would not have to wait as long (ideally need not wait at all) at signal 2. This is done by estimating the traffic at the signal 2 as well as taking into consideration the traffic at signal 1 and the signal duration allotted to it. This greatly reduces waiting time at consecutive signals. In order to provide better synchronization and reduce the waiting time of vehicle in the signals synchronization module uses synchronization algorithm

The synchronization consists of maps and synchronization algorithm

- Maps
- Synchronization algorithm

Maps
Maps provide the geographical location of the traffic lights. It also provides the distance between the traffic light and the time to travel the distance. The maps are customized to provide only hospital location and medical center location.
Synchronization Algorithm
Uses the distance and ETA from maps and the status of other traffic light from the cloud as parameter to synchronize the signals and provides the results to the scheduling algorithm.The synchronization algorithm considers the distance between the traffic lights and ETA, based on this parameter the synchronization is achieved.
Emergency Module
When the emergency vehicle begins its journey, we use Google maps to identify its location as well as determine the destination from the driver. Once this information is obtained, we map out the fastest route to the destination and send messages to all the traffic signals along the route. The signals keep a track of the progress made by the emergency vehicles and once they come into the vicinity of the signal, the signal turns green and allows the vehicles to go through to make a smooth passage for the emergency vehicle. This is done for all the signals along the route prescribed to the emergency vehicle. However, in case of a traffic jam at any particular signal, the signal is immediately turned green.

The emergency module consists of:
• Global Positioning System (GPS)
• Emergency algorithm

GPS
The GPS is used to locate the location of the ambulance.Once the ambulance is detected the nearest traffic light and distance is found with the help of maps from synchronization module.

Emergency algorithm
In order to provide smooth movement of the ambulance in traffic signals the emergency algorithm is used. It considers the distance and status of the signals as parameters. If the road is jammed then a message is sent to the scheduling module to schedule the timer to green otherwise based on the traffic signal status a threshold distance is calculated. Once the vehicle reaches the threshold distance the message is sent along with timer valueto the scheduling algorithm to turn the signal green.

VI. RESULTS

The following pictures show the execution and running of the system both in real time and the shell

- Green LED is on for 15 seconds indicating "GO"

Figure 6.1 (a) Results on shell for first 15 seconds (b) Green LED turned ON

(a) (b)

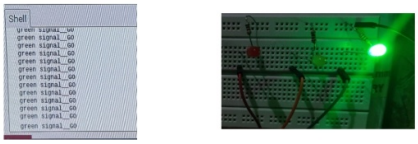
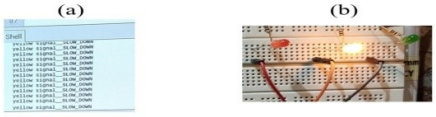
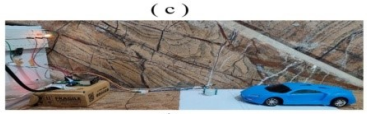


Figure 6.2 (a) Results on shell for next 5 seconds (b) Yellow LED turned ON (c) overall view of the System setup when yellow led glows

(a) (b)



(c)



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- Red LED is turned on for the next 15 seconds indicating "Stop"

Figure 6.3 (a) Red LED turned ON

Results when no violation has occurred.

Figure 6.31 (a) Results on shell showing no violation (b) overall view of the System setup when red led glows and there is no violation.

(a) (b)

Results when a violation has occurred

Figure 6.32 (a) Results on shell showing violation (b) overall view of the System setup when red led glows and there is violation.

(a) (b)

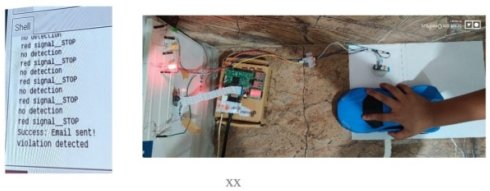

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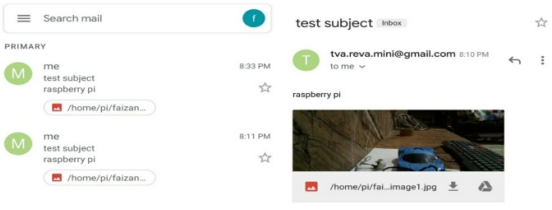
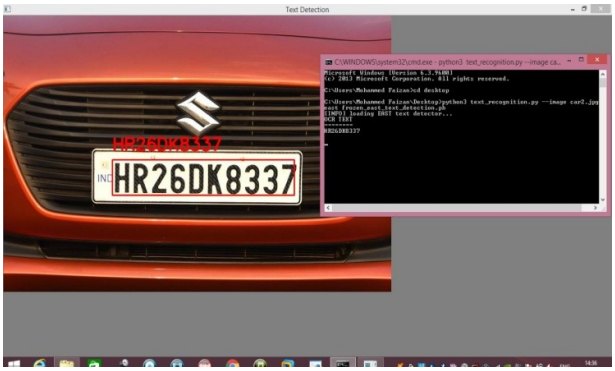
Figure 6.4:The image sent and received on tva.reva.mini@gmail.com





CONCLUSION

In our paper, the sole motivation was to account for every red traffic signal violation and provide a clear route to the emergency vehicles. As observed, the computer- based traffic management system performs in a highly efficient manner as compared to manual monitoring. It is not entirely possible for a human eye to keep track of all violations. However, the Traffic Violation Administrator, records every violation even to that one second into the red signal phase. It also warns the vehicle users of the violation thus, alerting them to not break the signal. This property of the TVA will ensure the violations under 5 seconds into the red phase are all recorded.

The TVA, if implemented, will not only automate traffic management, but also make 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 that are connected to each other in order to ensure smooth traffic flow. This is possible by connecting each individual traffic light to the cloud. It also facilitates the prioritization of emergency vehicles in major traffic snarls, by finding the fastest route and ensuring the roads remain clear. One of the main reasons why the implementation of Traffic Violation Administrator is possible is the existing infrastructure as well as the low cost of installation and maintenance. Since most of the traffic signals at major intersections are already equipped with CCTV cameras, there is no requirement for additional components. All that is required is to synchronize all these signals by connecting them all to the cloud.

However, there are many enhancements that can be made to this model. Using drones to identify vehicles that violate traffic rules so as to obtain a clear image of the vehicle number plate will ease the task of image processing. Also, drones can be synchronized effectively coordinate and provide aerial information to the congestion control system to optimize the signal timings in a more efficient manner. The scheduling algorithm can be based on machine learning, to learn and solve the traffic congestion problem smoothly.

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