# CENTRALIZED TRAFFIC MANAGEMENT SYSTEM USING COMPUTER VISION

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**Abstract**

**Aim**: 50% to 80% of 2 and 4 wheeler owners keep their engines operational while waiting at a red signal. This idling of engines leads to heavy avoidable fuel wastage, vehicular engine damage, respiratory problems, release of greenhouse gases and contributes towards global warming. The present system utilizes microcontrollers to set a fixed traffic signal sequence with present time allotment. In order to release emergency vehicle human assistance is required at the traffic signal controller. We suggest a machine learning based model running on a dual arduino and GPU that continuously monitors and manages the traffic junction using video fed through a CCTV camera. Also running in tandem is a microphone-Arduino setup to monitor for emergency vehicles. These combined allow the elimination of the need for a traffic cop or other human interaction.

**Keywords:** Arduino Uno, machine learning, automatic emergency vehicle detection, traffic management.

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## 1. INTRODUCTION

In the modern age of camera technology and large scale automobile industries, the traffic management systems have not risen to meet the demand of the ever rising increase in the road traffic. Considering the improvements in artificial intelligence and computing, the chasm between the possible and the presently implemented is very distressing. This paper is an attempt to improve this condition so that future innovations of autonomous vehicles and the general population explosion does not affect daily traffic commute of billions of people world wise.

In metro areas, particularly in emerging nations, traffic congestion is becoming a major issue. In addition, daily increases in traffic volume because traffic jams. These traffic jams are caused by a number of things, including bad road conditions, an ongoing increase in the number of vehicles on the road, and occasionally even dishonest behavior on the part of traffic officials. They represent a severe threat to the city's infrastructure and are also having an impact on people's socioeconomic lives by increasing the amount of time they spend working while stuck in traffic. This poses a major threat to the patient's or sufferer's life by interfering with the high priority vehicles' ability to provide necessary services.

The present system utilizes microcontrollers to set a fixed traffic signal sequence with present time allotment. To release emergency vehicle human assistance is required at the traffic signal controller. In the present system the Get Ready Signal(Orange signal) is given at the same time for adjacently sequenced lanes, this leads to major mishaps due to overexcited and negligent drivers. The present state of the lane is not considered leading to waste of time in empty lanes and underutilization of junction space.

## 2. LITERATURE SURVEY

A). Angad Kundra, Aman Maheshwari 2016[1]- This paper aims at giving a design for an intelligent traffic management system using computer vision and IOT. Computer vision can be used to implement a traffic counting mechanism at an intersection and prioritizing and prioritizing lanes with heavy traffic.
B). Ghazal, Bilal and khatib, khaled and chahine etall(2016)[2] – They suggest a system based on a PIC microcontroller that assesses traffic density using IR sensors and implements dynamic timing slots with various levels to track and regulate the flow of vehicles across the intersection of numerous roads.
C). Dang, Dheeraj & Tanwar, Jitin &Masood, Sarfaraz.(2015)-Priority-based strategy is provided by the suggested study. It seeks to provide an HPV user-interactive system in which an HPV driver can make requests to the system, to which the system intelligently answers. At a junction, the priority of each Road Segment (RS) is determined, and the traffic light turns green for the RS with the highest priority.
D). Nellore K, Hancke GP (2016)-The approach combines the measurement of the distance between the emergency vehicle and an intersection using visual sensing methods, vehicle counting and time sensitive alert transmission within the sensor network.

Although there have been many attempts at IOT solutions for the problem, there seems to be a lack of practical implementation on a mass scale of any such initiative, probably due to the inability to provide a simple system. The concept is not entirely new, but there seems to be no simple implementable combination of an emergency vehicle detection system with any smart traffic system.

**Objectives**

With the object to overcome the many shortcomings of the present system, we aim at the following objectives-

a) To understand and exploit the latest developments an artificial intelligence to enable the detection, classification and optimization in the operation of a traffic signal.
b) To analyze video frames of incoming traffic in real time through a machine learning algorithm to effectively regulate traffic flow.
c) To prioritize emergency vehicles at a traffic junction.

**Problem Solution**

80% to 100% of a 4 wheeler & 3 wheeler owners keep their engines switched on while waiting at red signals. Similarly 50% to 80% of 2 wheeler owners also keep their engines switched on while waiting at red signal. This idling of engines leads to heavy avoidable fuel wastage, vehicular engine damage, respiratory problems, release of Greenhouse gases and contributes towards global warming. One in 10 patients in India dies on the way to hospital, simply because motorists are clueless about what to do when they see an ambulance on the road, according to the Radhee Dishauster and Education Foundation. According to the National Crime records Burean, nearly 24,012 people die each day due to a delay in getting medical assistance. It is very important to regulate and manage traffic system optionally.

**Motivation**

The present system utilizes microcontrollers to set a fixed traffic signal sequence with present time allotment. To release emergency vehicle human assistance is require at the traffic signal controller. In present system the Get Ready Signal (change signal) is given at the same time for adjacently sequenced lanes, this leads to major mishaps due to overexcited and negligent drivers. The present state of the lane is not considered leading to waste of time in empty lanes and underutilization of junction space.

**Proposed Solution**

Our team suggests a machine learning based model running on a simple Arduino Uno and GPU combination that continuously monitors and manage traffic junction using video fed through a CCTV camera thus eliminating the need for a traffic cop or other human interactions. The live feed from the CCTV cameras is used to determine lane parameters. The watching action is purely based on the lane parameters. The switching action is purely based on the lane parameters like vehicle density, rate of change of vehicle density, and lane with high priority vehicle. The vehicles are individually tagged and parameters are calculated. High priority vehicle gets a special tag. Then the system creates a new sequence of signal switching based on the analysis of all lanes together. Lane analysis, sequence creation and signal switching actions happens simultaneously in real time. If any priority vehicle is tagged, that particular lane is switched green to move till the priority vehicle leaves the junction between every cycle the junction is also monitored for moving and standing traffic in the junction, case(i) if the junction is not totally clear the switching action is sequenced in such a way that the vehicles use only the empty part of the junction case(ii). If the complete junction is full with the traffic all the lanes are stopped till the junction is clear for movement. The system also switches signals on a larger time envelop so that lane with lover number of vehicles is not affected.

**Proposed Block Diagram**

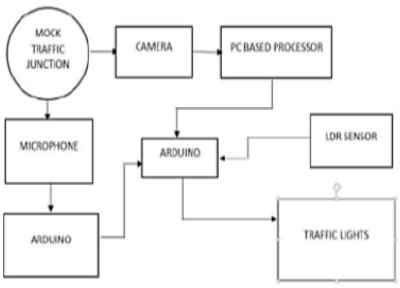


Fig.1 – Block diagram of Setup

As is shown above the two microcontrollers will play two simultaneous and separate roles. One in connection with the microphone will be on the constant monitor foe emergency vehicles, while the other will vary the traffic junction lights is accordance with the processed data. The traffic control operation will be better understand in the following flow chart diagram**.**

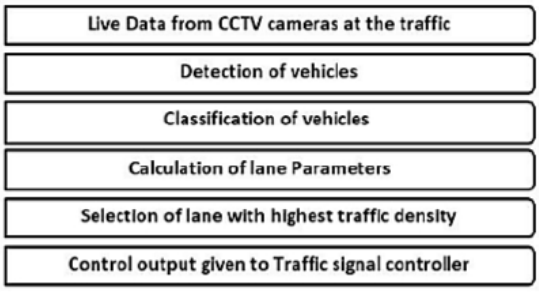


Fig.2 – Flowchart of Working Operation

The process begins with the CCTV cameras in each of the lanes constantly relaying the feed to be processed. The vehicles are detected and counted using computer vision. The lane parameters are calculated and then used according to the algorithm to get an output that's sent to the Traffic Signal Controller.

## 3. METHODOLOGY

### A. Hardware Setup

CCTV cameras are interfaced to the PC through a serial communication setup. One Arduino connects to the signal lights and the other to the signal lights. Required data is processed in the computing system and the final instructions are sent to the microcontrollers.

**1. Camera**

Initially we will be using a USB camera that can be directly connected to the PC. Once tested, the system will be integrated with the actual traffic signal camera.

**2. Arduino Uno Rev 3**

We are using two of these. One for the traffic signal setup, and the other for the emergency vehicle detection setup.

**3. Connectors and other accessories**

These include the analogue microphone, an LDR, the wiring, the boards etc.

**4. GPU**

As ML code generally needs a lot of processing we are using a general purpose laptop for testing the setup.

### B. Software Setup

Software involves the general coding of the general work architecture, the inter-device communication and also the machine learning system.

- The operational framework is built on python for its easy integration with machine learning functionality.
- For the machine learning itself a convoluted Neural Network (CNN) is used, specifically a Faster Region based Convoluted Neural Network (FRCNN). This choice was made for its obvious performance advantages.[5]

### C. System Functioning

Traffic Camera continually monitors the lanes, sending its feed to the PC. Here based on our algorithm it returns back the final response that is the total number of vehicles with their classifications to the microcontroller. The code performs FRCNN Detection on the input frame from the camera feed to extract all the individual vehicles in that frame. Each extracted image is then utilizes for classification. Then we use the trained CNN model saved as an .h5 model to classify the individual extracted image. This, a count as well as the classification of vehicles from the frame is obtained.

Once the classification and count process is completed the system calculates the lane parameters using the pre-loaded lane dimensions. The sequence is sent to the traffic signal microcontroller to execute the instructions.

The following diagram demonstrates the general operating cycle of the code. The LDR input is continually fed to the arduino to consider the initial operation condition. When light is more than a given threshold the code loops into a system that continually monitors the different cameras for number of vehicles and then routes the signals accordingly. If instead the light is less than threshold then the system reverts to a timer based switching system so that the lack of lighting doesn't interfere with traffic routing efficiency

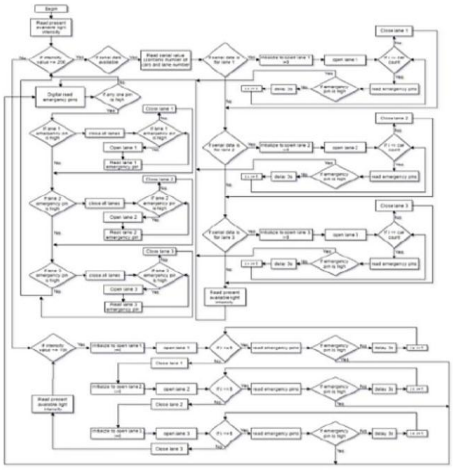

Fig. 3 - Block Diagram of General Operation Cycle

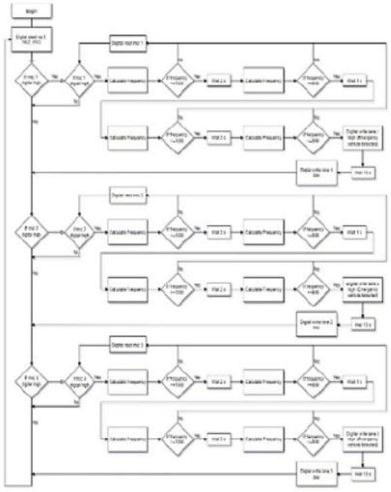

Fig.4 - Block Diagram of the Siren Detection Mechanism

. The detected signal is then processed to finally provide the output to the initial arduino regarding the signal where the emergency vehicle has been detected.

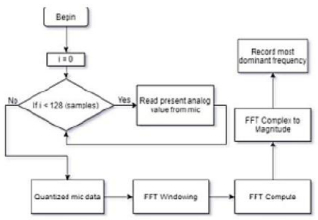


Fig. 5 - Block Diagram of Microphone Signal Processing

Other than the hardware setup the FRCNN code is also parametrically modified for our purposes by retraining with our requirements. This is done by individually clicking pictures of the components we would be using and then training a new CNN accordingly as shown below.

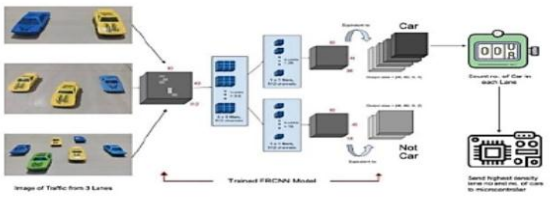


Fig.6 - Block Diagram of the FRCNN Development

## 4. RESULTS

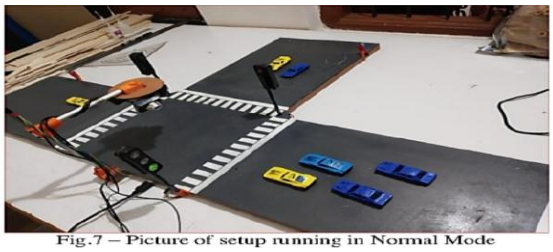

Fig.7 – Picture of setup running in Normal Mode

Fig.8 – Picture of Lane 2 with Low Traffic Density

Initially tested for normal function we were able to successfully detect the lane with highest density and then switch lanes accordingly as shown below.

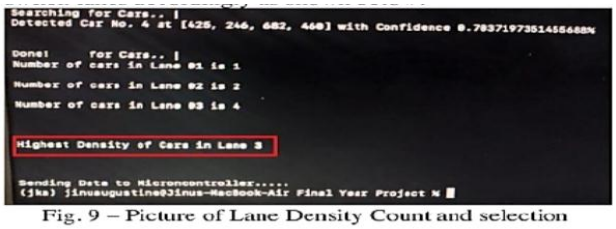


Fig. 9 – Picture of Lane Density Count and selection

Fig. 10 – Setup for Ambulance Detection

The microphone that's constantly monitoring sound for ambulance detects the sound from the 3rd lane and toggles into emergency access mode.

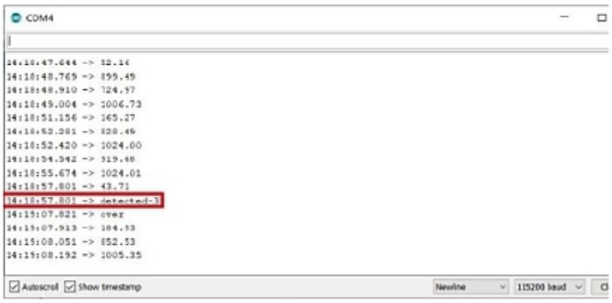


Fig.11 – Detection of the Emergency Vehicle

The above figure shows the time stamping of detection of the ambulance siren along with the lane where it was detected.

**Future Scope**

In the world where automobile industry is crucial to any countries development, the mass churning out of products at an increasing scale is all but inevitable. But unlike a new car or bike, building new infrastructure is massively expensive and always time consuming. With the increasing populations of the world and hence increasing strains on our present systems, maximizing our current system efficiency is absolutely crucial. We believe smart, compact and mass producible traffic solutions are key to solving many of the urban commute problems. In the billions of hours saved, the fuels conserved and the pollution prevented, the future seems a direct path to sunlit uplands.

## 5. CONCLUSION

With an effective implementation on a large scale we expect this systems to have vast and long term benefits including, improved junction management for reducing traffic jams and mishaps, cost effective in the long run by reducing human labour, reduces fatalities by prioritizing ambulances for a quicker junction pass and by implementing a single integrated system for passage of emergency vehicles. We recommend it be used in junctions where variability of incoming vehicles is large over time and where passage of emergency vehicles is more frequent.

Thus with a simple implementation of existing technology an efficient solution for traffic management is possible.

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