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Research Article

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Smart Traffic Light Systems

A. Vinidha Roc[1], P. R. Banuprakash[2], G. Paul Asir Nixon Raj[3], L. Prasad[4]
[1]- Assistant Professor, S.A Engineering College, Chennai, Tamil Nadu, India
[2, 3, 4]- U.G Scholar/S.A Engineering College, Chennai, Tamil Nadu, India

Abstract—

Traffic signals are the most efficient way of controlling traffic in a busy junction. But, we can see that these signals fail to control the traffic effectively when a particular lane has got more traffic than the other lanes. The idea behind this project is to implement a system which would easily control the traffic and helps for the emergency vehicles to reach at their destination easily and quickly. In our project, a system of cameras are used to regulate traffic. They obtain information in their respective places and coordinate with other cameras in the system to change traffic signals and suggest green signal for that route to avoid maximum traffic. Emergency vehicle can be detected with the help of sound sensors placed in the junction, which coordinates with the microcontroller and makes the particular Lane free.

Keywords- Image processing, speech processing, emergency vehicle, Traffic density reduction.

I. INTRODUCTION

In the fast growing generation the major problem evolving is traffic congestion and traffic control. We can see that these signals fail to control the traffic effectively when a particular lane has got more vehicle than the other lanes. This situation makes that particular lane more crowded than the other lanes. According to the survey major accidents are due to violation of traffic rules and failure of the maintenance. Let us take the case study of Tamilnadu which ranked number in road accidents in the year 2016. It was recorded that the total number of road accidents occurred were 15,642 in which almost 17,666 persons lost their lives, the main reason behind these accidents are violation of rules and increase in number of vehicles in road. Due to increase in number of vehicles that exist today, there occurs congestion even in small road which leads to the delay in reaching the target spot to the emergency vehicles. In order to bring a standard solution to this issue we have implemented this project to save as many people's life in case of accidents. The motto of the project is to reduce traffic congestion and to make a clear way to the emergency vehicle. By implementing this project a distinct way of approach will be made in the traffic system, thereby making human effort less in terms of monitoring. As image processing technique is used which works based on the captures of camera helps in detecting the theft and traffic violators at the same time.

In this Project, series of cameras(Free scale line scan cameras), KL25Z microcontroller, FRDM board, Sound sensor(),LED lights and MBED.ORG software is used for programming and obtaining the output.

II. DETAILED STUDY

The applications used here functions on two modules that is image processing module and speech recognition module. Image processing module consists of KL25Z microcontroller and the FRDM board. The speech processing module consists of the sound sensor (). Data obtained from the image processing module is used to control the traffic based on the density in each lane with the help of cameras. The speech processing module is used only in time when an emergency vehicle enters the lane in a junction, it gets the sound with the help of sound sensor and if the sound intensity matches with the assigned intensity in the controller the message is processed to the microcontroller, which in turn turns the particular lane green.

Microcontroller KL25Z which works on the basis of the captured image, it resizes all the images to a simple one so that no confusion occurs in the detection of vehicles. After resizing the image is converted to grey scale image, thereby using the edge detection and sobel detection technique only the outer edge of the image is being taken into account ignoring all the other aspects. This makes the image to appear like a box, this makes the controller to process in a faster rate to get the number of vehicles in each lane. In this way the number of vehicles in each lane will be calculated and will be freed according to the density. The sound sensor comes in to the act only when there is an emergency vehicle in the lane. Eventually when a rare case of two ambulances occurring in either lane the concept of Doppler Effect will take place, according to this technique the signal will be freed on the lane in which the intensity or frequency is higher, in other cases the system will function as per the above technique.

III. PROPOSED ARCHITECTURE

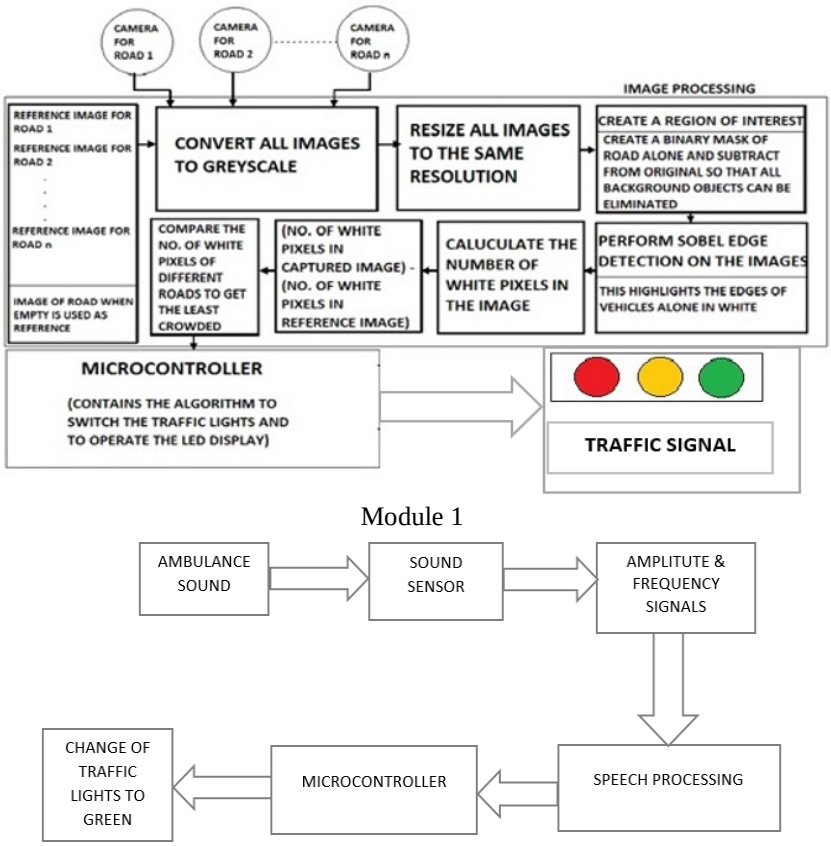

Fig 1: Block diagram

Architecture contains the Images processing unit as the central unit and Speech processing unit as the secondary. The central unit plays the major part of the system by maintaing the traffic in normal norms, the combined secondary unit is also important only in times of emegency.

As shown in fig 1 the CCTV's are connected to the controller which acts as the input to the system, by getting the input the process starts from resizing to taking the count of the vehicles in each lane, as shown in figure 1 the impulses obtained are carried over to the microcontroller and then based on the results obtained the signals are determined for each lane (i.e.) the lane with large number of vehicles gets the priority of freed at first proceeded by the lesser one. The Speech processing unit coordinates with the microcontroller by means of the sound of the emergency vehicle, when the sound is recorded it gets the input, processes it and sends the signal to microcontroller ,thereby the signal gets cleared for the particular lane in which the emergency vehicle is present. The secondary system and the series of cameras are to be interfaced with the microcontroller to get the desired output.

A) Image processing unit

Image processing is termed as processing of images using mathematical operations by using any form of signal processing for which the input is an image pr a series of images. The images are processed to identify the density of traffic on the roads The acquired images from the camera after being loaded into the image processor are first converted to gray-scale .The obtained image cannot be processed as it is. As we have to obtain a finite integer value to determine the traffic density in the image all images should be of the same resolution. After re-sizing the image, the image is sent to the next step in the image processing. A region of interest with the road alone is created .This image excludes all other parts of the image except the region of interest viz. The road containing the vehicles. After isolating the road containing vehicles from the original image it is then sent for edge detection. The vehicles that are present on the road produce a definitive edge in the image when edge detection is done on the image. A count of the white pixels in the image will give you the different traffic densities of all the roads by comparing the traffic of all the roads we can obtain the side with the maximum traffic.

B) Speech Processing unit

Speech processing deals with speech signals and the processing methods of these signals. The signals are usually processed in a digital representation, so speech processing can be regarded as a special case of digital signal processing, applied to speech signal. It's a special module where the input is taken in the form of sound and output will be produced corresponding to the input. In speech processing, the high sensitivity sound sensors are used which gets the sound present in particular lane and if the sound intensity is equal to the prefixed value and comparing the frequency signals with prefixed value, if both are matching, the microcontroller decides that ambulance is present in the particular

lane and thereby making green signal in order to make ambulance reach destination faster The input is termed as speech recognition and the output is termed as speech synthesis.

MICROCONTROLLER:

The integer values that are obtained after edge detection are sent to the microcontroller. The traffic signals and the speech processing unit are connected to the microcontroller. The microcontroller is loaded with a program that is capable of switching between the traffic lights by providing priority to the side that has a maximum traffic density and at the same time it also clears particular lane for emergency vehicle if it is present in the lane. Based on the count of the white pixels it is also possible to identify the sides that have exceeded their threshold values and the lanes get equally switched between the green lights and the if emergency vehicles exists on corresponding lane the signal goes green in order to help the emergency vehicle to reach destination easily and quickly. The micro controller acts as an interface that runs the algorithm for the traffic lights and controls the entire system enabling quick and hassle free traffic solutions to vehicles in busy junctions.

Specifications*:*

32 bit ARM CORTEX –MO+ core
- Up to 48 MHz operation.
- Single-cycle fast I/0 access ports.

Memories
- 128 KB flash.
- 16 KB SRAM.

Clocks
- 4 MHz and 32 KHz internal reference clock.
- System oscillator supporting external crystal or resonator.

Analog Peripherals
- 16-bit SAR ADC w/DMA support.
- 12-bit DAC w/DMA support.
- High speed comparator.

Communication peripherals
- Two 8-bit Serial Peripheral Interface.
- USB Voltage regulator.
- Two I2C modules.

Timers
- One 6-channel timer/PWM mode.
- Two 2-channel timer/PWM mode.
- Real time clock (RTC).
- Low power timer.
- System tick timer.

Human Machine Interfaces (HMI)
- General Purpose Input/output controller.
- Capacitive touch sense input interface hardware module.

Input / Output Configurations:

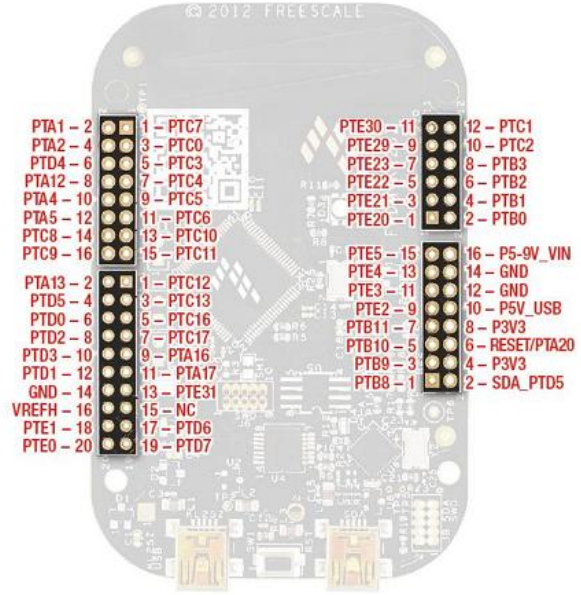

Fig 2: pin configuration of microcontroller

Power Supply:

- P5-9V_VIN Power supplied from the VIN pin of the I/O headers (J9 pin 16).
- P5V_SDA Power supplied from the Open SDA USB connector (J7). A Schottky diode provides back drive protection.
- P5V_KL25Z Power supplied from the KL25Z USB connector (J5).
- P3V3_VREG Regulated 3.3V supply. Sources power to the P3V3 supply rail through a back drive protection Schottky diode.
- P3V3_SDA Open SDA circuit supply. Header J3 provides a convenient means for energy consumption measurements.

FREE SCALE CAMERA:

It is a device used to capture images, record videos and two dimensions. It is a line scan camera which is used to capture vehicles in the lanes and it process the data to the controller. It uses image processing technique to function as per the code written to it.

Many effects can be implemented using line scan camera such as in time of rain, fog etc.., clear picture can be obtained in a detailed manner. The function of camera in the system is to act according to the code, by capturing the overall scenario of the road. The processing speed of the camera is nearly 20ms. With this speed the process of conversion of the image is done rapidly.

Fig 3: free scale module

Specification:

- Clock (CK): It latches the SI and the clock pixels out from low to high (continuous signals).
- Serial Input to Sensor (SI): It begins a scan or exposure discrete pulses, in which the pulse must go low before rising edge of the next clock pulse.
- Analog output (AO): Analog pixels input from the sensor (0-Vdd) or Tri-stated.

SOUND SENSOR:

The Sound sensor module is a simple microphone used to amplify the sound strength of the environment like door knocks and loud enough to be picked up by a microcontroller's Analog to Digital converter. The value of output can be adjusted by the potentiometer. Sound detector is a small board which combines microphone and some processing circuitry. It provides not only an audio output, but also there will be an indication of the presence of sound and an analog representation of its amplitude.

Fig 4: Sound sensor

Specifications:

- Operating voltage – 5V/3.3V
- Can detect sound /noise.
- Sensing element is a condenser mic has a on board amplifier and gain adjustment.

Features:

- Adjustable threshold.
- Digital output when sound is detected.
- The threshold sensitivity can be adjusted via potentiometer on the sensor.

LED LIGHTS:

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode, which emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. LEDs are typically small (less than 1 mm^2) and integrated optical components may be used to shape the radiation pattern.

Fig 5: LED lights

Specifications:

- Operating voltage:3.6V DC
- Current rating: 30milliamps
- Power rating: 100 milliwatts

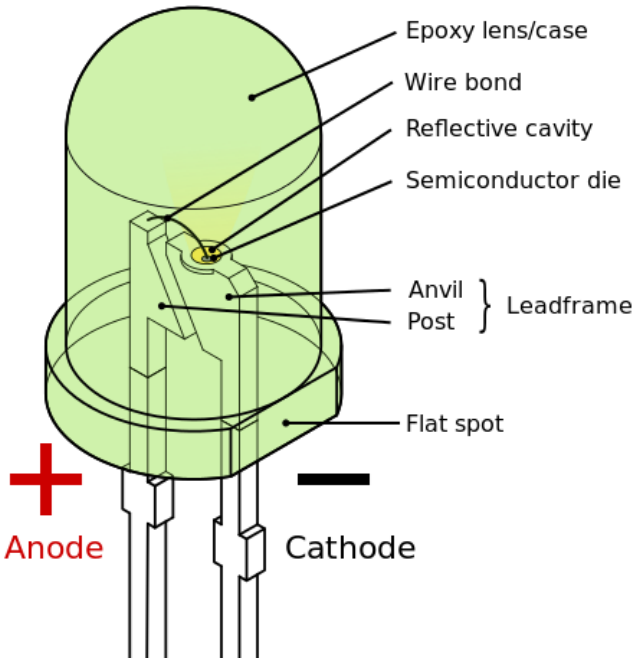

Fig 6: working of LED

IV. FLOW CHART OF THE PROCESS

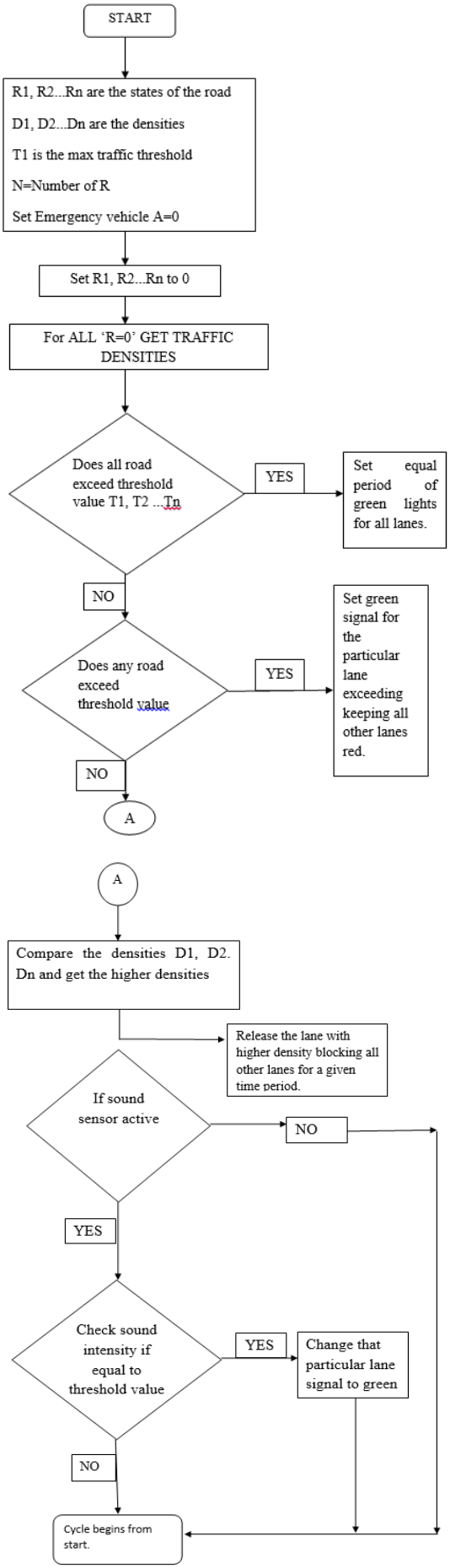

Fig: 7 Flow Chart

Steps of the Process:

1) Firstly the vehicles present in the lane are captured by the means of camera.
2) The captured images are fed to the controller and then compared with other lanes, then using binary mask technique the vehicles are segregated.
3) The segregated vehicles are brought to the same resolution, which is done in every lane.
4) Then the image is converted to grey scale by means of matlab code.
5) After this process using the edge detection and sobel edge detection technique the vehicles present in the lane are simplified, and the counting process takes place.
6) After comparing every lane, the lane with higher traffic density is freed first.
7) In case of emergency vehicles like ambulance enters the lane, there is a distinct methodology applied in the system.
8) As the ambulance enters the lane, with the help of sound sensor placed in the junction sound is detected.
9) When the sound is detected, the intensity is being checked, if the intensity matches with the set intensity, then the impulse is sent to the controller.
10) As soon as the controller receives the impulse, the signal is set to green, blocking or freezing all the other lanes.
11) If no emergency vehicle appears in the lane, then the normal functioning of the system will be processed.

V. LITERATURE REVIEW

K Nangare Yogini [1] Intelligent Ambulance Rescue, Traffic problems, congested traffic and flow management were recognized as major problems mostly in all the areas, which have caused problem for the ambulance which carries the emergency patient. Moreover road accidents in the city have been increased and loss of life due to the accidents is even more crucial and not measurable. To avoid this we introduce a scheme called as IARS (Intelligent ambulance rescue system). The main theme behind this scheme is to provide a smooth flow for the ambulance to reach the hospitals in time and thus minimise the problems. The idea behind this scheme is to implement an Intelligent Transportation System (ITS) which would control mechanically the traffic lights in the path of the ambulance. The ambulance is controlled by main server which is the central unit or brain or our system and ambulance controls the traffic signals, thus reaching to the hospital safely. The server also determines the location of the accident spot through the sensor systems and GPS (Global Positioning System) in the vehicle which encountered the accident and thus the server walks through the ambulance to the spot.

Anurag Kanungo [2] Smart Traffic Lights Switching and Traffic Density Calculation using Video Processing. The method to use live video feed from the cameras at traffic junctions for real time traffic density calculation using video and image processing. It also focuses on the algorithm for switching the traffic lights according to vehicle density on road, thereby aiming at reducing the traffic congestion on roads which will help lower the number of accidents. In turn it will provide safe transit to people and reduce fuel consumption and waiting time. It will also provide significant data which will help in future road planning and analysis. In further stages multiple traffic lights can be synchronized with each other with an aim of even less traffic congestion and free flow of traffic.

Md. Munir Hasan [3] Smart Traffic Control System with Application of Image Processing Techniques In this paper we propose a method for determining traffic congestion on roads using image processing techniques and a model for controlling traffic signals based on information received from images of roads taken by video camera. We extract traffic density which corresponds to total area occupied by vehicles on the road in terms of total amount of pixels in a video frame instead of calculating number of vehicles. We set two parameters as output, variable traffic cycle and weighted time for each road based on traffic density and control traffic lights in a sequential manner.

Rajeshwari S [4] Implementing Intelligent Traffic Control System for Congestion Control, Ambulance Clearance and Stolen Vehicle Detection. Each individual vehicle is equipped with special RFID tag (placed at a strategic location), which makes it impossible to remove or destroy. We use RFID reader, NSK EDK-125–TTL and PIC16F877A system-on chip to read the RFID tags attached to the vehicle. It counts number of vehicles that passes on a particular path during a specified duration. It also determines the network congestion, and hence the green light duration for that path. If the RFID-tag-read belongs to the stolen vehicle, then a message is sent using GSM SIM300 to the police control room. Also, when an ambulance is approaching the junction, it will communicate to the traffic controller in the junction to turn on the green light. This module uses ZigBee modules on CC2500 and PIC16F877A system-on chip for wireless communications between the ambulance and traffic controller. The prototype was tested under different combinations of inputs in our wireless communication laboratory and experimental results were found as expected.

P. Mittal et al [5] Controlling traffic lights, this paper proposes image mosaicking technique for controlling of traffic signals. Limitation of conventional automatic traffic signal control methods is that they can detect the vehicle using sensors, whereas sensors are failed to detect the vehicle, if vehicle is out of range of infrared rays, also sensors are incapable to give response if vehicle stops due to technical problem in the range of infrared rays. This paper proposed an intelligent traffic control method using image mosaicking technique. The striking feature of proposed method is that it measures the density of traffic dynamically. The efficacy of proposed method has been evaluated, using MATLAB™ Software.

K. Athavan [6] Automatic Ambulance rescue system Traffic congestion and tidal flow management were recognized as major problems in modern urban areas, which have caused much thwarting for the ambulance. Moreover road accidents in the city have been incessant and to bar the loss of life due to the accidents is even more crucial. To implement this we introduce a scheme called AARS (Automatic ambulance rescue system). The main theme behind this scheme is to provide a smooth flow for the ambulance to reach the hospitals in time and thus minifying the expiration.

The idea behind this scheme is to implement a ITS which would control mechanically the traffic lights in the path of the ambulance. The ambulance is controlled by the central unit which furnishes the most scant route to the ambulance and also controls the traffic light according to the ambulance location and thus reaching the hospital safely. The server also determines the location of the accident spot through the sensor systems in the vehicle which encountered the accident and thus the server walks through the ambulance to the spot. This scheme is fully automated, thus it finds the accident spot, controls the traffic lights, helping to reach the hospital in time.

Mohammad Shahab Uddin [7] Real-time Area Based Traffic Density Estimation by Image Processing for Traffic Signal Control system, Traffic congestion is a daily occurrence in most urban areas of Bangladesh now a day. In the last 10 years the scenario has worsen due to rapid increase of vehicles and insufficient roads to accommodate them. This paper describes a method of real time area based traffic density estimation using image processing for intelligent traffic control system. Area occupied by the edges of vehicles will be considered to estimate vehicles density. Calculating the areas of different live roads, the system will automatically estimate the traffic density of each road which will help to determine the duration of each traffic light. An intelligent traffic signal control system with the proposed traffic density estimation technique will be far better than the conventional timer based system of Bangladesh. The main contribution of this research lies in the development of a new technique that detects traffic density according to the area of the edges of vehicles for controlling traffic congestion. Specialized algorithm, morphology and images captured with cameras will be used for the detection of traffic density for the intelligent traffic control system.

Ms.Pallavi Choudekar [8] Implementation of Image Processing in Real Time Traffic Light Control, this project aims at making agriculture smart using automation technologies. The highlighting features of this project includes smart GPS based remote controlled robot to perform tasks like weeding, spraying, moisture sensing, bird and animal scaring, keeping vigilance, etc.

VI. CONCLUSION

Thus, our project creates an awareness about the automation in traffic system. It thereby reduces human effort and traffic congestion. By the implementation of this system, traffic rules can be regulated and violators will be reduced.

VII. FUTURE SCOPE

1. It can be achieved in IOT (Internet of Things).
2. Further advancements can be made such as artificial intelligence and cloud monitoring.

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