IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11, Iss 8, August 2022

AN IOT BASED AUTOMATED TRAFFIC CONTROL SYSTEM

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Abstract

Traffic control system is one of the major problematic issues in the current situation. Such scenarios, every signal is getting 60 seconds of timing on the road at a regular interval, even when traffic on that particular road is not dense. An automated Pi based traffic control system using webcams and sensors that help in reducing traffic density in busy traffic junctions. The design of this traffic infrastructure can help in avoiding traffic congestions. This project describes a system where web cams are integrated with Raspberry Pi to operate the lanes of traffic junction based on the density of the traffic and RFID sensors for emergency vehicles to be prioritized for safety of passengers. In this model we are using image processing techniques like background subtraction and filtering by contours, Haar cascades. As a result, the improvement in traffic system can be exponentially improved, which can lead to progressive in the overall traffic system. The image processing techniques are very helpful in detecting vehicles rather than vintage techniques like sensor density calculation, so we approached to this method.

Keywords: Automated Pi, Raspberry Pi , RFID sensors, Haar cascades, sensor density

Introduction

IoT has evolved from the convergence of wireless technologies, micro electromechanical system (MEMIES), microservices and the internet. The convergence has helped tear down the silos between operational Technology (OT) and information technology (IT), enabling unstructured machine-generated data to be analyzed for insights to drive improvements. A prototypical traffic system consists of four lanes each having a signal with a fixed time interval that operates clockwise or anticlockwise. The problem with previously designed ultrasonic sensors-based system and conventional system is that it cannot detect the traffic accuracy on each lane because of miscalculation in traffic densities therefore, time is elapsed even during a empty lane condition thus causing a bottleneck condition. There are several traffic control systems using methods such as GPS tracking, RFID technology, image processing using CCTV cameras, VANET and ultrasonic sensor based. A Raspberry Pi microcomputer and multiple webcams are used in each lane to calculate the density of traffic and operate the lane based on that calculation. While automating the lanes, the webcams are used to calculate vehicular density and updates the signal at their respective lane. The motivation behind this this approach was to create an image processing system that will be effective and make it very simple to implement. The system design, components and operation used to build and control the system are discussed in the following sections.

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Problem Definition

In the current problems of the world, urban mobility is one of the major problems especially in metropolitan cities. Previous traffic management systems are not capable enough to tackle this growth of traffic in road networks. Previous traffic system, manages the traffic by assigning a fixed interval for every lane but not on the basis of number of vehicles. Also in peak hours traffic system failed to manage effectively, thus we can see this issue in many metropolitan cities like Bangalore, Hyderabad, Etc. It would be difficult for emergency vehicles like ambulances, fire brigades in that traffic.

Literature Survey

[1] R. Dhakad and M. Jain, proposes that Road traffic congestion conditions are getting worse day by day, it is due to rapid growth of vehicle volume on roads. Therefore, the road traffic management is a major concem. Vehicles, mostly uses traffic congestion information broadcasted by FM Radio operators. Currently FM Radio operators get this information telephonically from media reporters in India. This information might be insufficient as these media reporters and drivers do not cover all road segments at all the time. If radio operators start acceptance of traffic calls from entrusted vehicle drivers, then some vehicle drivers intentionally send wrong information to the radio. In work we are presenting and implementing a GPS based road traffic congestion reporting system (TTM). The proposed approach uses Smartphone, equipped with a GPS receiver to probe congestion on the roads and accelerometer to compute the speed of vehicle driver.

[2] Xinyun and X. Xiao, "The design and simulation of traffic monitoring system based on RFID that in order to alleviate the city traffic pressure, reduce the delay time of vehicles on the road, per design a traffic monitoring system based on RFID, Integrated climate, road conditions and power control all the factors considered, these papers choose to use passive tags to identify the vehicle.

[3] M. F. Rachmadi et al. "Adaptive traffic signal control system using camera sensor and embedded proposed that Video based sensor systems can play a key role in delivering data for better road planning and traffic management. Smart road technologies will largely depend on data quality and quantity in the future. Video based detection systems, being an indispensable part of intelligent traffic (ITS), show huge potentials as they do not only offer a flexible way of data acquisition but are also being developed at a huge pace due to recent evolutions in hardware and software technology.

[4] X. Jiang and D. H. C. Du proposes that with the development of wireless communications, Vehicular Ad Hoc Network (VANET) has received considerable attention on information sharing and data delivery services. In order to collect and control traffic conditions, Intelligent Transportations Systems (ITS) has deployed a number of Road Side Units (RSUs) along the roads to collect and deliver traffic information to the Traffic Control Center (TCC) for analyzing traffic data. Although some VANET architectures have hem proposed based on the predictable routes and schedules of buses, none of them considered taking advantage of such traffic infrastructures which already been supplied by ITS and combine them with scheduled buses.

[5] Mehal Zaman Talukder, Sheikh Shadab proposes that an automated microcontroller based traffic control system using sensors along with live web updates can be a helpful step in optimizing the traffic flow pattern in busy intersections. This intuitive design of the transport infrastructure can help alleviate the traffic congestion problem in crowded cities. This paper describes a system where ultrasonic sensors and integrated with the Raspberry Pi to operate the lanes of an intersection based on the density of traffic. The current condition of the intersection is updated on a user accessible website.

[6] S. N. Mahalank, K. B. Malagund and R. M. Banakar, "Device to device interaction analysis in loT ed Smart Traffic Management System: proposes that Device to Device Communication pattern is italyzed for loT based

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Smart Traffic Management System in the paper. In this type of communication there is no any human intervention in a system because of direct communication between the devices, hence it is completely automated. D2D Communication Patterns are in great demand in loT sector where a Thing (Device) is controlled by Internet from any remote place by using another Device. are in an experiment of Smart Traffic Management System the method to determine Traffic Density on a particular lane is discussed. Ultrasonic Sensors are employed as the data acquisition unit to collect the information regarding Traffic Density and Raspberry Pi is used as Control Unit for processing the data.

[7] T. Roopa, A. N. lyer and S. Rangaswamy, "CroTIS-Crowdsourcing Based Traffic Information System, proposes that Road Traffic congestion is a perennial problem across the globe. The nature of the problems sociated with vehicular traffic is not uniform across the globe. In the recent past, several solutions were proposed to improve traffic management. However, most of these solutions cater to the traffic scenarios in the developed countries where traffic is lane based and the issues being encountered is quite different from that of developing countries. The existing solutions cannot be readily applied to the traffic situation of developing countries

Methodology

Existing system

Osman et al. proposed a system in which they have used surveillance cameras to detect traffic density in MATLAB, a traffic controller and a wireless transmitter used to send images to the server after that server calculated traffic density by using those images of every section. This system used fixed (predefined) thresholds that depend on a number of vehicles on road. Ant algorithm was used to set a time span of red light for a particular lane of the intersection, which is determined by traffic density on road and forwarded to the microcontroller and then server.

Microcontroller Coding

Jadhav et al. used surveillance cameras, MATLAB and KEIL (Microcontroller coding) to control traffic congestion. This paper also discusses the priority-based traffic clearance and red signal broker (Number plate detection). Due to using heavy hardware, it is difficult to manage and become costly. In vehicle monitor system, IR sensor I and IR sensor2 is fixed at a distance. When vehicle comes on road the IR sensor detect vehicle entry and IR sensor detects vehicle exit. The microcontroller internal timer and counter starts and automatically, calculates vehicle speed and count the vehicle and displays on LCD. The entire hardware runs automatically with the help of embedded C programming dumped into PIC microcontroller. Circuit diagram is built from the block diagram in PCB.

Sensor Model

Bui et al. Analyzed a real-time process synchronization-based system to manage the traffic flow dynamically Sensors were used to detect the traffic, where vehicle to vehicle and vehicle to infrastructure communication was done by using wireless communication devices. Controller placed at the center of the intersection received vehicles and pedestrian’s information und requests and process using first come first serve method.

Wireless magnetometer

A wireless magnetometer provides a cost-effective and convenient alternative to other sensing technologies. It requires no wiring or external control box, but achieves an accurate and repeatable response. Furthermore, wireless magnetometers are much less invasive, less expensive, and easier to commission quickly compared to inductive loops. This is because wireless-magnetometer units are small, self-contained, and don't require extensive work under the concrete.

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Pressure Sensor Based

A pressure sensor is a device which senses pressure and converts it into an analog electric signal whose magnitude depends upon the pressure applied. Since they convert pressure into an electrical signal, they are also termed as pressure transducers.

Infrared Method

Swathi et al. proposed smart traffic routing system that chooses the shortest route having the least congestion sensors are used to collect data about traffic density, these sensors une solar energy and battery. Sensors kept transmitting infrared light and when an object came near, they detect traffic density by monitoring the reflected light from the vehicle. However, readings may change with the change in temperature and humidity.

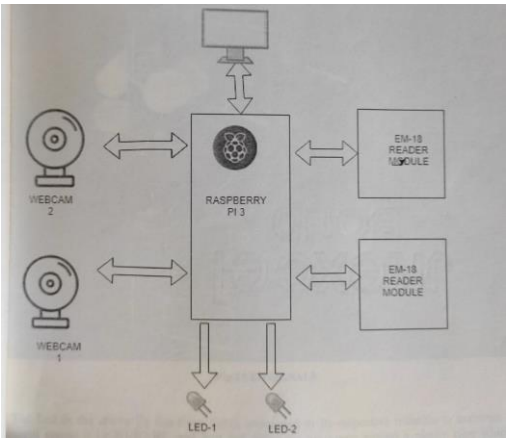
WSN Method

Al-Sakran et al. proposed a system in which major goals were detecting vehicles and get their location by using sensors and RFIDs after getting data it sent to centralized controlling center by using a wireless connections for further processing. Researchers used cloud computing, RFID, GPS, wireless sensor network (WSN), agent and other modern tools and technologies to collect, store, manage and supervise traffic information Existing traffic information acquisition systems suffer from high cost and low scalability. To address these problems, the application of wireless sensor networks (WSNs) has been studied, as WSN-based systems are highly scalable and have a low cost of installing and replacing the systems Magnetic, acoustic and accelerometer sensors have been considered for WSN-based traffic surveillance, but the use of ultrasonic sensors has not been studied.

Proposed System

The System Architecture of our Smart City Traffic System comprises of components like Webcam Em-18 RFID Sensors and Port Expanders Thus Raspberry Pi communicates with RFID through GPIO pins that extended from both of the RFID readers from both the lanes and the webcam are connected to raspberry pi through usb that is operated using OpenCV Sub package in the Raspbian Package This model uses Pi 3 B+ has a quad-core Broadcom BCM283780 and a Cortex-A53 processor clocked at 1.4 GH gives you full 64-bit support and offers more power than previous iterations of the Pi, including immediate predecessor, the Pi 3. There's 1GB of LPDDR2 SDRAM for memory and a microSD card slot that you'll use for storage and loading, for whichever operating system you want to put on it.

The RFID module radiates 125KHz through its coils and when a 125KHz passive RFID tag is brought into his field it will get energized from this field. These passive RFID tags mostly consist of CMOS IC EM4102 which can get enough power for its working from the field generated by the reader, and this Updates the Led lights on that Particular Lane.



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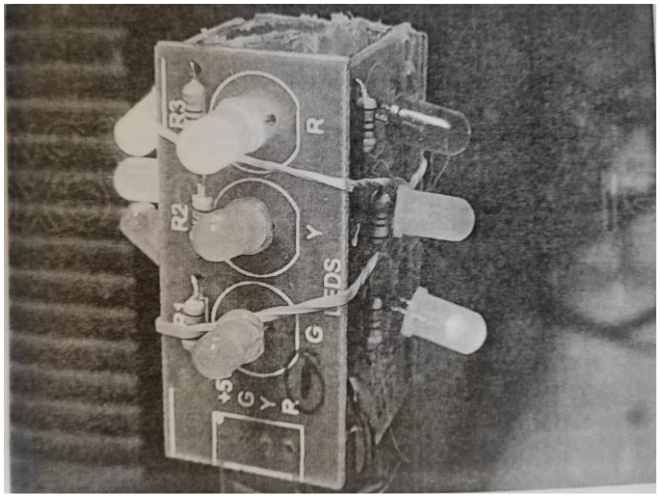
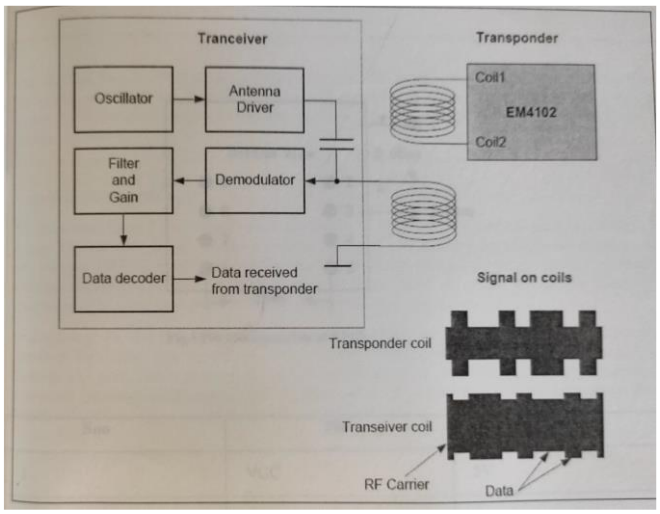
SYSTEM ARCHITECTURE OF TRAFFIC SYSTEM



F2 LED SIGNALS

Interfacing EM-18 RFID reader with Raspberry Pi

The module radiates 125KHz through its coils and when a 125KHz passive RFID tag is brought into this field it will get energized from this field. These passive RFID tags mostly consist of CMOS IC EM410 which can get enough power for its working from the field generated by the reader.



EM-18 READER MODULE

The use of voltage divider in Em-18 is due to the reason. The UART TX output of EM-18 is of 5v. The input pin of Raspberry Pi GPIO is rated at3.3v. So 5v cannot be directly given to the unprotected 3.3v input pin. Therefore, we use a voltage divider circuit using appropriate resistors to bring down the voltage to 3.3v.

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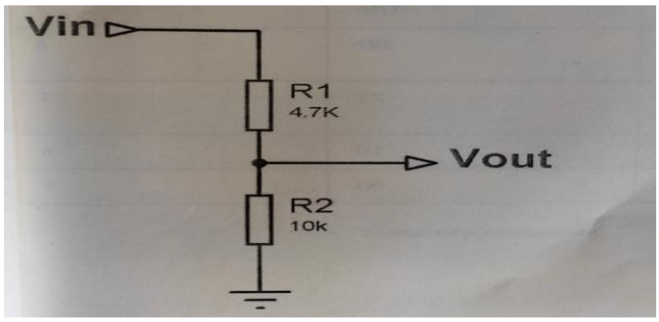
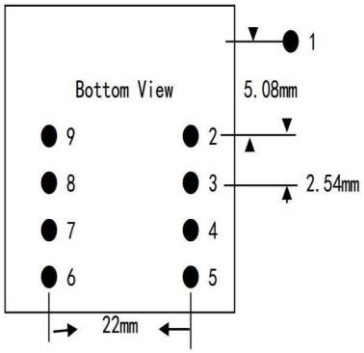


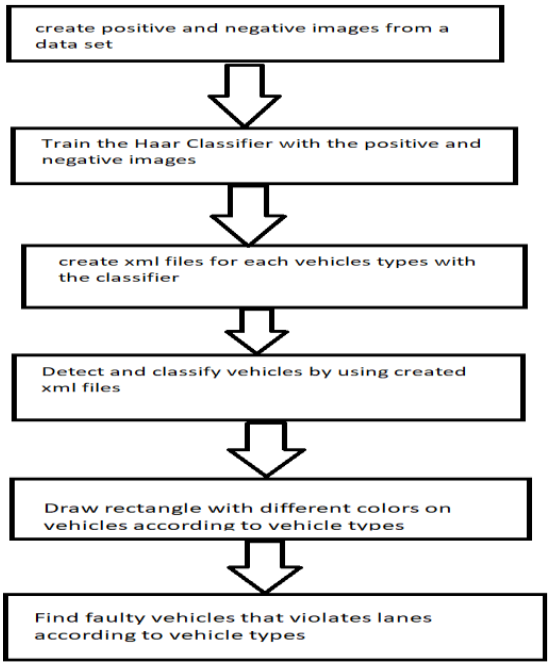
Voltage divider of Em-18 Reader



Pin Configuration of RFID

Algorithm Illustration

The haar-cascade cars.xml was trained using 326 images of cars from the rear (360 x 240 as scale). The images were extracted from the Car dataset proposed by Brad Philip and Paul liplike taken of the freeways of southern California. The cascades are not rotation invariant, scale and invariant. In addition, detecting vehicles with haar cascades may work reasonably well.



HaarCascades Algorithm

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Requirements And Technical Description

In this project we are counting number of cars in a live video either USB cam or video file. So, the software requirements we use in this project are:

1) Raspbian OS

Raspbian is a Debian-based computer operating system for Raspberry Pi. There are several versions of Raspbian including Raspbian Stretch and Raspbian Jessie.

INSTALLATION OF NOOBS:

1)Once you've downloaded the NOOBS zip file, you'll need to copy the contents to formatted SD card on your computer.

2)Download and extract the files from the NOOBS zip file.

3)Copy the extracted files onto the SD card that you just formatted, so that this file is at the root directory of the SD card.Please note that in some cases it may extract the files into a folder; if this is the case, then please copy across the files from inside the folder rather than the folder itself.

4) On first boot, the "RECOVERY" FAT partition will be automatically resized to a minimum, and a list of OSes that are available to install will be displayed. OpenCV (Open source computer vision) is a library of programming functions mainly aimed at real-time computer vision.[1] Originally developed by Intel.

3) NumPy

NumPy is a general-purpose array-processing package. It provides a high-performance multidimensional array object, and tools for working with these arrays. It is the fundamental package for scientific computing with python. It contains various features including these important ones.

With OpenCV 4 then we must run our code in terminal windows only. Before we run this program, we must be in CV only for this need to enter below commands.

$source /. profile

$work on cv

If you are working with OpenCV 3 then you can run your code in python IDE or terminal.

Hardware Requirements

The hardware components we use in this project are: 1) Raspberry Pi3 b+

2) USB camera: A USB webcam is a camera that connects to a computer, usually through plugging it in to a USB port on the machine. The video is fed to the computer where a software application lets you view the pictures and also transfer them to the Internet.

3) VGA to HDMI cable

4) SD card to 16GB

5) Adaptor 5A

Results and Discussions

Screenshot_1 Normal Traffic

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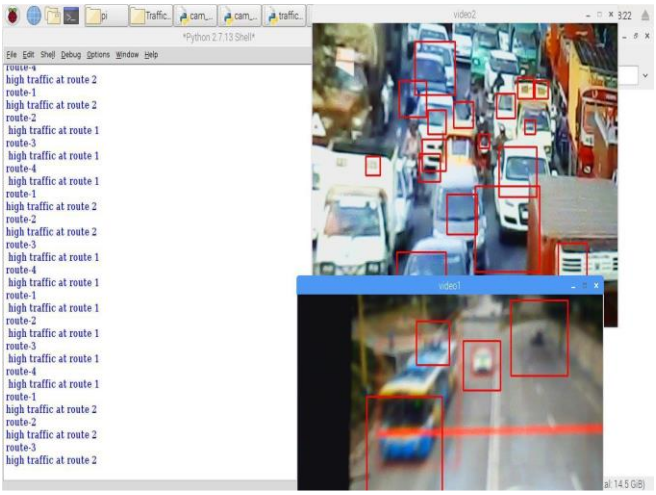
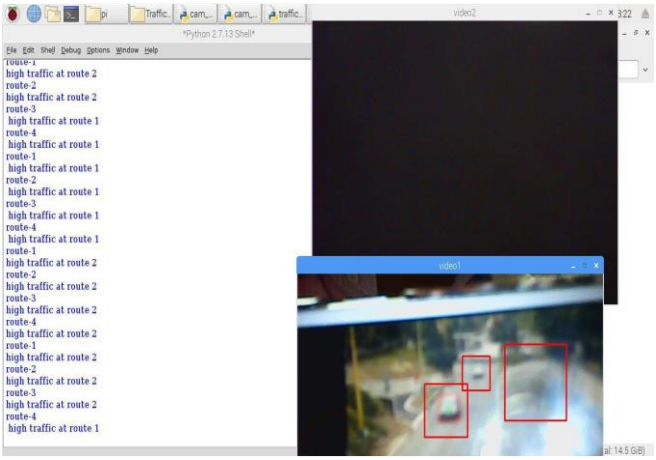
In the initial phase all the traffic lanes get equal signal timings that rotate in clockwise and executes as above screenshot explains when trafficlights.py is run from python 2(idle). In the next case when both the usb webcam from both lane are executed such that both captures traffic but the traffic is cleared first in the lane where the founded vehicles are more. This is described in the next screenshots.



traffic when both the cam captured frames

From the above Screenshot, if we observe the traffic in lane 2 is heavy such that traffic is cleared first in lane 2 based on the comparison between two videos



Traffic only when one webcam works

ISSN PRINT 2319 1775 Online 2320 7876

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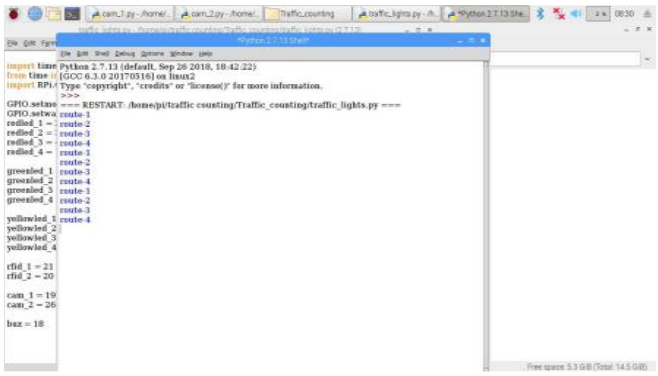

No of vehicles found through Webcam

Performance Evaluation

In this project we found the traffic density (count) by Using webcam through OpenCV tools. we used a dataset cars.xml and we detected the vehicles with 70% accuracy because of the repeated tests conducted by us by live feeding the webcams with live footage of traffic and comparing the results obtained also we used RFID for emergency vehicles that the reader gets activated when vehicle approaches near it and instantly updating the light even if there is heavy traffic in other lane. RFID provide not much accurate when there is heavy traffic on all sides. we think this can be achieved through the points discussed in the future work of this project by maintaining a centralized server.

Conclusion and Future Scope

A prototype was developed to demonstrate the applicability of our proposed system. Several experiments on real traffic data were carried out to evaluate the efficiency of the proposed algorithm. The traffic was monitored and calculated by vehicle detection through cam detection technique. As soon as the traffic crosses the specified threshold on a road, the system stops the normal operation and keep the green light on till the situation on the road became normal. In this study, images processing techniques are applied for detecting and tracking faulty drivers in a highway traffic. For detecting the vehicles Haar Cascade classifier is used. The axes coordinate of the detected vehicles in the image are evaluated and faulty vehicles are tried to detect according to this axis's coordinates. System accuracy rate reaches a very good value. This study shows that Haar Cascade classifier is a good candidate for object detection. Also, the no of vehicles Passing by can be obtained in the terminal of the raspberry pi.

This project presents an effective solution for rapid growth of traffic flow particularly in big cities which is increasing day by day and traditional systems have some limitations as they fail to manage current traffic effectively. Keeping in view the state-of-the-art approach for traffic management systems, a smart traffic management system is proposed to control mad traffic situations more efficiently and effectively. It can further extend the signal timing intelligently according to traffic density on the particular roadside and regulates traffic flow by communicating with local server more effectively than ever before. The decentralized approach makes it optimized and effective as the system works even if a local server or centralized server has crashed. The centralized server communicates the nearest rescue department in case of an emergency situation which provides timely human safety. Moreover, a user can ask about future traffic level at particular road hence avoiding wastage of time in traffic jams. The system also provides useful information to higher authorities that can be used in road planning which helps in optimal usage of resources.

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