Traffic Congestion Management and Monitoring in IoT

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Abstract— Cities are developing at a faster pace with increase in population giving rise to increase in no. of vehicles on road. This has resulted in heavy traffic congestion. Research has been going on based on Internet of things for the reduction of traffic congestion. One of the most recent research topics in the Internet of Things is Intelligent Traffic System. Existing signal system lacks the technology to handle the traffic in efficient way. Using IOT, we can propose the alternate approach to improve the traffic conditions. Proposed system makes use of different sensors which are deployed on the roadside for collecting data regarding congestion which will be further processed by the micro controller situated on the traffic signals. Depending on the threshold, the signal can be controlled dynamically and efficiently. This paper also includes higher priority for emergency vehicles like Ambulance such that the lane that contains emergency vehicle would go first until emergency vehicle passes.

Key words: Internet of Things, Microcontroller, Congestion Control, Intelligent Transportation System

I. INTRODUCTION

In the past decade, the definition of IOT has been more inclusive covering wide range of applications, like utilities, transport, healthcare, etc. Nowadays, Traffic Congestion is the biggest problem faced by densely populated countries like India, China etc. One of the main problem causing traffic congestion is large red light delays. To manage and monitor the traffic congestion, IOT can be used. IOT is the network of physical devices, vehicles, and other items embedded with electronics, software, sensors and actuators, and network connectivity which enable these objects to collect and exchange data. In the traditional traffic management system, ineffective traffic lights with predefined timers are used, which are even manually controlled by police officers. Without considering real-time data, it can happen that the green signal is active to the roads with less traffic, while lot of vehicles are waiting on the other side of the road with active red signal. Such problem can be managed by using dynamic signal approach, due to which some unavoidable circumstances like waiting time, accidents, etc. can be reduced. Our proposed approach aims to implement dynamic control of signals based on real time traffic conditions. Another major problem in of unmanaged traffic congestion is faced by ambulance or any emergency vehicles, delays in such a vehicle can cause unexpected results. Such a problem is also solved in the proposed system; the signal is turned green immediately after the emergency signal received from the Ambulance driver.

II. LITERATURE REVIEW

A. IOT based smart city traffic alert system design

There are many attempts to deal with traffic congestion has been done by KeertiKumar B Malagund,Shubham N Mahalank ,R . M. Banakar [1].It has detailed analysis of the smart traffic city alert system operation. This system can be made using the Raspberry Pi board, routers, ultrasonic sensor and Email servers. Sensing traffic and alert service providing unit. The developed traffic alert algorithm is unique in nature which caters to hardware operation and software process unit design. Smart traffic alert system uses Ultrasonic sensor to detect the congestion then sends signal to the Email server through the routers which are used to connect the Raspberry Pi board to the server. In turn, the email server sends email to the traffic police about the congestion in a particular area. Advantages of this system is, it gives solution by sending notification and emails to police personal. Cost factor is the major disadvantage as Raspberry pi is costlier and ineffective.

B. Simulation of traffic management systems using Arduino boards

Traffic congestion can be managed by simulation which is proposed by GHEOHGHIU Razvan Andrei, TIMNEA Radu Serban, STAN Valentin Alexandru, and BURETEA Laurentiu Dorin [2]. It has a laboratory model called as Data acquition system architecture to avoid conflicting and potentially dangerous commands, such as green or red light malfunctioning. This paper also gives an objective that if the system is capable to generate proper responses in different traffic situations like priority requirement. In this model, Arduino boards are used for controlling signal group whether it simulated or not. This paper evaluated the existing system of traffic by monitoring their responses and determining their efficiency. So, the main purpose for a traffic management system model was to determine the system responses in the special situations. This model is useful for both for didactic purpose and for the existing system. This paper proposed an adaptive traffic control system and the main objective is to administer a complex traffic management system by adding different modules.

C. Priority Based and Secured Traffic Management System for Emergency Vehicle using IOT.

For the priority based vehicles Abdullahi Chowdhury [3] has proposed Intelligent Traffic system. To reduce the traffic congestion and to provide a clear pathway to the emergency vehicles in the urban area an innovative ITS system considering the priorities of emergency vehicles based on the type of an incident and a method for detecting and responding to the hacking of traffic signals have been proposed in this paper. In first method in which hacking is not involved, Emergency Control Room collects the data from incident and reports to the Central Traffic Controller and then it controls traffic signals to clear traffic for emergency vehicles. In case of hacking if a particular traffic signal profile significantly deviates from its normal pattern, it can be interpreted as a hacked signal by the central traffic controller by using an approach similar to the statistical anomaly detection used in intrusion detection can be used to detect a hacking. Once the hacking is detected, the controller restarts the normal traffic patterns in all hacked traffic signals.

D. A Communication-oriented Perspective on Traffic Management Systems for Smart Cities: Challenges and Innovative Approaches

There are many challenges and approaches towards the smart cities that has been done by Soufiene Djahel, Ronan Doolan, and Gabriel-Miro Muntean [4]. This paper proposes methods for improving the efficiency of Traffic Management System (TMS) in Large and Smart Cities. Furthermore, methods have been researched such that it could cope up with ever growing population and to build future smart cities. In TMS, the most important phase is Data Sensing and Gathering (DSG) in which heterogeneous road monitoring equipment measure traffic parameters (such as traffic volumes, speed and segments occupancy, etc.) and periodically report these readings to a central entity. Then these data feeds are fused and aggregated during the Data Fusion, Processing and Aggregation (DFPA) phase to extract useful traffic information. Data Exploitation (DE) uses this processed data to compute. Finally, Service Data (SD) phase, in which TMS delivers this knowledge to end user. The advantage of this system is that, it provide potential use of smart cars and social media to enable fast and accurate congestion detection and mitigation. The limitation is also present which is, this system is insufficient to build a reliable and secure TMS that can handle rise of vehicles in smart cities .

E. Internet of things: A new application for intelligent traffic monitoring system.

An Intelligent traffic monitoring system has been proposed by Laisheng Xiao, Zhengzia Wang[5]. This paper gives an idea about how intelligent traffic monitoring system or traffic congestion system can be managed or monitored by using Internet of things. Internet of things has a number of advantages such as low cost, high reliability and it is never affected by bad weather. This paper explored the issue about traffic congestion and proposed a feasible approach. Automatic detection of vehicles by using vehicle license plate is falling in the trap due to its low recognition rate and affected by adverse or bad weather. This paper introduced a global unique electronic power controlling code as identity identification or detection of vehicles instead of license plate and utilized RFID to read EPC code. Next technology is GPS by which the position of the vehicles can be obtained and lastly, GPRS which provide high speed services for the users. Mainly RFID reader is used for reading the EPC code which is available on the vehicle. And the limitation is, it is not applicable for fully automatic monitoring and management for vehicles and highways in an intelligent traffic monitoring system.

F. Automatic Intelligent Traffic Control System

Automatic Intelligent Traffic monitoring system has been proposed by Lingangaouda R, Pyinti Raju, and Anusuya Patil [6]. This paper focuses on the problem faced by ambulance, priority based vehicles and how to control the traffic density. This is a real time scenario. Firstly, they proposed a solution for ambulance by using RFID concept. RFID is used to green the ambulance lane. Then, this paper gives an idea for priority based vehicles. For this, they have used Infrared transmitter and receiver for greening the signals of vehicles lane. By this, congestion must be prevented. And lastly, they focused on the density of traffic. The advantage of behind this system is that, it provides IR transmitter and Receiver and RFID for emergency or priority based vehicles. And the limitation behind this is that, there is no any automatic control on the traffic density and fast treatment of the patient is not possible.

G. Advanced Traffic Management System using Internet of Things

There is another system for densely populated areas which has been proposed by Mahesh Lakshminarasimhan[7]. This paper gives an idea about the traffic condition in densely populated areas like Amsterdam and Los Angeles. This paper proposes an advanced traffic management system which is implemented using Internet of things. Later, an architecture was proposed based on big data analytics including Hadoop. This paper also gives an idea of supervised learning which will help in presenting or determining the standards of road, overall traffic cost, calculating the average speed of different vehicles on the road. This paper also proposed an idea for the shortcoming of traditional traffic management system. The main advantage of this system is that, it provides Big Data analytics and RFID. And this paper has some design complexity issue.

H. Development of IOT device for traffic management system

IOT device has been developed for Traffic management system by Hon Fong Chong, Danny Wee Kiat Ng [8]. This paper proposes an idea for the development of internet of things for the traffic management system. They have used an IOT cloud server. They have also introduces GREEN LIGHT PHASE TIME which helps in reducing the queue length and waiting time of vehicles on the roads. The system also replaces the current system of traffic police on duty in the morning and evening peak hours. In this paper, IOT Cloud server is provided, which is the main advantage for managing and monitoring the traffic congestion. There are certain limitations present like Fixed cycle TLS is unable to cope with dramatically increase of registered vehicles.

III. EXISTING METHODOLOGY

As we know, traffic congestion is drastically increasing day by day. The main reason behind the traffic congestion is due to the rise of vehicles. We all know India is a populated country. As the population is being increasing, the number of vehicles also getting increased. This leads to heavy traffic congestion. Traffic signal is also the major reason for the traffic congestion. Our existing system have static Traffic signal. This traffic signal is unable to control the heavy traffic congestion. If there is a crossroad, which consists of four roads. If there is no traffic congestion in first road, then also signal turns green for that direction. So, this is a major problem for the traffic. And the traffic on other road remains constant. If there is an emergency vehicle like ambulance on other road, it will remain in the traffic until the signal on other road turn to green. Present system is unable to solve the traffic congestion problem. So, proposed system is dynamic control of the signal. And also, the priority based vehicles does not get stuck in the traffic. Proposed architecture that is the dynamic traffic signal helps in reducing this kind of problem.

IV. PROPOSED SYSTEM METHODOLOGY

A. System Architecture

This paper proposes an idea for the development of internet of things for the traffic management system. Existing system makes use of static signals to control the traffic, which is not so effective. To overcome traffic problems problem, dynamic signal control is introduced in this approach. The main objective of this system is to control traffic congestion at the signals by dynamically controlling the signals. Proposed system uses sensors placed on roads which collect the data about the congestion and the sensed data is sent to micro-controller that controls the signal by activating GREEN LIGHT PHASE TIME which helps in reducing the queue length and waiting time of vehicles on the roads. Following figure shows the system architecture.

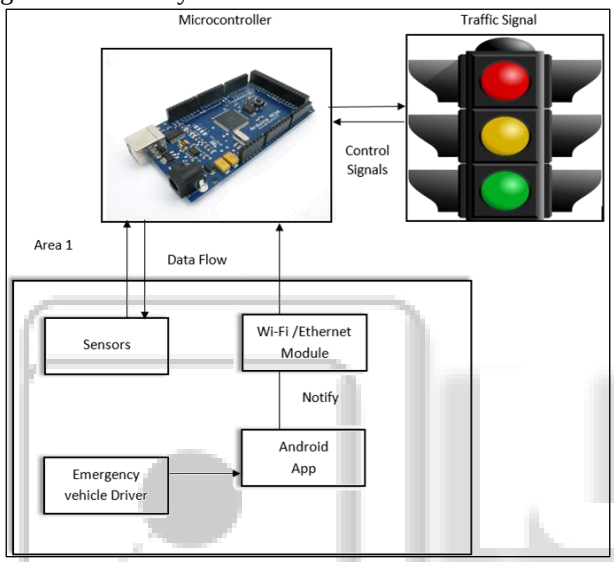

Fig. 1: Traffic Management System

B. Dynamic signal control

Ultrasonic sensors are fixed on each road at the cross road, sensors sense the traffic data and sends to the microcontroller. The two ultrasonic sensors are considered, which are fixed at different distance from the signal on each lanes, the data at first sensor is considered as moderate level of traffic and data at second sensor is considered as excess level of traffic. Microcontroller switches the signal according to the sensor data and switching mainly depends on congestion.

C. Preference to Emergency Vehicle

The proposed architecture also handles the case of emergency vehicles. Proposed approach includes an app especially for emergency vehicles. First the vehicle should be registered to use this service. If the vehicle is already registered, it will send signal to the Wi-Fi module deployed on the Microcontroller. Microcontroller will receive the control signal and gives higher priority to the lane having emergency vehicle. As a result, the lane having higher priority emergency vehicle will turn to green until emergency vehicle passes through it. Later, other sides would be sent according to traffic status at that moment.

V. IMPLEMENTATION

A. Proposed Algorithm

1) Start
2) Receive data from the sensors to microcontroller.
3) Convert the data in cms.
4) Set the flags according to the data received to not congested, congested or fully congested.
5) If(Ambulance detected)
6) green light to particular road till Ambulance passes.
7) else
8) If(Road1 is fully congested)
9) road1 have green signal for 5s.
10) Similarly check and make signal green for other fully congested roads.
11) elseIf(road1 fully congested && road2 is congested)
12) road1 have green signal for 5s then road2 have green signal for 3s.
13) Similarly check or other roads which are fully congested and congested.
14) elseIf(road1 is congested)
15) road1 have green signal for 3s.
16) Similarly check for other roads which are congested.
17) elseIf(no road is congested)
18) Blink yellow lights.
19) Continue checking for the roads which are congested, not congested or fully congested.
20) Goto step2.
21) Stop

B. Results and Discussion

The inputs which are been given are the data that has been captured from sensors. By using that data, switching of signal takes place. Microcontroller plays an important role in switching of the signals. Working of the system totally depends on the congestion data received and applied on real-time basis on the system without delay. Results obtained through this can be seen further below step by step as system runs.

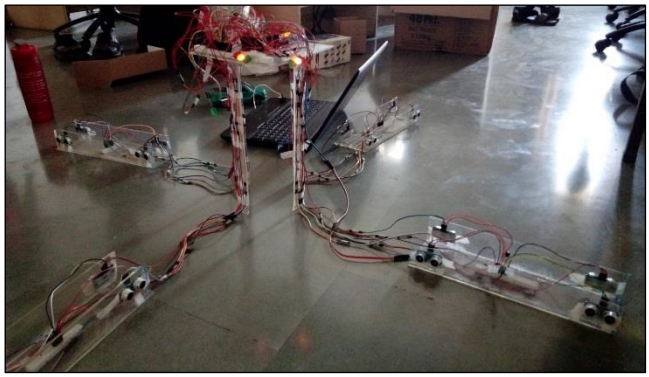

Fig. 2: Dynamic Signal Model for normal traffic conditions

Above snapshot shows blinking of yellow signal. This shows that, there is no congestion and all the vehicles can pass slowly through this location. Vehicles will pass normally without any delay.

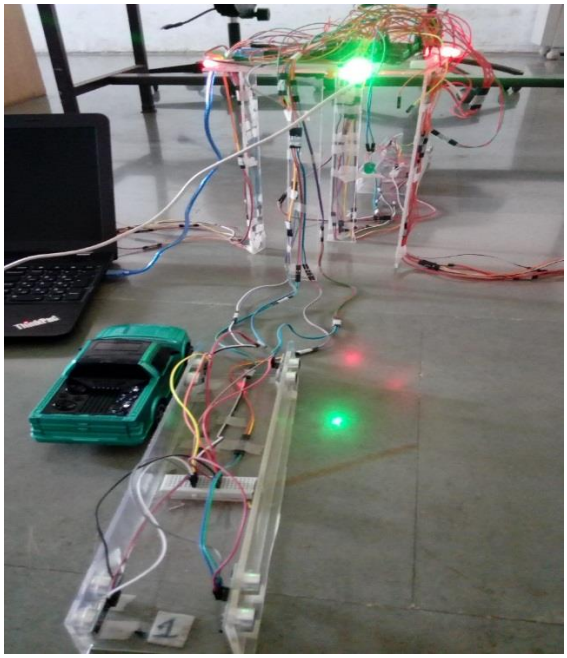

Fig. 3: Dynamic Signal Model for Congested Roads

Above snapshot shows that as road1 is congested microcontroller gives priority to road1 and it turns green signal on of road1.

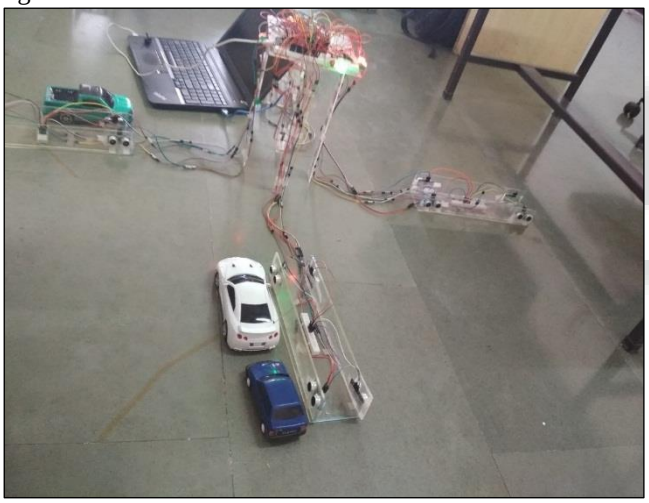

Fig. 4: Dynamic Signal Model for Fully Congested roads

This snapshot shows that when there is full congestion on one of the road (road4) and other road (road1) has normal congestion then microcontroller gives priority to fully congested road and signal of that particular road turns green. After that signal of another road turns green. There are proper delays for both the roads. As road4 is fully congested, so green signal of road4 glows for longer time than normally congested road (road1).

There are two ways to give preference to the emergency vehicles in this proposed system. First way by using hardware components like IR Indicator and IR Detector and second, by using Ambulance Trace App.

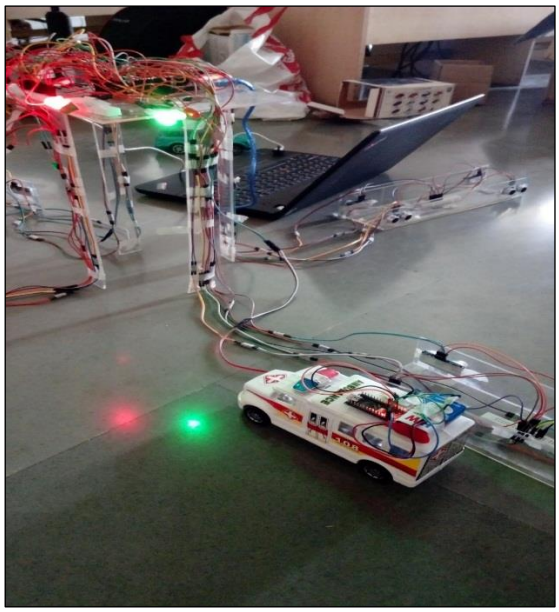

Fig. 5: Dynamic Signal model for Ambulance Detection

Above snapshot shows that signal turns green when any emergency vehicle comes near to signal. It happens with the help of IR detectors which are placed on the dividers near to the signal. IR indicators are present on emergency vehicles when these vehicles comes near to the IR detector it detects the IR indicator and it sends the data to the microcontroller and microcontroller gives highest priority to it and signal turns green of that particular road.

Fig. 6: Ambulance Trace App GUI Interface

This screenshot shows the GUI of Ambulance Trace App. This app contains two buttons i.e. show location and notify. When ambulance driver tap on show location button then it will show the exact location where the ambulance is. This also shows the latitude and longitude points. When driver click on

Notify button then it communicates with the Node MCU and it glows green light.

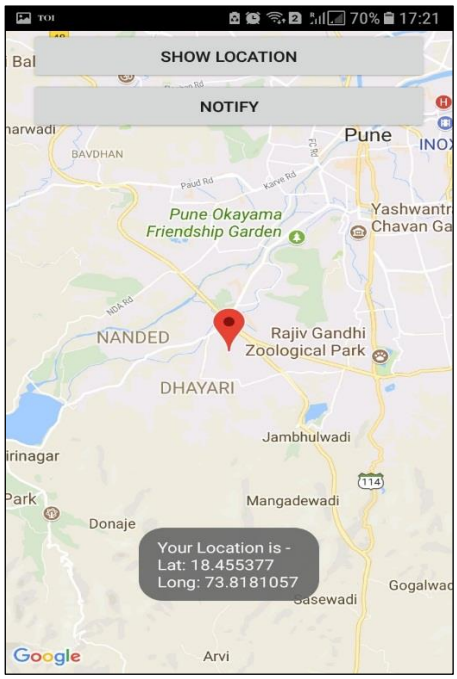

Fig. 7: Ambulance Trace App Tracing location of Ambulance

Above screenshot shows the current location of Ambulance when the ambulance driver tap on the show location button. This will show the exact location with longitude as well as latitude.

Fig. 8: Dynamic Signal Model for Priority Vehicle Detection

This snapshot shows that when ambulance driver tap the Notify button then signal turns green of that particular road though there is congestion on other roads, signal gives priority to the emergency vehicle.

C. Conclusion and Future Work

In this paper, a dynamic traffic signal is proposed by which all the traffic congestion related issue can be solved. Proposed approach reduces the traffic at signals by dynamically controlling the signals which is achieved by using the microcontroller that controls the signal and sensors which gives the data about the congestion. In addition, the proposed scheme also helps for the emergency vehicles. For future research, the proposed architecture will be applied to the auto detection of the emergency vehicles like ambulances and location detection of vehicles. The proposed system will be applied by using image processing for detection of vehicles.

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