IoT Based Traffic Signal Management System Using Wireless Sensing Network

Manish Shriram Patil
E&TC, Sinhgad College of Engineering,Pune
Savitribai Phule Pune University Pune, India

Dr.Achala Deshmukh
E&TC, Sinhgad College of Engineering,Pune
Savitribai Phule Pune University Pune, India

***Abstract*—**Traffic signal plays a critical role in smart cities for mitigating traffic congestion and reducing the emission in metropolitan areas. This paper proposes a Smart traffic signal timing Management System using IR sensor, to minimize the traffic delay for vehicles passing through an intersection. IR sensor is used to count number of vehicles passing signal and will send report to traffic monitoring and control (TMC) for traffic estimation. Traffic data obtained from this sensor is clustered in TMC which forms data logs stored in database, which can be used to express traffic information as per our systems requirement. TMC system consist of microcontroller (ATmega32),Bluetooth controller (HC-05), ADC and android device to connect server to sensor to receive traffic information. Data collected from the database, using dynamic time division for signal algorithm system intelligently decides amount of delay timer of Green-Orange-Red traffic signal light.This delay timer is set automatically based upon flow of traffic on each road of respective junction and data maintained in database.

***Keywords*—** *AVR microcontroller,IR Sensor, Analog to digital convertor (ADC),Smartphone. Bluetooth Controller (HC-05), Dynamic time division for signal algorithm.*

I. INTRODUCTION

The demand for vehicle has increased tremendously along with the population and economic growth of our country but the infrastructure growth is increasing slowly because of limited area available. The traffic congestion in metropolitan cities has been crucial issue for practical operation and researchers. Appropriate solution can't be obtained regularly by providing new infrastructure. Therefore we need to use the existing infrastructure via smart and intelligent traffic management seems more feasible for development and implementation of traffic signal control technique.

A situation of very high traffic congestions is gridlock such situation arises when local queue spills back by restricting traffic movements in all possible directions. The urban gridlock is highly effected by the gridlock. Transportation of labour,goods,machinery are the key factors which influences the environmental and industrial development of any country.The mismanagement and traffic congestion will result in long waiting time,loss of money and fuel.Therefore it is neccessary to have efficient and economic traffic control system for countries development.

Traffic controlling is becoming major problem in many countries.Traffic controlling authority needs to find solution for this problem which is arising due to overuse of vehicles on road.There are many measure taken to reduce such problems like building of inner and middle ring roads,During peak hours there should be the restrictions of heavy vehicles etc.One of the method which can be use to overcome this issue is to built a smart traffic signal system using wireless sensors.

II. RELATED WORK

Zahra zamani [1] has described the work of various applications of data mining tools.The case study was carried out to demonstrate the use of hierarchical cluster analysis. Total time of day signal control system was designed using evolution. This system defines time of day(TOD) intervals automatically using previously collected data.The proposed system uses sensors for counting the total volume of traffic at each junction. Each sensor counts the number of entry vehicles. The time of day is decided by the data collected by creating the clusters using Clementine software.

After studying this paper we can conclude that, this system recovers historically detected data and clusters the information over 24 hours time period. This system is not able to control real time traffic flow and cannot provide or measure the different environmental condition But it generates daily Time Of Day interval and timing plans based on previous data trends.

Chunga yang [2] has presented a paper which describes about the use of embedded technology and wireless sensor (infrared sensor) Network to smartly deicide the time of Green, Red light at each junction of road based upon the total traffic on all neighbouring road. Users who need to know the present position of traffic congested roads are provided with cell phone interface which helps to select shortest and traffic free route to the car drivers.

After complete study of this paper one comes to know that the proposed system controls the traffic signal on the basis of length of vehicle of every road. Therefore generating output signal for Green, Red and Orange traffic light but this system uses GSM module to provide the traffic information only to

those who have done pre-registration Hence it is not much user friendly.

Imane L'hadi [3] in there paper has discussed about the use of solar light pads efficiently which are deployed in dangerous areas of highways. The proper arrangement of poles is done in groups in such a way that each group was equipped with an actuator sensor and a sensor for detection of vehicles and for switching light-emitting diodes of group poles(actuators) on or off. The communication between the components of system was done using Zigbee Network which were transmitted by the use of repeaters.

After studying this paper we understand that how proper lighting can reduced accidents in dangerous portion of highways and also we get the idea of using Solar Panel efficiently with Embedded System can be utilized in such areas.

Anand Gupta [4] has discussed about the proper utilization of GPS data for mining . It will help in the detection of various location, which faces the frequent traffic congestion. Every GPS enabled devices like Tablet ,Mobile, and different vehicle has accessed to the data thus knowing future traffic congestion, which helps the user to decide route having less traffic.

After studying this paper we can conclude that there are few flaws such that it does not give accurate output because it cannot distinguish between jams and random short–term stoppages. The author had discussed about clustering as the solution for it , this system is capable only of detecting traffic congestion. This system can't control real time traffic.

Kitae Jang [5] in there paper have discussed about controlling and signal monitoring by detecting grid lock situation. They have developed systems that makes use of algorithm called signals optimization algorithm, which aims equalization of the growth rates across links in over congested Urban road ways network .This algorithm is capable of delaying queue by distinguishing the queue over those links which are rarely used. This built system can avoid traffic congestion but it is not able to control the real time traffic congestion.

III. HARDWARE DESCRIPTION

The design aspect of individual modules are considered. A brief notes of various devices used are discussed in this section.

A. Silent Features of Microcontroller

AVR family Microcontroller (ATmega32) is used for implementation of this project.ATmega32 is 8 bit higher performance microcontroller of Atmel's AVR family. It is based upon enhanced Reduced Instruction Set Computing (RISC) architecture having very powerful instruction sets. At mega works on the maximum frequency of 16MHz.

B. Bluetooth Module

The Bluetooth module used in this project is HC-05,which is a wireless technology used to share or exchange the data between two Bluetooth connected devices having range about 10-15m.HC-05 operates in between the frequency range of 2.4 GHz to 2.4 GHz.

C. IR Sensors

IR sensor is a non intrusive sensor, which are developed above ground level. IR sensor counts the number of vehicles passing through the given junction in analog form which are further changed into digital form through ADC

D. Smartphone

In this project an android application is developed using android studio software so use of android mobile is used.

IV. SOFTWARE DESCRIPTION

Java language is used to develop the code for running smart traffic signal management system Java code can be run on every platform which supports Java even without the need for recompilation. Android studio application is used to developed an android application for mobile phone in which coding for the total time delay of signal is performed.

Net beans software is used to display the real time data along with the location of all junctions. Coding for the data to get stored in database is done. Net beans allows various applications to get developed from set of different modules components known as modules. MySQL is used which is the open source database management system.

V. SYSTEM DESIGN

After taking into account literature survey and taking the proper judgement of the need throughout the world, these papers are made less extreme and A new method is built which predicts the traffic flow of each junction of road and automatically sets the delay for Red light having heavy traffic. Fig1.shows the Architectural diagram which helps to understand proposed system in a easy way. The system mainly consists of two sector which all together communicate via wifi network with each other and form a perfect system.

Primary sector is the PC base station where all the data is stored in data logs which is obtained from the system location. The data stored forms the data base, known as data logs. Using this data logs the delay time of traffic signal light is controlled.

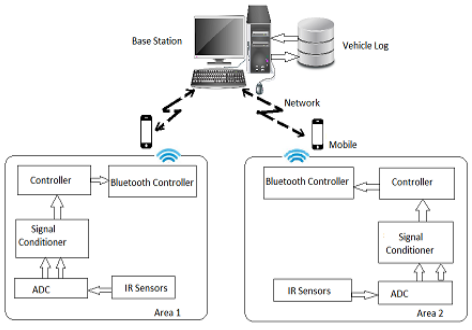


Fig. 1. Architectural framewok of Smart Traffic Signal Management System

Secondary sector includes complete hardware made up of IR sensors which captures the premier data in real time, microcontroller of AVR family, Android mobile phone to exchange information with hardware and to upload the data to the server, finally a Bluetooth device (HC-05) is used to connect Smartphone to hardware. Android application is developed in this device which is not restricted to any coherence clauses. This module is actual Traffic Controlling and Monitoring Module (TMC).The proposed operation of Smart Traffic Signal Management can be understood in effective way with the help of following:-

Firstly, IR sensor sense the number of count of vehicles and forward it for analog to digital conversion using ADC. After the conditioning of this signals, the signal forwarded to microcontroller. Main function of the microcontroller is to convert digital data into the user define format and then transfer this information to server via mobile phone, HC-05.All the collected data is then stored in database forming data logs, where the real time data mining on obtained data is carried out due to which system will provide allocation of time for delay of red-orange-green signal respectively.

This project has two categorical indicators outlook, Firstly traffic flow for each junction and secondly the traffic flow on a road. Proposed system is intelligent enough to decide when to glow signal light green and smartly decide the delay time for red-green -orange signal light to glow using information stored in database performing dynamic time division for signal algorithm. It can be understood in following way;

Say,

S1,S2,S3 and S4 are the four signals, then Therefore, total time(T) distribution for signal can be calculated as :

$$\text{Total Time(T)} = \frac{\text{Total Count of Vehicles at S1}}{\text{Total Count at Evry Vehicle}} \times 120$$

$$\text{Total Time (T)} = \frac{S1}{S1+S2+S3+S4} \times 120$$

We must note the 120 is the default time which is set at initial stage. It is not mandatory to keep default time as 120.

A. DATA FLOW DIAGRAM (DFD)

a) We collect all values from the sensors as input.

b) Update the vehicle count and send it to the database and aslso display on PC.

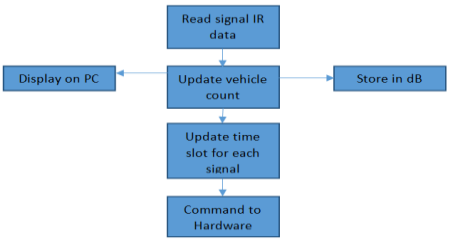


Fig. 2. Data Flow Diagram

c) At Server end,it need to perform multiple tasks such as storing the data in database and comparing threshold value.

d) Finally command is given to the hardware and then by making use of available data in datalogs,the system decides the delay for which the traffic signal light remains green,orange and red depending on real time traffic flow.

VI. RESULT

The final result of proposed smart system takes the input from IR sensors in the form of number of counts of vehicles and forward it to Bluetooth device in digital form.

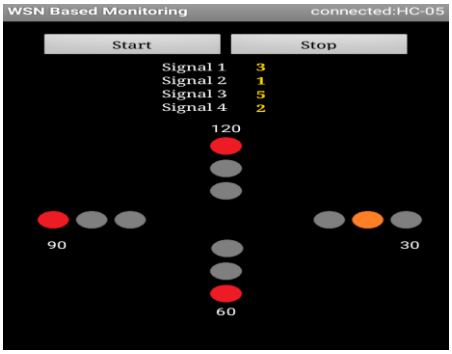
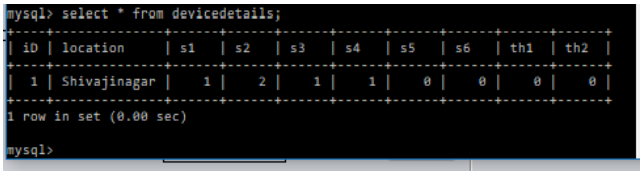


Fig. 3. Traffic signal Systems information at associated junction

By making use of available data in datalogs,the system decides the delay for which the traffic signal light remains green,orange and red depending on real time traffic flow. Fig 3. shows the screen shot of the information that controls the traffic light at associated junctions.



```
mysql> select * from devicedetails;
+----+-------------+------+------+------+------+------+------+------+------+
| iD | location    | s1   | s2   | s3   | s4   | s5   | s6   | th1  | th2  |
+----+-------------+------+------+------+------+------+------+------+------+
|  1 | Shivajinagar |    1 |    2 |    1 |    1 |    0 |    0 |    0 |    0 |
+----+-------------+------+------+------+------+------+------+------+------+
1 row in set (0.00 sec)

mysql>
```

Fig. 4. Screenshot of the information stored in database.

By After the IR data is reads it gets updated at database in the form of data logs. Fig. 4 shows the screen shot of the counts at different locations.

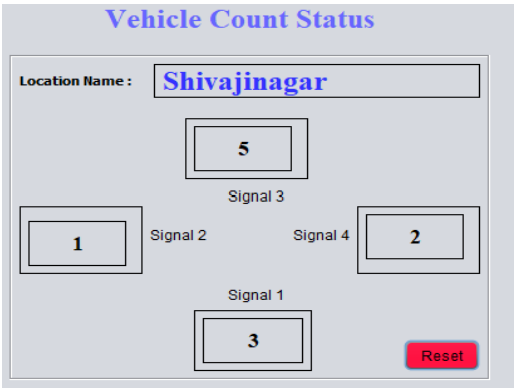


Fig. 5. Display of Vehicle Count to admin at control room

The count gets updated at database and it also get displayed on PC at control pannel room for admin.Fig 5 shows the screen shot of data being displayed on PC. Also Reset button is provided for emergency vehicles.In such cases when admin presses reset button it will set all the signals in default state and signal will be red for very less period of time.It should be noted that the vehicle count shown in above figures is taken to explain the final results.As the readings will be real time it will change with completion of each cycle.

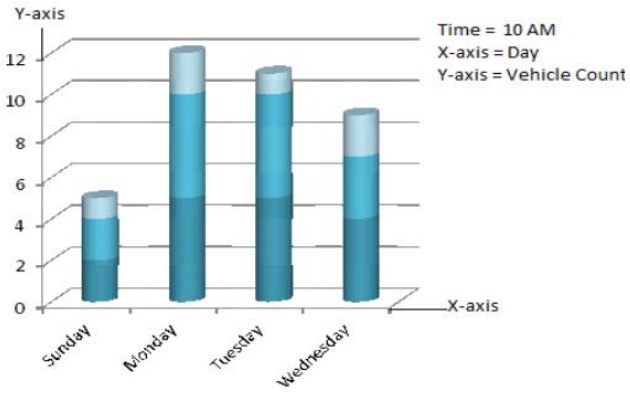


Fig. 6. Data Graph

Fig.6 shows the data graph of survey being done on the basis of time per day traffic. Survey can be done on the basis of the data stored in database by comparing two different locations or one location on the basis of month,day or time wise traffic counts and then we can take preventive measures to stop accidents which may occur at more traffic congestion areas.

VII. CONCLUSION

After designing and developing a traffic light system successfully with proper integration of both the hardware and the software, since the waiting time of the vehicles for the lights to change is optimal, the emission of carbon monoxide from the vehicles is reduced. This will give a positive effect to the greenhouse effect towards the environment. The traffic light system will also save the motorists time and reduce their frustration while waiting for the lights to change since it helps in reducing congestion at the traffic intersections. In future camera can be implemented for security purpose and image processing technique can be implemented.

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