Density based Automatic Traffic Junction Synchronization

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Abstract: Traffic congestion nowadays has become a chronic issue in the Metropolitan cities due to which it takes more time to travel than the same distance travelled during the off peak hours. This decreases the productivity of an individual by instances such as delayed delivery of services, unnecessary fuel consumption, air and noise pollution, delay in the case of emergency. The traffic congestion has become a predominant problem due to the rapid increase in the demand of vehicles. In places where junctions are closely spaced, encounter a typical issue of lingering in the same traffic signal for multiple times due to the slow moving vehicle caused by congestion. In order to control this issue, research works have been carried out in automating the traffic control system with the help of sensors, image or video processing and also by prioritizing emergency vehicles approaching the junctions. However, employing camera to monitor the traffic is an expensive task. Thus, we are proposing the Density based synchronous of junctions that are closely placed which helps us to save our commuting time significantly and thus enhancing one's productivity.

Index Terms: Traffic congestion, density based traffic management, traffic junction synchronization.

I. INTRODUCTION

Technology has been improved and implemented widely and in almost all the sectors. A comfortable life is what the people of this century are leading with the help of devices and machines such as television, air conditioners refrigerators, washing machines and much more. For commuting purpose people choose to have their own vehicles rather than waiting for the public transport in a crowd. This increases the number of vehicles on the road which further hurdles the smooth flow of the vehicles on the road. Thus giving rise to the issue of traffic congestion.

Traffic congestion aids the road accidents due to the irritated drivers. Thus, controlling this issue becomes obligatory to avoid the unnecessary accidents.

Traffic Signaling Systems employed are still dependent on a trained policeman for the density based controlling. This is a tedious job for a person to perform as the traffic congestion is increasing day by day. To ease his job, we take the help of technology by using certain devices to understand the traffic condition and take necessary decisions to control the situation. The traffic density is detected by the help of sensors whose reading are fed to the microcontrollers that are programmed to take the necessary actions according to the condition of the traffic congestion. The emergency vehicles are not prioritized on the road which leads to delay in serving the needy or the victim. There are hundreds and thousands of cases in which the victim or the patient dies on the way to the hospital due to the traffic congestion caused on the way to the hospital. Also, there are cases where the emergency vehicles are unable to reach the place on time where the accident has occurred because of the traffic congestion. Thus, to avoid this scenario, we need to prioritize the emergency vehicles on the roads so that they reach the needy at the right time to serve them better.

II. LITERATURE SURVEY

In this section, let us discuss briefly some of the research works relevant to the Traffic Signaling Systems. Initially, the traffic congestion problem was brought under control with the help of timers that are predefined by observing the junction for a significant amount of time. This controlled the traffic issues in places where there were constant flow of vehicles. This model is still followed in most of the places in India. However, this method fails in the places where vehicles' flow varies according to the time of a day.

Microcontrollers like PIC microcontroller [1] are employed to detect the traffic density by counting the number of vehicles on the road at every minutes of the day. The data was sent to the master microcontroller which was accessed by the administrator at the central station. The administrator would decide the change in the traffic lights according the traffic condition.

Density detection was done with the help of another technology i.e. Image processing [2] that helps us to regulate the traffic congestion. This method enhances the use of infrastructure although the operational cost is high.

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IR sensors [3] were made use to detect the traffic density. The sensors would detect the density of the traffic and return the data to the microcontrollers that decided the glowing time of the green traffic light. The sensors are placed on the sides of the lane which would sense the presence of vehicles thus detecting the traffic density.The emergency vehicles were given a priority with the use of Wireless Sensor Networks [4]. As the emergency vehicle approached the junction, this method helped to clear the congestion by releasing the vehicles of that lane by the use of certain fussy logic.

From the above literature works, we can understand that there has been no research done over synchronizing the closely placed junctions and regulate the traffic congestion problem with the help of traffic density detection. In our project, we have made use of Ultrasonic sensors [5] that are placed at a certain distance to detect the density and the same is reported to the microcontroller that are preprogrammed to take necessary actions according to the readings given by the sensors. Further, the two junctions that are density based traffic regulated are synchronized [6] with the help of master microcontroller.

III. DENSITY BASED TRAFFIC SIGNALLING SYSTEM

The whole idea of regulating the traffic congestion problem with the help of detecting the density of the traffic on the road is done using Ultrasonic sensors and Arduino. The concept of density detection aids to the priority based traffic regulation. The traditional ways to control the traffic congestion was improved by adapting the density detection theory.

Alongside, a priority is given to the emergency vehicles approaching the junction with the help of Radio Frequency Identification (RFID) transceiver. The emergency vehicles like Ambulance will be provided with the RFID tags. As the vehicle approaches the junction, the RFID receiver detects the signal and clears the traffic of that junction as soon as possible which helps the emergency vehicle to move faster even in the congested roads and reach the destination as soon as possible. The density of the traffic is detected using the Ultrasonic Sensors. The single sensor is placed at the pavement side of the lane. As the vehicles pass by the sensor, it becomes an obstacle and thus the sensor detects the traffic density. In this system, there are three traffic lights, Red, Yellow and Green. These are placed at the side of each lane of the junction. As the vehicle crosses the sensor, it detects that there is high traffic density in the lane. The lane that has high traffic density will be allotted with more time to release the vehicles. The data from the sensors about the traffic density is being transmitted with the help of serial communication to the Arduino where analysis of the received data is made and comes out with a suitable solution to regulate the traffic congestion. This data is saved for further use while synchronizing the nearly placed junctions. If there is an emergency vehicle detected coming towards the congested junction, the RFID receiver obtains the data from the RFID tag attached to the emergency vehicle and sends a message to the Arduino to clear that lane's traffic till the emergency vehicle passes the junction. The Arduino, when receives the message from the RFID receiver to clear the traffic congestion of a particular lane, it makes the green

traffic light of that lane to glow till the emergency vehicle passes the junction. Fig.1 shows the general block diagram of the entire traffic signaling system based on traffic density detection with the help of ultrasonic sensors and microcontrollers.
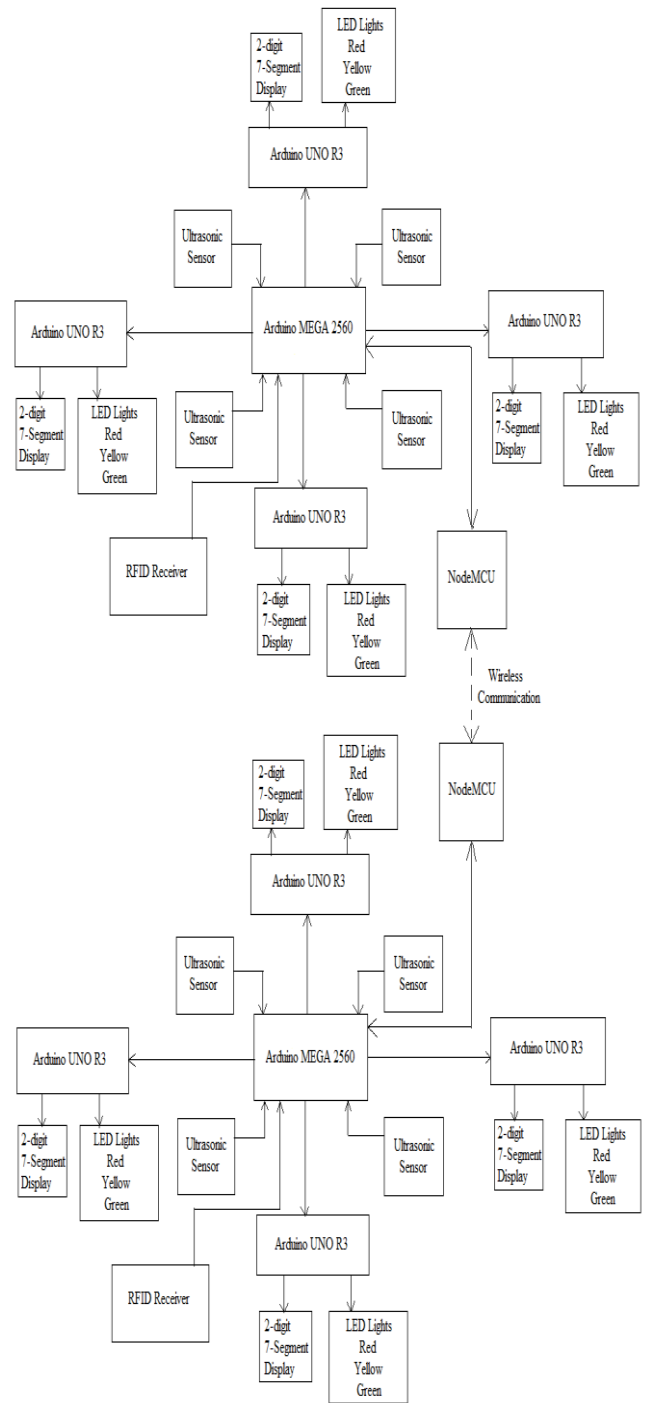

Fig.1. General Block Diagram

IV. HARDWARE AND SOFTWARE DESIGN

The Hardware components that are used in building this model are explained below briefly.

A. *Ultrasonic Sensor*

The Ultrasonic sensor shown in the Fig.2 is a device that measures the distance between two objects with the help of the time taken by the sound to reflect back from the obstacle or an object to the sensor.

It generates high frequency sound waves and calculated the time required for those waves to reflect back from the obstacle or an object. In our project, we have used Ultrasonic Sensor HC-SR04 to detect the density of traffic.
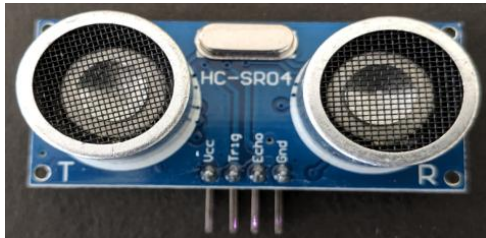

Fig.2. Ultrasonic Sensor

This sensor is interfaced with Arduino MEGA 2560. It transmits the information about the distance between the object and the sensor to the Arduino MEGA so that the Arduino can make use of the same data to accomplish density based traffic regulation. Fig.3 shows the interfacing of Ultrasonic sensor with the Arduino MEGA.
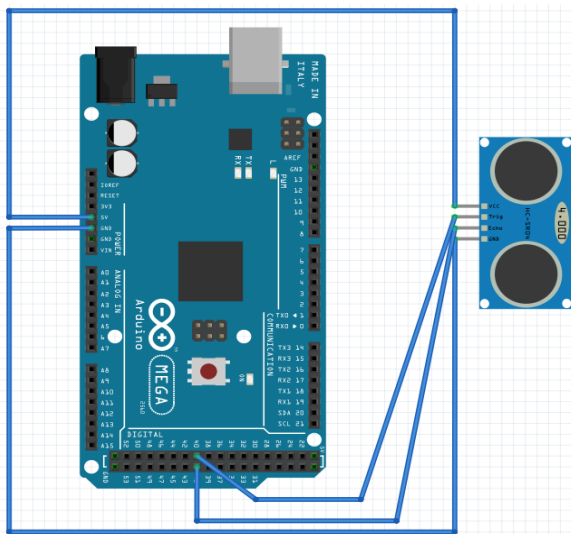

Fig.3. Interfacing Diagram of Ultrasonic sensor with Arduino MEGA

B. *Arduino UNO*

Arduino UNO shown in Fig.4 is one among the Microcontroller open source boards. It consists of several input/output pins that can be used to interface various other devices or components or other circuits. It can be programmed to act accordingly using Arduino Software. The program is uploaded using USB cable of type B.
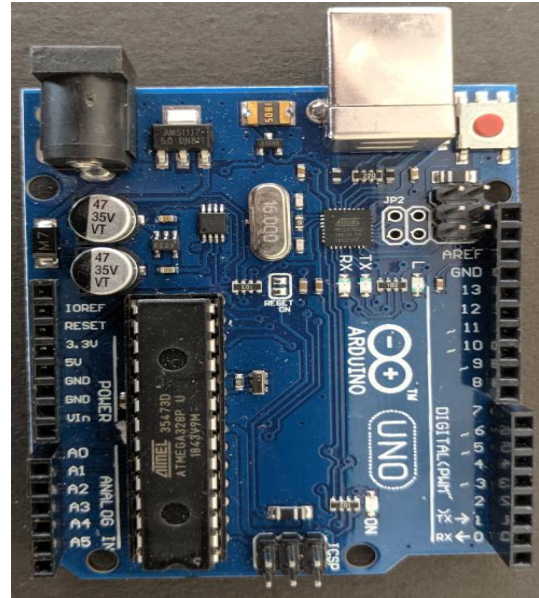

Fig.4. Arduino UNO

USB cable or a 9 volt battery is used to power the board. In our project, the Arduino UNO is used to interface LED lights and & segment display. The LED lights that are interfaced indicates the traffic lights and glow according to the commands given by the Arduino UNO. Similarly, the 7 Segment display is used to show the timer that has been assigned to each lane of a junction and down-counts the number till it changes the LED lights every time it reaches zero.

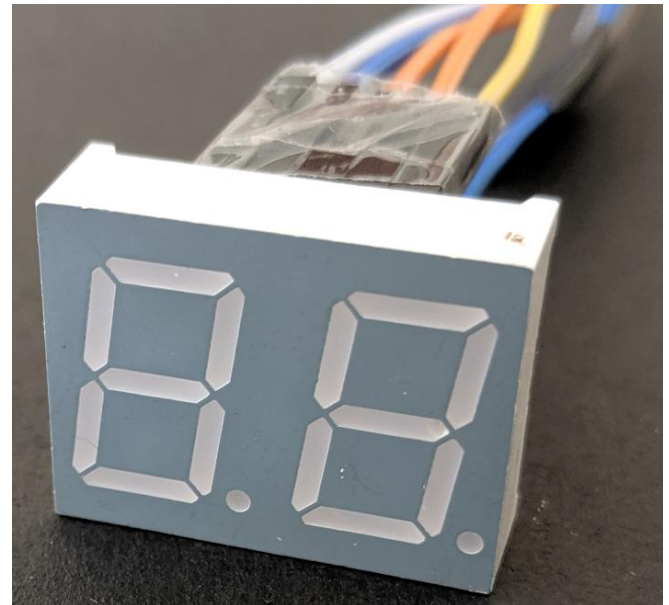### C. *2-Digit 7- Segment Display*

Fig.5. 2-Digit 7-Segment Display

The 7-segment display is used in our project to display the timer numbers that are preset to glow the traffic lights. We have used common anode configuration. It is interfaced to the Arduino UNO. Fig.5. shows the 7 segment display. Fig.6 shows the interfacing of &segment display with Arduino UNO.
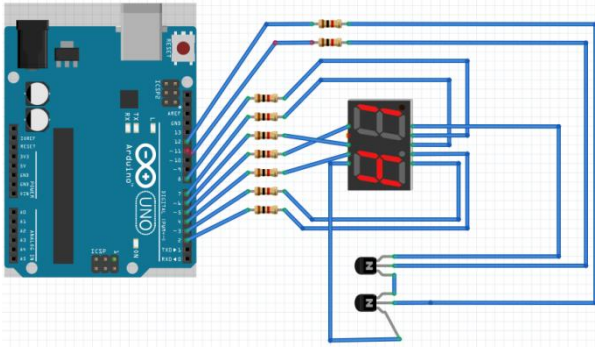
Fig.6. Interfacing diagram of 7-segment display with Arduino UNO

D. *Arduino MEGA 2560*

Arduino MEGA 2560 shown in Fig.7 is also another microcontroller open source board. This is made use for those implementations that need more number of input / output pins. It consists of 54 digit input / output pins and 16 analog input / output pins. It can be programmed by the Arduino Software with the required libraries and the same is uploaded using USB cable of type B.
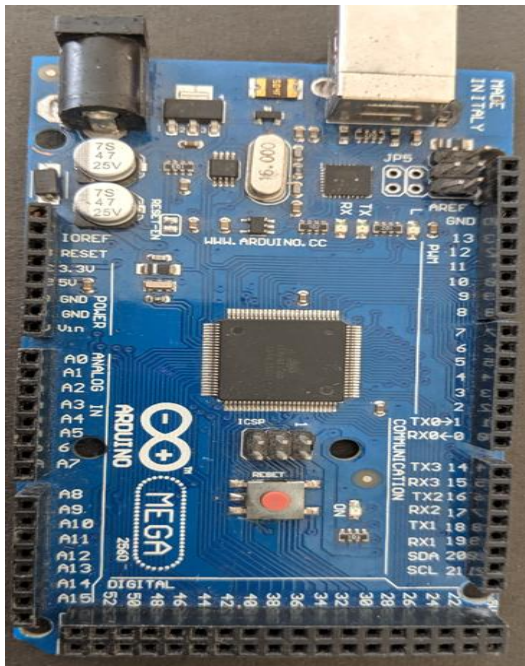

Fig.7. Arduino MEGA 2560

In this project, the Arduino MEGA is used to interface Ultrasonic sensors along with all the four Arduino UNOs to establish a closed network. It also interfaces RFID reader and a NodeMCU is also connected. The sensors that are interfaced transmit the data about the distance between the vehicles and the sensor. The data is analyzed by this microcontroller and necessary decisions are transmitted to the Arduino UNOs to act accordingly. The RFID reader transmits the message of an emergency vehicle detected by it. The Arduino MEGA that receives this information commands all the Arduinos to glow RED except the one on which the emergency vehicle is detected, till the vehicle crosses the junction.
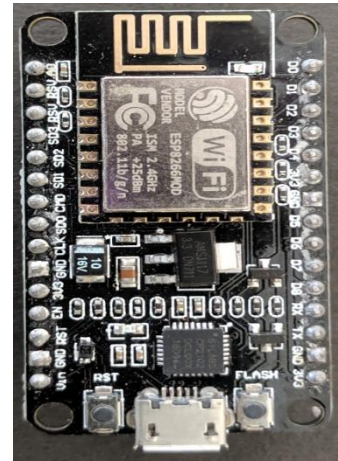
E. *NodeMCU*

Fig.8. NodeMCU

NodeMCU is another open source board as shown in Fig.8 which has an IoT platform. It operates on ESP8266 Wi-Fi module SoC. It is powered by a microUSB port. The same USB is used to dump programs into it. Here we use NodeMCU to communicate between the Arduino MEGA 2560s i.e. the master Arduinos. This communication is required to bring synchronization between the two junctions. The NodeMCU is interfaced with Arduino MEGA 2560.

The Arduino MEGA of two junctions have been interfaced with NodeMCU which aids to a wireless communication between both the junctions. This is necessary to synchronize the junctions which help us to avoid releasing more traffic from the preceding junction when the succeeding junction is still congested. The wireless communication takes place between two NodeMCU interfaced to the each Arduino MEGAs of the junction. Fig.9 shows the interfacing of NodeMCU with Arduino MEGA.
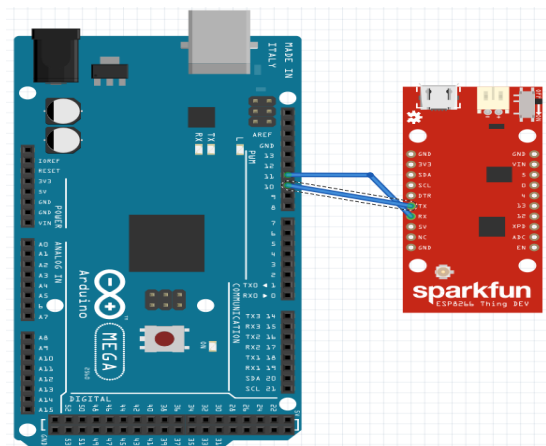

Fig.9. Interfacing Diagram of NodeMCU with Arduino MEGA

F. *RFID Tags*

As the name tells, the RFID tags operate in radio frequency. They operate wirelessly. The data is exchanged between the RFID tag and its reader through the radio waves. The RFID tags shown in the Fig.10 commonly consists of two main parts, they are;-

• Antenna, which is used to receive the Radio frequency waves.

• Integrated Circuit, which is used for storing and processing of data and also it modulates the radio waves to be sent and demodulates the received radio waves.

Fig.10. RFID tag

In this project, the RFID tags are attached to the emergency vehicles. This is done in order to be detected when the vehicle is approaching the congested junction. Once the vehicle comes in the range of the RFID receiver, the signal lights turn GREEN till the vehicle crosses the junction. This decision is taken by the Arduino MEGA which in turn commands the Arduino UNOs to perform accordingly.

G. *RFID Receiver*

The RFID receiver or reader shown in the Fig.11 reads the unique ID from the tags. As the RFID tags come in the range of the receiver, it reads the ID and transmits the same to the Microcontroller. The RFID receiver consists of two main parts, they are:-

• Transceiver, which is used to transmit the

• Antenna, which is used to send or receive the radio waves from the tags.

In this project, the RFID receiver is interfaced to the Arduino MEGA. The RFID reader receives the radio waves from the RFID tags attached to the emergency vehicles and sends a message to the Arduino MEGA which in turn commands Arduino UNO to release all the vehicles of the lane till the emergency vehicle crosses the junction.

Fig.11. RFID Reader

V. ALGORITHMS

• To begin with, the circuit is powered on using external power supply.

• The Ultrasonic sensors connected to the Arduino MEGA, when the object comes into its range, transmits the distance information to the Arduino MEGA.

• Arduino MEGA with the available information about the distance does the following calculation and necessary decisions are taken accordingly.

• Arduino UNOs receive the data transmitted from the Arduino MEGA and performs the actions specified by the same.

• LED lights and the 7-segment display interfaced to the Arduino UNOs glows according to the commands received by the same.

• In the case of emergency vehicle detected approaching one of the lanes of the junction, the Arduino UNO receives the message by the RFID receiver through the RFID tag attached to the vehicle. It clears the traffic of that particular lane by commanding all other lanes of the junction to stop till the emergency vehicle crosses the junction.

• The two closely spaced junctions are communicated wirelessly by using NodeMCU with the information of the traffic density and are thus synchronized to avoid vehicles to commute to the succeeding junction till it is free to accommodate new set of vehicles from the preceding junction.

• The succeeding junction receives the information about the traffic density of the preceding junction through the wireless communication and takes necessary decisions to avoid vehicles lingering in the same junction for multiple times.

VI. RESULTS AND DISCUSSION

The entire prototype of the density based traffic management system has been implemented. Arduino UNO and Arduino MEGA 2560 have been made use as microcontroller and processing unit.

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Along with the microcontrollers we have employed ultrasonic sensors that are in turn connected to the Arduino MEGA 2560 that aided to achieve the density based traffic regulation. The information from the ultrasonic sensors are successfully received by the Arduinos and necessary decisions according to the conditions provided has been taken. The LED lights indicating the traffic lights are also glowing according to the timings decided by the Arduino MEGA. Arduino UNO drives the LED lights and the 7-segment display effectively as per the conditions.
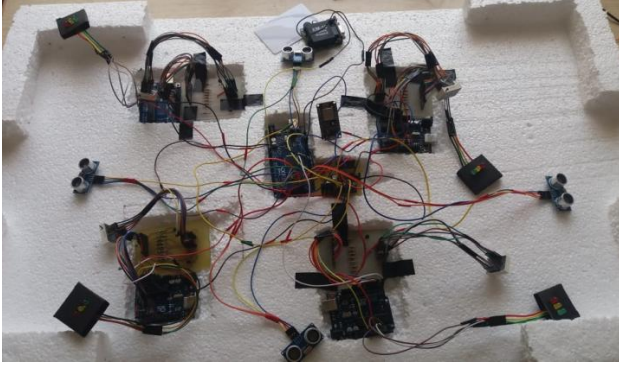

Fig.12. Implementation of density based traffic regulation with synchronization.

The NodeMCU connected to the Arduino MEGA 2560 successfully communicates between the other Arduino MEGA 2560 of the other junction. Thus achieving the synchronization between two junctions.

The emergency vehicles are prioritized on the roads to help them reach the destination as soon as possible. The lane that detects the emergency vehicle approaching the junction will be cleared as soon as possible till the vehicle crosses the junction. Finally, all the objectives were served effectively by the prototype that is implemented.

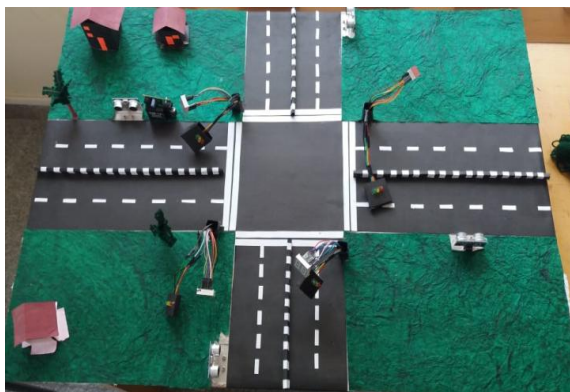Fig.12 and Fig.13 shows the implementations of the density based automatic synchronization of junction.

Fig.13. Design of the traffic junction with the sensors placed at the side of the lane.

VII. CONCLUSION AND FUTURE SCOPE

Traditional traffic controlling system involves trained police person to control the traffic by analyzing the density approximately to his knowledge. This was a cumbersome work for the policeman when the traffic congestion was heavy during peak hours. Thus, to avoid this we proposed a system that regulates the traffic using traffic density concept.

The proposed system is implemented effectively. The system also synchronizes the two nearly placed junctions to avoid the vehicles to linger in the same traffic signal for multiple times. The system so developed can be further improved by employing the IoT concept to communicate between all the traffic junctions in the city to reduce as much as time possible to reach the destination. Also, the information of the traffic density has to be transmitted safely to the microcontrollers without being altered in between the communication. Thus, encryption of the data being transmitted can be the future works for the currently implemented prototype.

REFERENCES

1. R.Weil, J. Wootton and A Garcia Ortiz, " Traffic Incident Detection Sensors and Algorithms", "Journal of Mathematical and Computer Modelling", Vol27(9), 1998, pp.257.291
2. K.Thatsanavipas, N. Ponganunchoke, et al., "Wireless Traffic Light Controller" Proceedings of 2nd International Science, Social Science, Engineering and Energy Conference, Nakhonphanom, Thailand, 2010
3. Wanjing M.A, Xiaoguang YANG, "Design and estimation of an Adaptive Bus Signal Priority System based on Wireless Sensor Network", "Proceedings of 11th International IEEE Conference of Intelligent Transporation Systems", Beijing, China, 2008.
4. Hikaru Shimizu, Masa-Aki Kobayashi et al., " A development of Deterministic Signal control System in Urban Road networks", Society and instruments Control Engineer Conference, Japan, 2008.
5. Ashok P.V , Sivasankari.S, et al., "IoT based Traffic Signalling System", Intenational Journal of Applied Engineering Research ISSN 0973-4562, Vol 12, Number 19, Chennai, India, 2017
6. Xiaojian Hu, Jian Lu, et al., "Traffic signal Synchronization in the saturated High-Density Grid Road network", Hindawi Publishing Corporation, Computational intelligence and Neuroscience, Nanjing, China, 2014.

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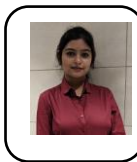
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