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IoT Based Traffic Signalling System

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Abstract

Currently in India, we still rely on Traffic police towards regulating the traffic signaling system based on traffic density. There has been some research work carried out in automating the traffic signals by employing image processing, Infra Red sensor and in some places prioritization in traffic signaling towards emergency vehicles based on fuzzy logic.

The challenge with all these system is that it is very expensive while employing camera for capturing the traffic for regulating the traffic signal. In employing Infra Red sensor, the proximity of vehicle and sensor need to be very close for calculating the density for controlling the traffic signal.

So to obviate the above mentioned drawbacks and with the upcoming of Machine to Machine Communication leading to IoT, we here have developed an IoT based Traffic Signaling system where ultrasonic sensors deployed at every 50 meters of road which would capture the traffic density and communicate to Arduino for changing the traffic signal accordingly. This information sent to Pi3 using Wifi Module where analysis made on Heavy traffic and less traffic with date and time and the same communicated to Web page of cloud which can be viewed by the Traffic police authorities for further analysis

Keywords: M2M, IoT, Arduino, Pi3, Wifi

INTRODUCTION

The entire World is becoming more technological savvy and India is no exception to this. With the tremendous growth in IT and other sectors, people have started to lead a comfortable living which includes Television, Air conditioner, Vehicles. So when it comes to transportation, people tend to use their own vehicles for going out rather than standing in crowd for catching public transport.

Traffic congestion occurs due to high number of vehicles. Traffic congestion is a situation that occurs due to increase in number of user's vehicles and is characterized by slower speed, longer trip times and increased vehicular queuing.

As traffic demand increases, vehicle speed slows down the traffic stream resulting in traffic congestion.

Traffic congestion can lead to drivers becoming frustrated and engaging in road rage. In traffic environment, Traffic Signals are used to regulate traffic condition in the roads. These signaling systems are still dependent on human for controlling it based on density of traffic

Traffic Signaling currently in vogue is purely manual where Traffic police responsible in regulating the traffic signal system based on traffic density. This is a very cumbersome situation as most of the times you do not see the police personnel controlling the traffic signal leading to traffic congestion on the roads.

So towards this some amount of research work been carried out by employing Information and communication Technologies for regulating the traffic signaling system.

In one of the research [1], PIC Microcontroller employed for calculating the vehicle count on real time mode. The recorded data are communicated by the microcontroller to the central station. The administrator access traffic conditions on any approachable traffic lights and also nearby roads towards reducing traffic congestion

Research [2] also been carried out by employing image processing technique to find the traffic density and accordingly regulate the traffic. Image processing employed for edge detection.

In one another research, Infrared based Traffic density [3] developed where Sensors are placed on either side which would detect the presence of vehicles and accordingly information sent to microcontroller which would regulate the traffic signaling system.

Research [4] also carried out in employing IR Sensor in prioritizing the vehicles pertaining to emergency vehicle where microcontroller used to give red signal to all side of road except the one with emergency vehicle. Also research [5] carried out using same IR sensor by employing fuzzy logic in defining the direction of emergency vehicle too.

The drawback in these existing systems is that most of them employ IR sensor only which can only detect the presence of vehicle when in close proximity though these sensors kept on the sides of the road. Also these systems do not communicate among themselves in regulating the traffic signaling.

So with the upcoming of Machine to Machine Communication leading to IoT, we here have developed an IoT based Traffic Signaling system where ultrasonic sensor deployed instead of IR sensor on the side of road every 50 meter. In here, we have a traffic junction consisting of three lights which are Green, Amber and Red arranged on the sides. Two pairs of sensors are placed across the roads towards marking distance for density zones.

There will be an ultrasonic sensor and ultrasonic receiver opposite to each other. This sensor works on basis of sound wave and proximity of vehicle with Sensor is not an issue in counting the number of vehicle .The count of vehicles is sent to Arduino Microcontroller where traffic signaling system changed based on traffic density. That is for high traffic density there be more allotment of time and for low traffic density normal time is given. The traffic density information of every road is sent to Raspberry Pi3 towards analyzing as heavy traffic and normal traffic. This information along with date and time are updated on webpage of cloud for further analysis

LITERATURE SURVEY

In this section, we would be discussing briefly on various literatures available pertaining to Traffic Signaling System

Research been carried out employing PIC Microcontroller[1] towards density based Intelligent Traffic Signaling System. This system records total number of vehicles in the memory on real time basis based on user predefined interval. These data captured are sent to computer from the microcontroller. The administrator at the central station computer can access traffic conditions pertaining to any approachable traffic lights and nearby roads reducing traffic congestion. This system in future can inform the people about different place traffic conditions.

Another research on Density Based Traffic Signal System [2] is based on image processing technique like edge detection to find the traffic density that regulates the traffic signals. The advantage of building Intelligent Traffic Control System is that it reduces congestion; operational costs, provide alternate routes to travelers and increases capacity of infrastructure.

Density based Intelligent Traffic Control system[3] been calculated using IR Sensor that assigns the glowing time of green light by means of microcontroller. Sensors here are placed on the sides of road that would detect the presence of vehicles and send information to microcontroller. Micro controller here makes a decision towards assigning the glowing time of Green and Red light. That is timing of traffic lights are set based on the density of the vehicles.

Intelligent Traffic Signal Control system [4] been developed using AVR 32 bit microcontroller with programmable flash memory, built-in 8 channels Analog to Digital Converter and IR Sensor. These sensors detect the presence of emergency vehicle and accordingly microcontroller give red signal to all sides of road except for one with emergency vehicle.

Wireless Sensor Networks [5] was presented in the Priority Based Traffic Light Controller where the direction of any emergency vehicle uses a fuzzy logic and by collecting all the information, the central monitoring system gives the corresponding appropriate response.

From the literature reviewed, it is clear that there has been no work reported so far which allows M2M communication leading to IoT towards traffic control system. Also all the existing system have used IR sensor for traffic signaling system which got a challenge. The challenge is that the vehicles need to be close to these sensors for detecting the presence of vehicle which is not always possible. So accordingly we here have developed an IoT based Traffic Signaling system where an Ultrasonic sensor placed on sides of road every 50 meters. The count of vehicle is sent to microcontroller and accordingly based on the traffic density, the traffic signal system changed. This information on traffic density on the road is sent with date and time to Pi3 where analysis is made on heavy and normal traffic. This

information sent to webpage of Cloud for traffic personnel to get clear idea on traffic of every road for future planning and analysis.

IoT Based Traffic Signalling System

IoT based traffic signaling system is based on traffic density on road where the count of vehicles is done at each side of road by placement of sensor. In this system, three traffic lights i.e Green amber and red are placed on junction of road sides. Two pairs of sensor are placed across the roads which mark the distance for density zones. In here ultrasonic sensor are placed and ultrasonic receiver opposite to each other. In here Sensors are placed at 50 meters distance from one another. The logic here is that as the vehicles crosses the first pair of sensors, a digital signal is produced and accordingly sensor assumes that there is traffic congestion on the road. So based on the data gathered, Arduino microcontroller sends the timing signal output by comparing with adjacent road's traffic. As the vehicle crosses the second pair of sensors, Sensor assumes that it contains high traffic density respectively. For high density traffic, there will be more time allotment and for low density traffic normal time is given.

The data on traffic density and traffic signaling control are sent wirelessly to Raspberry Pi3 where analysis made as Heavy traffic and Normal Traffic with date and time. This information is finally updated on Cloud webpage which can be used for further planning and analysis by Traffic department.

The system design of IoT based Traffic signalling system is shown in Figure 1 where Ultrasonic sensor is placed on sides of road every 50 meters. The sensor here would capture the data for counting the density of that particular side and corresponding signal will be provided by Arduino Microcontroller based on heavy and normal traffic. The density traffic information with appropriate signaling along with date and time of each road sent to Pi3 where analysis done as heavy and normal traffic. This traffic analysis sent to Cloud webpage for further analysis in future.

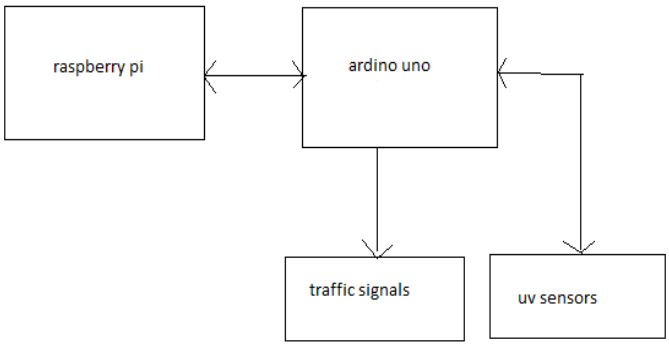

Figure 1: IoT Based Traffic Signaling System

Algorithm

The Algorithm been developed for function of IoT Traffic Signaling System based on Traffic Density is given below:.

- Traffic density data collected from ultrasonic sensors placed 50 meters distance on sides of road.
- Sensor data pertaining to vehicle count are sent to Arduino which decides the condition for controlling traffic signal by giving more time for heavy traffic and less time for normal traffic.
- Traffic Density data with date and time of each road is sent wirelessly from Arduino to Pi3 where analysis been carried out as heavy and normal traffic.

The analyzed information with date and time as heavy and normal traffic for road is updated on cloud webpage for future analysis

Hardware and Software Design

The hardware components used in this system towards the development of the Prototype are explained below.

Ultrasonic Sensor

Ultrasonic sensor used in our project measures the distance to an object by measuring the time taken by the sound to reflect back from the object. Ultrasonic sensor consists of two membranes. One membrane produces sound and another membrane registers the arrival of the sound impulse and stops the timer. The distance travelled by the sound can be calculated from the timer easily. These sensors are used in lots of places like measuring tapes in construction sites, car parking and so on. Also these sensors are used in danger zones of working machines too. This is shown in Figure 2.

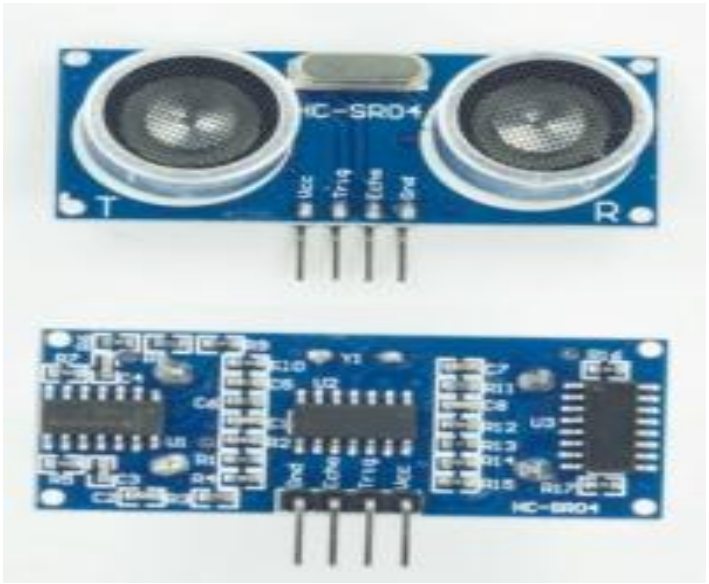

Figure 2: Ultrasonic sensor

ESP8266 Wi-Fi Module

ESP8266 is a Wi-Fi networking module or solution allowing Wifi networking function from one host to another. The ESP8266 requires 3.3 v to 5V. ESP8266 need to communicate via serial 3.3 V and does not have 5V tolerant inputs, so you need level conversion to communicates with a 5V microcontroller like most Arduino use. This shown in Figure 3.

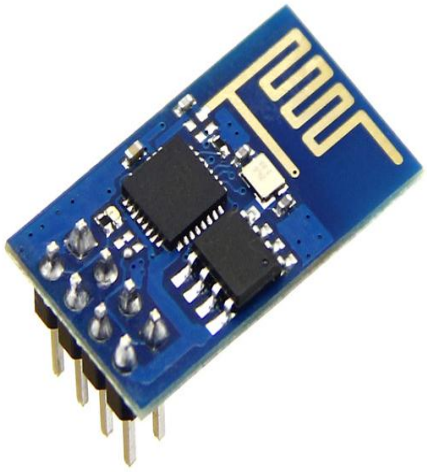

Figure 3: ESP8266 Wi-Fi module

Arduino Microcontroller

Arduino Uno is a microcontroller board based on AT Mega 328P. These microcontroller posses 14 digital input/output pins, 6 analog inputs, 16 Mhz quartz crystal, USB connection and a power jack. Arduino Uno can be programmed with Arduino Software IDE.

Raspberry Pi3

Raspberry Pi3 is a third generation Raspberry Pi which replaces Raspberry Pi2 model B in February 2016. Pi3 features 1.2 GHz 64 bit Quad Core ARM v8 CPU , 802.11n Wireless LAN, Bluetooth 4.1 and Bluetooth Low Energy., 1 GB RAM, 4 USB Port, 40 GPIO Pins, Full HDMI Port, Ethernet Port, Combined 3.5 mm audio jack and composite video camera, Camera Interface, Display interface, Micro SD Card Slot, Video Core IV 3D Graphics Core.

The Arduino UNO is responsible for getting traffic density information from the ultrasonic sensor which is kept every 50 meter distance on sides of road. . To accomplish this task in Arduino, we use the Arduino IDE version 1.6.12 where traffic density information received for controlling traffic signals. The Raspberry pi is installed with the Noobs Operating System and has been provided with a 8 GB memory card.

Both the Pi and the Arduino have to be connected to the same network. The raspberry pi runs a python code that receives data continuously from the Arduino and then performs analysis based on traffic density information received towards heavy and normal traffic. This information is onto webpage of Cloud.. The IoT based Traffic Signaling System is also tested with the possible real time sensor values that will generate different output based on specific threshold. The test cases used to verify the correctness of application logic. The actual output of the system verified with the expected output and found it is perfect.

Implementation Results an Analysis

The complete hardware prototype of IoT based traffic Signaling system been developed employing Arduino and Raspberry Pi3 as microcontroller and processing unit. In addition ultrasonic sensor deployed and same connected to Arduino microcontroller for controlling the traffic signal based on traffic density information received. Also the Arduino unit connected using Wi-Fi Module to Pi3 for communication of traffic density of each sides of road for analyzing the traffic as heavy and normal traffic for each road. The results been updated as HTML Webpage in Cloud server. Figure 4 shows the complete IoT based traffic signaling system Prototype with all sensors and connection.

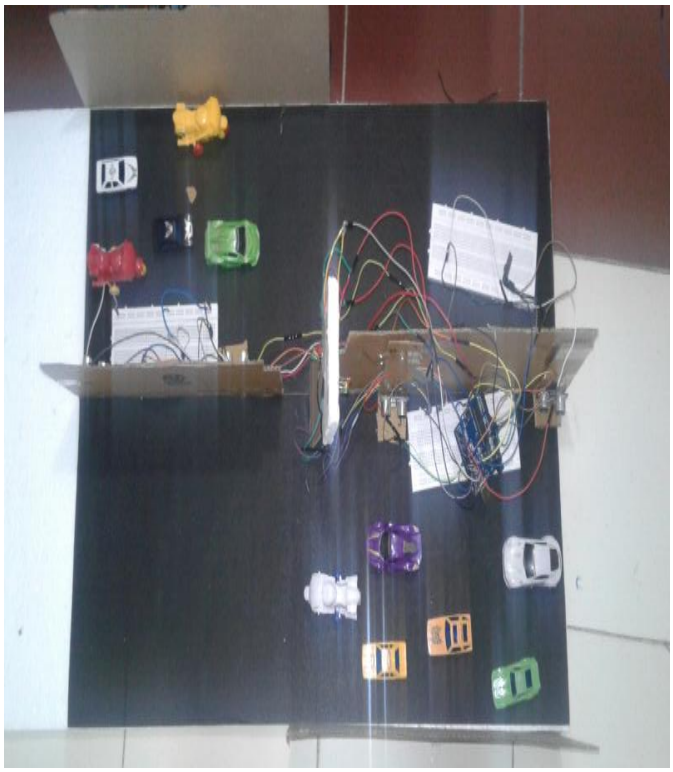

Figure 4: IoT Based Traffic Signalling System

Figures 5 and 6 shows the Traffic signaling system changing to RED and GREEN based on traffic density. Figure 7 shows the Arduino IDE Environment of controlling the traffic signal based on traffic density Figure 8 shows the Webpage showing the traffic density with date and time and traffic analysis

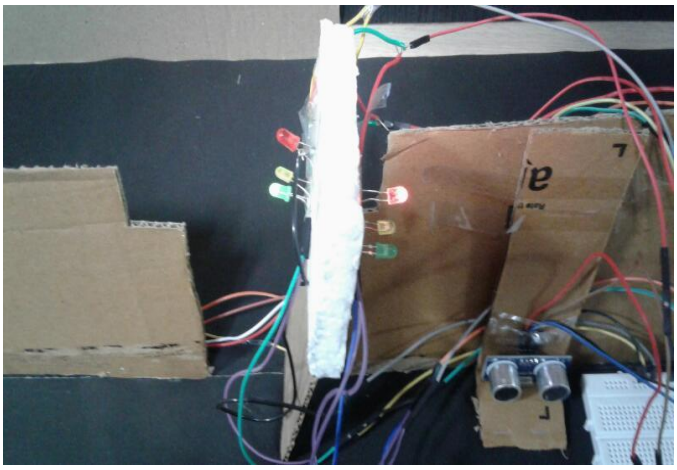

Figure 5 : Traffic signaling system changing to RED and GREEN

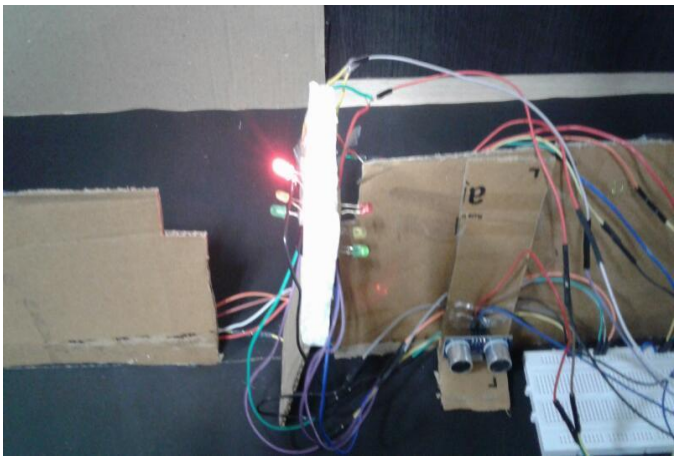

Figure 6: Traffic signaling system changing to GREEN and RED

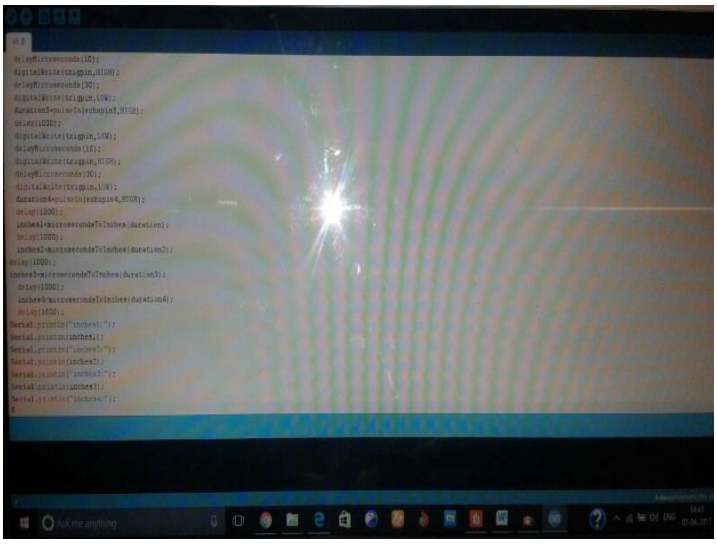

Figure 7: Arduino IDE Serial Window

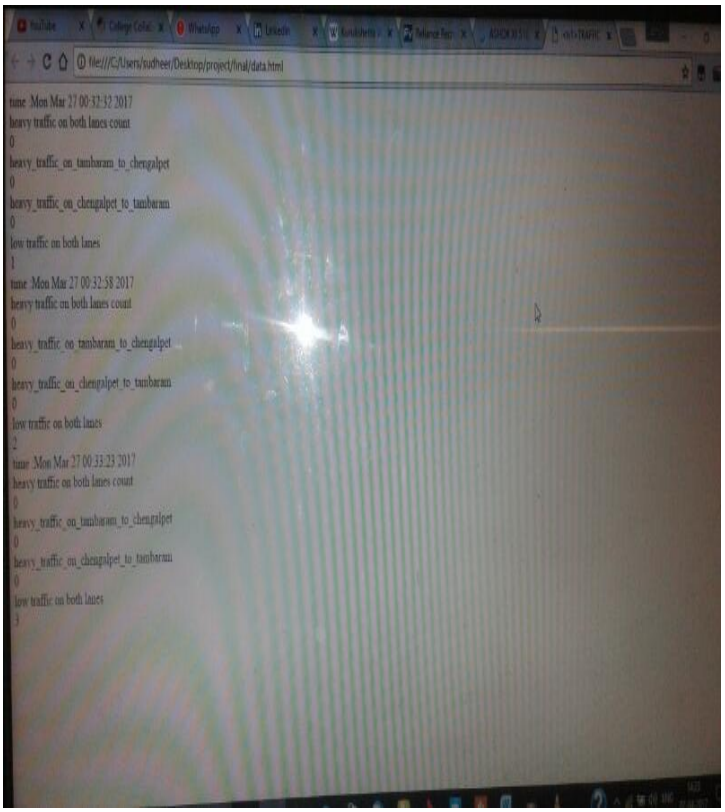

Figure 8: Traffic Analysis Information

CONCLUSION AND FUTURE WORK

Traditional Traffic Signaling system relies purely on Traffic police for controlling the traffic signal for regulating the traffic based on traffic density. Lot of research been carried out in computing the density of traffic by employing Sensors for controlling the traffic light signals. Also some have employed image processing also for controlling the traffic signals too.

So accordingly with the upcoming of Machine to Machine Communication employing IoT, we here have developed IoT Based Traffic Signaling System where ultrasonic sensor deployed on sides of road every 50 meters to count the number of vehicles. The traffic density information is sent to Arduino microcontroller where based on the condition the traffic signal changed accordingly by allotting more time for heavy traffic and less time for normal traffic. This information sent to Raspberry Pi3 where analysis traffic been done as heavy and normal traffic based on number of vehicles with date and time. This information sent to Webpage of cloud server.

The system so developed is not fully complete as we have developed a prototype only for controlling density. In future, we propose to extend the system for of alleviating traffic congestion by capturing the traffic density information. In addition the traffic density information need to be secured while transmitting the information for controlling the traffic signal.

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