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Traffic Monitoring and Control System Using IoT

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ABSTRACT

This research aims to monitor the traffic condition and to control the traffic light. This system can reduce not only traffic congestion but also waiting time. This system is designed to be implemented in places nearing the junctions. This research is based on the effective use of Internet of Things (IoT). This system will display the traffic conditions in the website and the traffic light can be controlled from this website. This system has been implemented by using esp8266, ultrasonic sensor and arduino. Esp8266 nodemcu which is IoT device is used to transmit the traffic information to the website which is connected with this device. Ultrasonic sensors are placed on each road to sense the presence and absence of vehicles. Traffic information is received from these sensors. Traffic light prototype is built by using an arduino UNO. This traffic light can be controlled from the website. The system will display the traffic states in the website that can guide the drivers to select the right way and avoid traffic congestions.

Keywords: *Internet of Things (IoT), ultrasonic sensor, Wi-Fi module (ESP8266), wireshark software*

I. INTRODUCTION

Nowadays, world's population is increasing. So many vehicles are used in transportation system. As the use of vehicles is increasing, the problem of traffic is arising. Traffic congestion is a common problem in large cities.

Thus the traffic management system involves in vital role in every country. If the transportation is poor, that means the image of this country will not develop. Because of the traffic jams and lack of proper traffic management system, time and money of the public is being wasted. Traffic congestion results in direct economic loss, and also exacerbates the air pollution of the urban cities because vehicles emit more carbon dioxide and other toxic materials when they are at a lower speed [4]. There are a lot of technologies to build the traffic management system such as RFID, Bluetooth, zigbee, GSM-GPS based system [1]. Among them, the traffic efficiency can be improved with the help of internet of things (IoT). This research intends to determine the design of the implementation of the internet of things (IoT) for traffic management system. Traffic management system using IoT is built to help people to get latest information of traffic condition in different area [6]. The traffic signals can be managed by monitoring the traffic density to avoid traffic congestion on road using network communication between website and hardware module [9]. Traffic lights are typically used to control the flow of vehicles at intersections. The problem with the traffic system is that even though there are no vehicles on one side and there are many vehicles on another side, the traffic signals will flow for given fixed time [7]. Due to that, there is time waste process. Thus, the system must be implemented to controls the traffic based on the heavy flow of vehicles at any particular side. In this system, the number of vehicles on each side at the junction will be counted by using ultrasonic sensors. Ultrasonic sensors are used to sense the number of vehicles on the road. Therefore this system will make transportation to be developed.

II. INTERNET OF THINGS

Internet of things (IoT) can be expressed as a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols [3].By using IoT, any device that is connected to the internet can be controlled and monitored from any place. This device is considered as IoT device. IoT is simply connecting all the surrounding smart devices (things) to internet. So, IoT is a giant network of physical object devices, vehicles, buildings and other items which are embedded with electronics, software, sensors and network connectivity. IoT connect between the physical world and virtual world [8].

IoT is considered as a part of the internet of the future and will comprise billions of intelligent communicating 'things'. The future of the internet will consist of heterogeneously connected devices that will further extend the borders of the world with physical entities and virtual components. IoT is an emerging research paradigm and apparently the discovery of its body of knowledge is still in an infancy stage. Most scholars agree on the idea of expanding and interpreting the pioneering conceptual definition of Kevin Ashton who defined IoT as "a standardized way for computer to understand the real world". IoT-based systems have been proposed in several applications such as supporting disabilities, managing diabetes therapy, building smart home, improving safety in mining operations [2][5]. The following equation describes IoT in a simplified manner,

IoT = Physical Entity+Controller,Sensor,Actuators+ Internet

Internet of things can be compared to the communication among humans, with respect to the equation above. For instance, humans have biological sensors such as ears, eyes, skin, taste buds, etc. to perceive what is happening in their surroundings [2]. This research focuses on the communication between traffic lights, sensors and users. In this case, each sensors which sense and transmit traffic data act as eye.

III. LITERATURE REVIEW

N. Choosri, in March 2015, proposed IoT-RFID testbed for supporting traffic light control. In this paper, RFID technology is used to figure out congestion level of road. RFID tags are equipped in every vehicle and RFID reader is installed at the intersection to read the tag when the tags are within the operating distance of the reader. With this configuration, the reader can count the number of identified tags to figure out congestion level.[2]

Dr. Sanjeev Uppal, in April 2016, proposed smart traffic control system using GSM. This system allows traffic management and traffic reporting advice to road users. It provides the users who wish to obtain the latest traffic information on congested roads by using GSM phone with SMS facility. The presence of vehicles is sensed by sensor mounted on each road. The timing sequence of traffic lights is decided by the total traffic on all the adjacent roads. [10]

Aadish Agrawal, Shreyash Saurabh, in 2017, proposed traffic control system using zigbee module. This system can change all the traffic light signals to green in order to provide a clear way for the emergency vehicles. In this system, the emergency vehicle is equipped with the zigbee transmitter and zigbee receiver is implemented at the traffic pole. If zigbee transmitter is switched on by the driver, the transmitter will communicate with nearby traffic signal and it will convert the traffic light to green. [11]

IV. SOFTWARE REQUIREMENT

A. Thinger.io IoT platform

Thinger.io is an open source IoT platform. IoT devices are connected with this platform and manage these devices from this platform. An account is registered to their cloud infrastructure and the open source libraries can be used for connecting devices. This platform can connect with any devices such as Arduino, ESP8266, Raspberry Pi and so on. Turning on a light from the internet and reading a sensor value are made by writing a single line of code on the MCU.

B. Wireshark software

Wireshark is the open-source packet or network protocol analyser. It is a network analysis tool formerly known as Ethereal. It can capture packets in real time and display them in human-readable format. Using wireshark, user can troubleshoot network problems, examine security issues, debug protocols and learn network process. It can also save packet data to file for offline analysis. It is a GUI based network capture tool.

V. PROPOSED SYSTEM

The functional block diagram of overall system is shown in Figure 1. The system is divided into two parts: monitoring section and control section.

In monitoring section, it includes IoT devices. Each IoT devices consists of esp8266 nodemcu, ultrasonic sensors, arduino, TM1637 LED display and LEDs. Arduino , LEDs and TM1637 are used to build the traffic light. Ultrasonic sensor and nodemcu are used to monitor the traffic condition. Ultrasonic sensor senses the traffic condition and the result is send to the website by using nodemcu esp8266 wifi module. So user can see the traffic information from this website.

In control section, arduino and nodemcu are connected to change the timing sequence of traffic light. Arduino that is used to build the traffic light is interrupted with nodemcu via the website from control room when the traffic jams at the road.

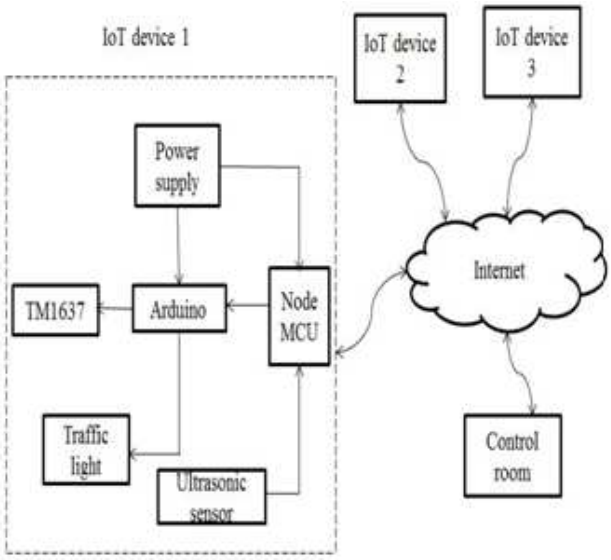

Fig.1. Overall block diagram of proposed system

Fig. 2. Ultrasonic sensor

Hcsr04 ultrasonic sensor is composed of ultrasonic transmitter, ultrasonic receiver and a control circuit. Ultrasonic transmitter transmits ultrasound waves at 40kHz.Transmitted waves bounce back if they hit any flat surface or object in their path. Bounced back waves reach the ultrasonic receiver. Ultrasonic receiver receives the bounced back waves and notifies the control circuit about it. Control circuit calculates the time taken by waves to reach back after transmission. It can measure distance between an active range of 2cm to 4m.It has four pins-Vcc ,Gnd, Trigger and Echo.

$$D = 1/2 \times T \times C ,$$

Where D = distance,
C = the sonic speed(340m/s),
T= time between the emission and reception

The value is multiplied by ½ because T is the time for go-and-return distance.

Fig.3. NodeMCU ESP8266

The ESP8266 is the name of a micro controller designed by Espressif systems.The ESP8266 itself is a self-contained WiFi networking solution offering as a bridge from existing micro controller to WiFi and is also capable of running self-contained applications. This module comes with a built in USB connecter and a rich assortment of pin-outs. NodeMCU is a firmware that allows user to program the ESP8266 module.

NodeMCU microcontroller consists of nine digital I/O pins and one analog I/O pin. It requires 600mA of current for its full load opertaion. It operates at 3.3V power supply. The microcontroller is equipped with an esp8266 WiFi module [1]. The esp8266 WiFi module has 4MB of flash memory. Nodemcu has 80MHz CPU frequency and upload speed is 115200 baud rate. This device can be directly programmed from the arduino IDE.

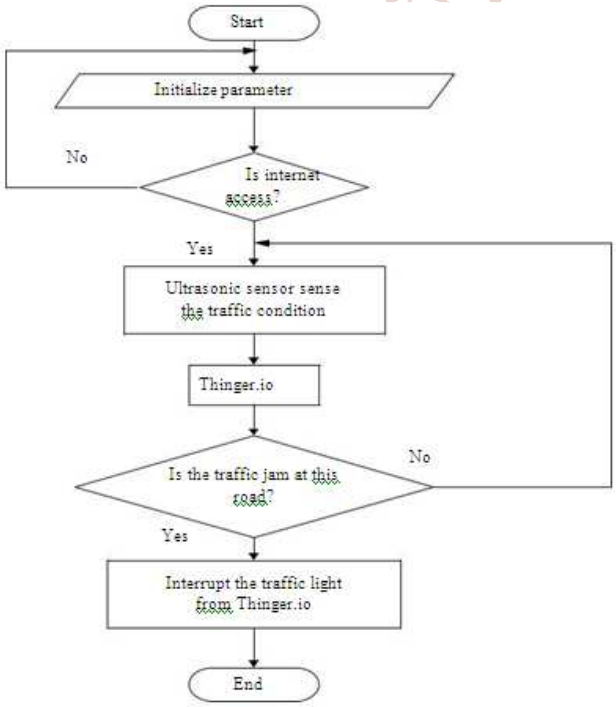

Fig.4. Flow Chart of the System

Firstly, start block is represented as initialization of the system. Then, parameters that used in the system are declared and check the internet connection of the devices. If device is not connected with the internet, go back to the second step. If the device is connected with the internet, go to the next step. In this step, ultrasonic sensor senses the traffic condition and then this result is sent to the thinger.io. Then the result is checked. If the result is "free", go to the 4th step. If the result is "traffic jam", traffic light is interrupted from thinger.io IoT platform.

VI. EXPERIMENTAL TEST AND RESULT

A. Monitoring Section

Fig.5. Testing ultrasonic sensor and sending to the thinger.io

Figure 5 shows the monitoring of the traffic condition and display the result in the thinger.io IoT platform. Ultrasonic sensor is connected with nodemcu and senses the condition. And then, the result is sent to the thinger.io via nodemcu. To use the thinger.io IoT platform, an account is signed up to this platform. And, device must be added in device list and dashboard is added in dashboard list to monitor and control the traffic condition. In dashboard, condition is displayed with many ways by adding widget. The figure in the left shows testing the ultrasonic sensor with object in front of it. The figure in the right shows that the traffic condition of the road can be seen from dashboard list in thinger.io.

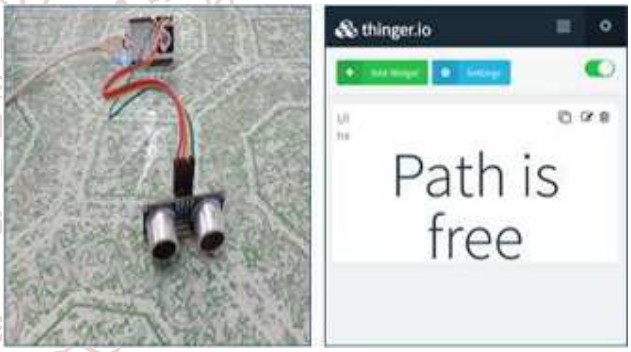

Fig. 6. Testing ultrasonic sensor and this result is sent to the thinger.io

Figure 6 also shows the monitoring of the traffic condition and the result is shown in the thinger.io IoT platform. The figure in the left shows testing the ultrasonic sensor with no object in front of it. The figure in the right shows that the condition which is no vehicle in front of ultrasonic sensor can be seen from thinger.io IoT platform.

B. Control Section

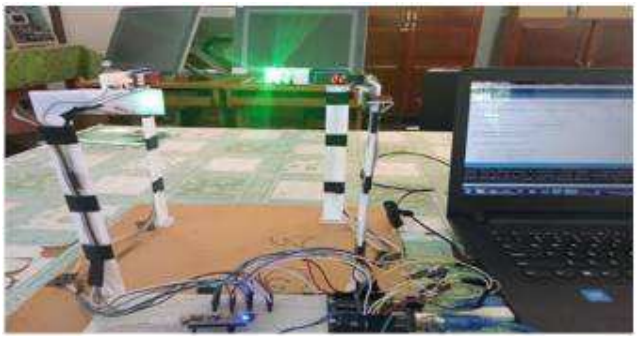

Fig.7. Traffic light with regular timing sequence

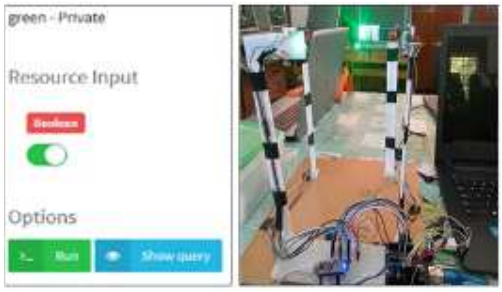

Fig.8. Controlling timing sequence of traffic light from thinger.io

Figure 8 show the timing sequence after interruption. Traffic light and timing sequence are built by using arduino. Interruption can be made from thinger.io IoT platform when it needs to change the timing sequence of traffic light. When there is traffic in first lane and there is no traffic in other lane, the timing sequence of the first lane is interrupted at green time duration. This can made long green time duration for first lane and long red time duration for other lane.

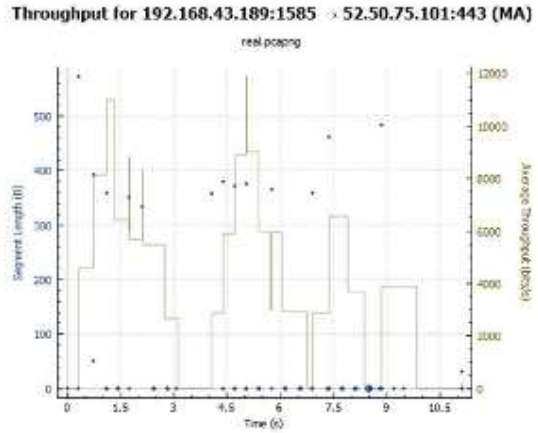

Fig.9. Throughput graph between computer and thinger.io

Figure 9 shows the throughput graph between computer and thinger.io. Throughput is defined as the quantity of data being sent or received by unit of time. This graph is resulted from wireshark software. Wireshark software is used to test the response speed of the system. All the packets which are passing through system network interface from computer to thinger.io IoT platform can be seen by using this software. From these packets, response speed such as round trip time and throughput graph can be produced in this software. This throughput graph can be produced from these packets. In this figure, Y axis at the right represents the average throughput in bit per second, Y axis at the left represent the segment length and X axis represents the time. At this graph, average throughput 4500 bits/s are sent from computer to thinger.io at every 1 second.

VII. CONCLUSION

As the volume of vehicles inside city is increasing significantly, citizens using public transportation are more troubles for traffic jam. In this paper, a traffic management system that is capable of monitoring and controlling the traffic condition have been developed and implemented by using internet of things (IoT). By using this system, users can know the traffic information from anywhere and so they can decide the right way to reach their destination in time. Thus, the system developed in this paper proves to be reliable and cost-effective.

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