

Vehicle Traffic Congestion Control & Monitoring System in IoT

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Abstract

Vehicle traffic congestion and monitoring has become one of the critical issues in road transport. With the help of Intelligent Transportation System (ITS), current information of traffic can be used by control room to improve the traffic efficiency. In this paper, we propose a new context-aware approach to find the current status and density of traffic and dynamic management of traffic signals along with the environmental conditions. To facilitate this, our proposed architecture of Vehicle Traffic Congestion Control & Monitoring System in IoT would perform well. Basically, this architecture is divided into two major modules i.e. hardware module (Microcontroller, Bluetooth controller, Sensors, etc) and software module (Server, Data Mining techniques, Android Applications, etc). The system utilize new technologies for real-time collection, organization and transmission of information to provide an efficient and accurate estimation of traffic density and weather condition, which can be exploited by traffic-aware applications.

Keywords: Internet of Things (IoT), Intelligent Transportation System (ITS), Traffic Monitoring System, Congestion Control.

1 Introduction

The Internet of Things (IoT) term was derived in 1999 by Ashton. IoT is a growing technological trend in recent years. It has gained significant attention in academia and computing industry during the past decade. IoT promises a world where all the smart objects around us are connected to each other and spontaneously communicate with each other with the minimum human intervention. IoT offers much more facilities as

compared to other networking approaches like LAN, Ethernet, wired/wireless, etc. hence it has become the main reason of research interest in current computing era. The goal of IoT is to create a better world for the human beings. IoT is the new and emerging model in the computing which spontaneously links physical and virtual smart objects. IoT has high volume contextual information which enables context-aware smart applications like: Healthcare, home and office, entertainment, ticketing, smart building, medical technology, telecommunication and media, transportation and logistics, automotive, aerospace, aviation and supply chain management, disaster alerting, recycling, agriculture, breeding and environmental monitoring, smart environment, smart home, smart cities, smart water, smart meter, retail, logistics, industrial control, smart animal farming, smart agricultures, domestic and home automation, e-Health, security and emergencies [9].

ITS is one of the most important application of IoT [7]. There is rapid increase in the vehicles perhaps traffic congestion on the road is also increases. Now, it is a very serious problem because on road, more number of vehicles are present and due to that the congestion in traffic increased along with the increase in pollution and more time is waste on road traffic every day. Therefore, traffic state estimation is one of the most recent issue in ITS [2] which plays an major role to reduced the travel time, improve the traffic efficiency, weather condition, etc. Various sensors are available in the market which are useful for the ITS. Here, we restrict our work using only few sensors like: IR sensor, temperature sensor, gas sensor, sensor array, etc.

All over the world number of vehicle is increases [10]. Let us consider for India, in 1991 number of register cars were 119161. At present (2015) the registered number of cars are 224030. In next 5 years (2020) it will become 573513, that means number of vehicle will increase almost by double compare in 2015. And in 2050 number of cars (vehicles) will increase by 4 times more than the present (2015) i.e. 1019710 as shown in fig.1 and fig.2.

	Actual	Units	Mar 2015	2020	2050
South Korea - Car Registrations	20217803	Cars	20260595	20043676	21726007
China - Car Registrations	2038003	Cars	1975532	2496564	2656564
Japan - Car Registrations	249565	Cars	410358	230750	218298
India - Car Registrations	224030	Cars	248874	573513	1019710
Germany - Car Registrations	223254	Cars	343674	231114	231114
France - Car Registrations	149013	Cars	147414	151890	151890
Canada - Car Registrations	135075	Thousand	151188	197149	22149
Italy - Car Registrations	134697	Cars	164456	76038	76038
Russia - Car Registrations	115390		100130	201980	201933

Fig.1. Comparative analysis of registered number of cars overall the world
(Source: <http://ieconomics.com/car-registrations-forecast>)

Fig.1 shows the comparative analysis of registered number of cars overall the world. From the given data, we can predict that, in future as the number of cars (vehicle) will increases the traffic on the road will also increases along with the pollution. To avoid the traffic congestion, to monitor the traffic density and to know the current traffic situation along with the pollution/weather condition, we proposed a novel vehicle traffic monitoring system in IoT.

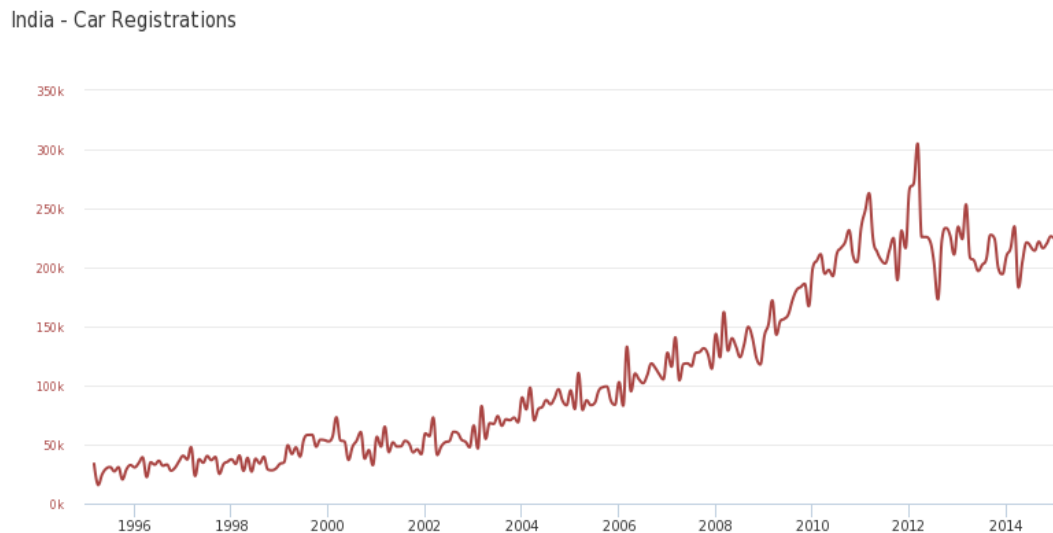


Fig.2. Car registrations in India from 1991-2015

(Source: <http://ieconomics.com/car-registrations-forecast>)

The proposed system will measure the real-time traffic density, weather condition and controls the traffic congestion on road using dynamic management of traffic signals. For understanding, let us consider an example: A vehicle wants to go from any source to a destination then, the user will login into proposed android app with the login details and it will be able to find out the real-time traffic density also user can able to find out optional routes to go to destination to avoid road traffic. So, efficiency of congestion in traffic will improve. Also, user can able to view the real-time weather/environmental condition like: temperature, pollution, gas, sunny, rainy, cloudy, etc. and user can predict the future pollution and accordingly user can increase the greenery. We can also manage the traffic signals by monitoring the traffic density to avoid traffic congestion on road using network communication between the server and hardware module via Bluetooth.

A sensor is a transducer and its purpose is to detect/sense characteristic of its environment. It will detects the events or changes in quantities and it provides a corresponding output. Generally, a sensor will output in the form of electrical or optical signal. The IR sensor is basically consists of a pair of a phototransistor and an IR LED. It also called a photocoupler or an opto-coupler. An IR LED emits infrared radiation, reception and/or intensity of reception of which by a phototransistor dictates

output of the sensor. It will be use for counting number of vehicles crossing the road. A sensor array is a group/collection of sensors, usually it is deployed in a certain geometry pattern and it is used for collecting and processing electromagnetic or acoustic signals. Here we are going to use the temperature sensor, gas sensor, etc.

This paper is structured in five different Sections. Section 2 describes the survey of existing system in which we discusses the various survey papers and analysed it. Section 3 describes the design and methodology. Section 4 describes the implementation and results. Finally in section 5, we conclude our proposed work and given future direction.

2 Related Work

Sheng-hai An, et al. [7] discussed comparison and analysis of ITS and they integrate the ITS technologies to design the integration model. Authors also discussed that, traffic issue is not only limited to particular country but also includes overall world i.e. globally. In the same, they provided some suggestion using new technology to overcome traffic congestion and controlling the traffic density. Author also discussed the importance of ITS and its uses along with applications.

Wang, H., et al. [8] developed an framework for collaborative traffic information collection, fusion and storage for city intelligent transportation system based on the wireless sensor network. The proposed framework not only solve the given problem but also has higher flexibility and reliability compared to traditional city transportation system. Author also introduced relative research about the emergency response scheme and transport priority schemes.

P. Händel, et al. [1] developed an framework to deployed a smart phone based measurement system for the road vehicle traffic monitoring and usage-based insurance (UBI). Author described that the given framework consists of seven layers, spanning from the physical smart phones and servers to the overall business model at the top layer. Also, the purpose of proposed framework (sensed by the primary data) is to model, predict, and control the traffic flow.

I.M. Costea, et al. [5] design the modern traffic monitoring system for optimizing the road traffic flow with the aim of meeting the current and future necessities for road travel. Proposed system increases the efficiency of the process for monitoring the road traffic conditions by providing permanent knowledge of the meteorological parameters of different zones.

Bo Yang and Yiqun Lei [3] developed an vehicle detection and classification system for low-speed congested traffic based on the low-cost triaxial anisotropic magneto resistive sensor. Author proposes a novel fixed threshold state machine algorithm based on signal variance to detect vehicles within a single lane and segment the vehicle signals effectively accordingly the time information of vehicles entering and leaving the sensor monitoring area. They shows result that the proposed algorithm can reach up to 99.05% accurate and the average classification accuracy is 93.66% which verify the efficiency of proposed algorithm.

3 Design and Methodology

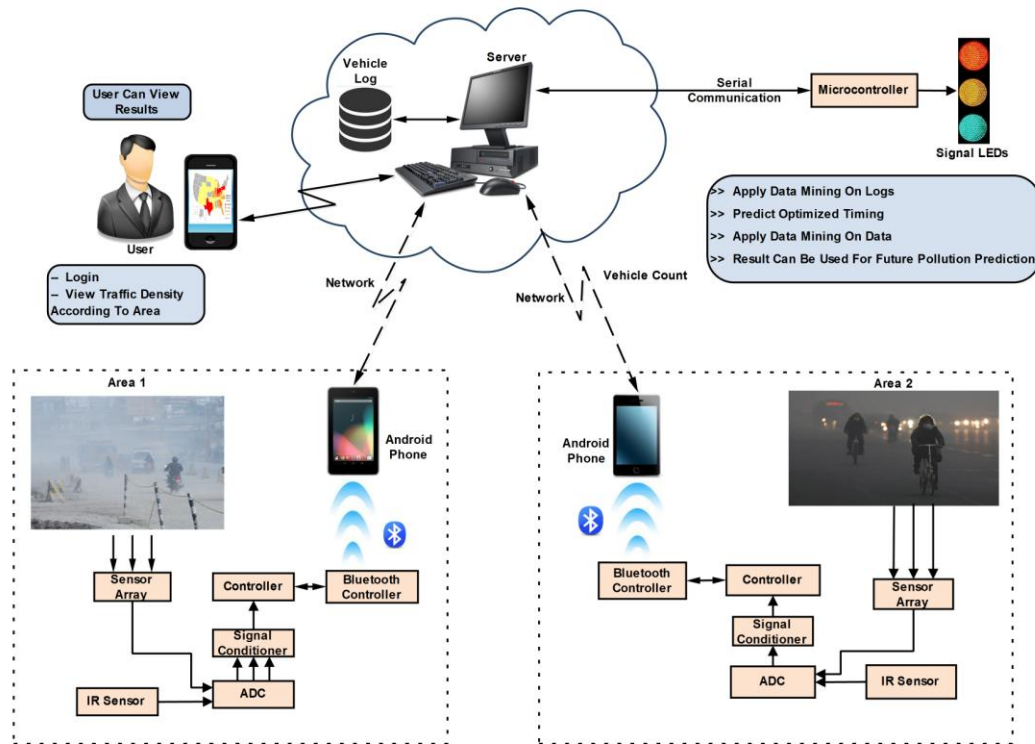


Fig. 3. Architecture of proposed system

The above fig.3 shows overall architecture of proposed system. This proposed system basically divided into two module i.e. hardware module and software module. In hardware module, we are going to use the android Phone/Device, Microcontroller (ATmega 32), Sensors (IR, Temperature, Sensor array), Bluetooth controller (HC-05 Bluetooth module), IC (MAX 232), Resistors, Capacitors, etc. And in software module we are going to use the android application at end-user, web server, database and data mining techniques. In proposed system, sensors will send all the sensor information/values to a microcontroller. Then microcontroller will receive that information/values and transfers to android device via Bluetooth controller. After that, android device (which is located in hardware module) will send all the collected information to the sever via internet over the web server and store it in database. In database, all mining operations will perform using the KNN and Naive Bayes algorithms [14],[15] for getting required results. Also traffic signals will be manage dynamically according to traffic density. When user needs a real-time traffic data or weather condition then, user will login to the android application, then android application will request to the web server for the user requirement and server will get back to end user with require results and user will now able to see the traffic data, traffic density, traffic condition and pollution/weather condition. This proposed

system can be useful for particular/any geographical areas (area1, area2, etc.) as shown in fig.3.

3.1 Hardware Module:

Here we are going to use various hardware components for our proposed system which includes: Smart Phone/Device, Microcontroller (ATmega 32), Sensors (IR, LDR, Thermocouple, Gas sensor, etc), Bluetooth controller (HC-05 Bluetooth module), IC (MAX 232), Resistors, Capacitors, etc. as shown in fig 4.

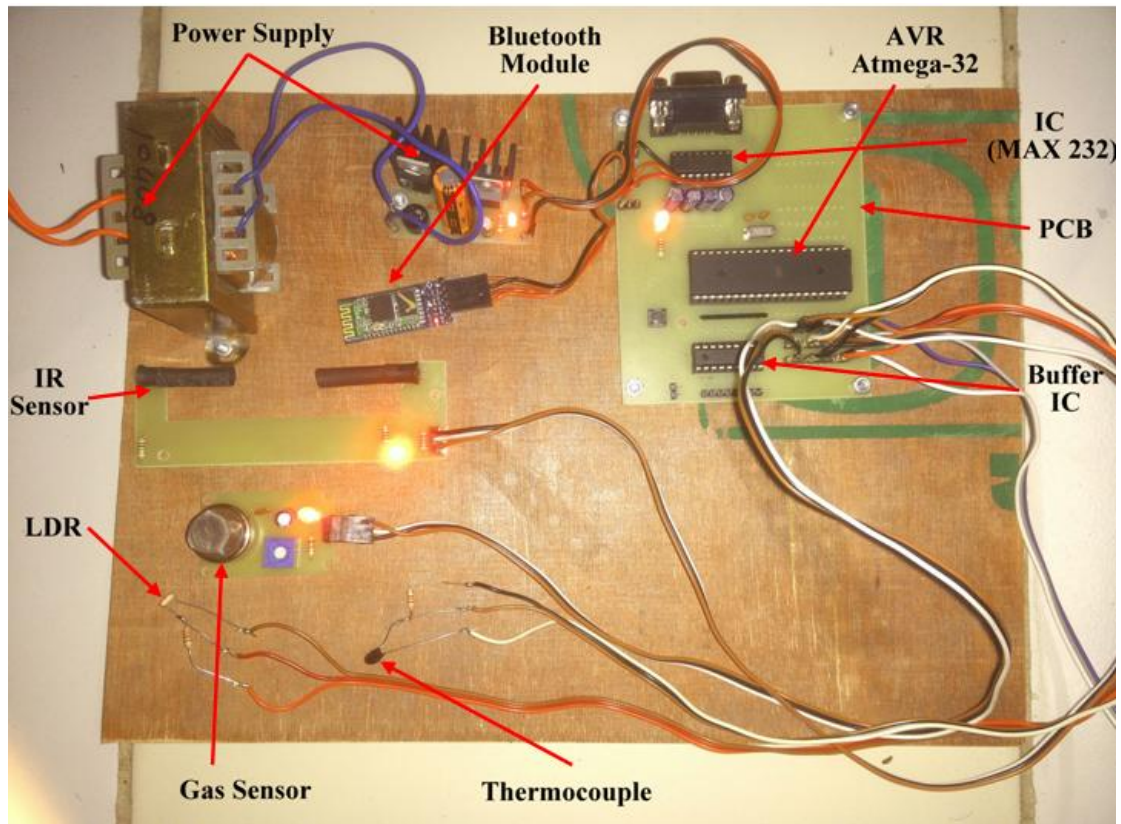


Fig. 4. Hardware Module

Microcontroller (ATmega 32). ATmega32 [11] is an 8-bit high performance microcontroller and it belong to Atmel's Mega AVR family. Atmega32 is based on enhanced Reduced Instruction Set Computing (RISC). Most instructions are execute in one machine cycle. Also, Atmega32 can work on a maximum frequency of 16MHz.

Sensors (IR, Thermocouple, Gas sensor, etc). Various sensors (IR, Thermocouple, Gas sensor, etc.) will use to sense the sensor values. IR sensor will used to count the number of vehicles on the road, Thermocouple sensor will used to know environmental temperature and gas sensor will used to know the gas/pollution in the environment for weather condition.

Bluetooth controller (HC-05 Bluetooth module). HC-05 [12] is easy to use Bluetooth SPP (Serial Port Protocol) module and it is designed for transparent wireless serial connection setup. Bluetooth controller is used to communicate between the hardware module and the android device.

IC (MAX 232). The MAX232 IC [13] is used for the conversion of TTL/CMOS logic levels in to RS232 logic levels during the serial communication of microcontrollers with PC.

Resistors. It is a passive two-terminal electrical component. It implements electrical resistance as a circuit element and acts to reduce current flow. Also, act to lower voltage levels within circuits, at the same time.

Capacitors. It is a passive two-terminal electrical component and it is used to store energy electro statically in an electric field. Practically capacitors vary widely, but all contain at least two electrical conductors (plates) separated by a dielectric (i.e. insulator).

Smart Phone/Device. It will be useful to read the real time sensor values to know the current status of traffic density and weather condition.

3.2 Software Module:

Here we are going to developed and use various software tools and techniques for our proposed system which includes: Android SDK, Web Server, Embedded C, Eclipse, Net-Beans, Express PCB, etc. Also, data mining/clustering technique will used to sort out and mining the received big amount of data/information in a specific manner using the KNN, Naive Bayes and ID3 algorithms [14],[15].

Server Machine (CPU)/ Web Server. It is middleware between the hardware module and the end user. Here we are going to developed an admin panel where we can observe all the current status of traffic density, whether condition, etc. Also it will helpful to tracking, broadcasting, managing traffic and weather condition. Here we are going to develop our own web server.

Android SDK. It is used to developed an android applicaiton. Here we are going to develope two applications, one for end user and other for hardware module. First one android application will receive all the sensor values and tranmit/upload that sensor values to the server other app will use to monitor the traffic density, wheather condition, etc.

Embedded C. It is extension of C programming language and it is useful when we want to developed hardware module. Here we will done programming in Embeded C and will load it in to microcontoller.

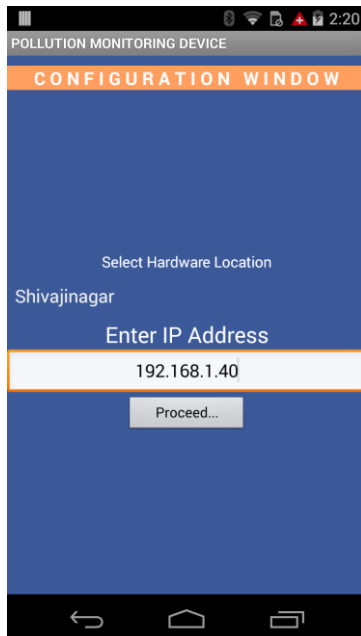
Net-Beans IDE 8.0.2. It is IDE and we are going to use it to developed our project with the help of Java and will test on it. Server side coding will done in Net-Beans IDE 8.0.2.

Express PCB. It is a free PCB software and is a snap to learn and use. For the first time, designing circuit boards is simple for the beginner and efficient for the professional. We done our circuit diagram and PCB using this software.

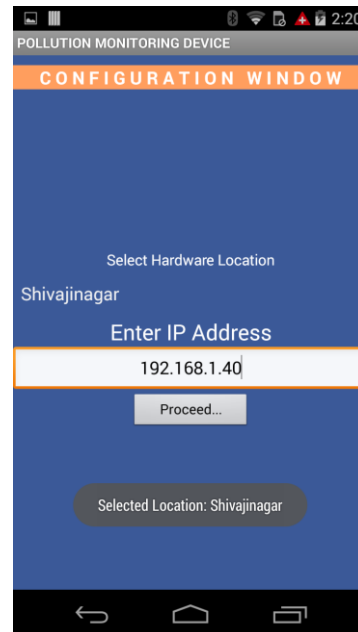
Eclipse. It is an IDE to developed and execute required projects. Here we used it to developed android app.

4 Implementation & Results

We have developed an android application to connect with Bluetooth module and display given sensor values which are collected from the hardware module and finally upload/sends this values on the sever machine. This developed android app will active on any android device and it will always connected to hardware module. Screenshots of developed android application is as follows:



Screenshot 1: When open app

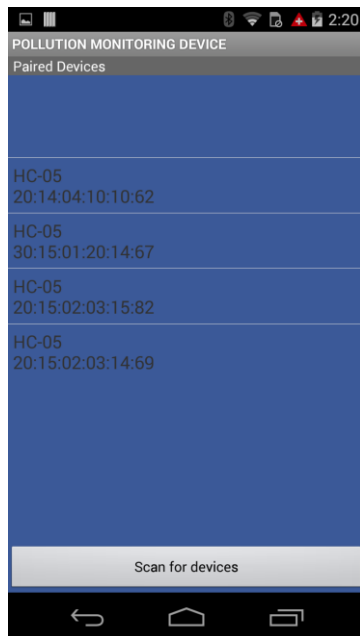


Screenshot 2: Select location & enter IP of server m/c

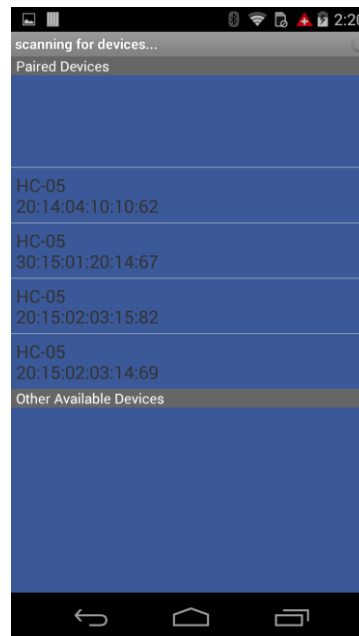
The above screenshot 1 shows the first window of our developed application. When we open app, this window will display. The screenshot 2 shows the configuration window. Here we need to select the required hardware location (where hardware module is placed like- area1, area2, etc.) and enter the IP address of server

machine to connect to the web server and click on proceed button. e.g. we will provide many locations like : area1 (Shivaji Nagar), area2 (Pashan), area3 (Susgaon), etc. Here, we select area1 (Shivaji Nagar) and after selecting location the message will display as shown in above screenshot 2.

After clicking on proceed button, next window i.e. paired devices window will open as shown in screenshot 3 and list of all the previous paired devices will display. Here, we need to connect our app to Bluetooth module so we will click on "Scan for devices" button to find other available devices and it will search for the Bluetooth devices near by it and ultimately it will show all the paired devices in upper half window and other newly available devices in lower half window as shown in screenshot 4. And finally we need to select required one. In our case, we have HC-05 Bluetooth module, so we will select it from the given list.



Screenshot 3: List of paired devices window before scanning

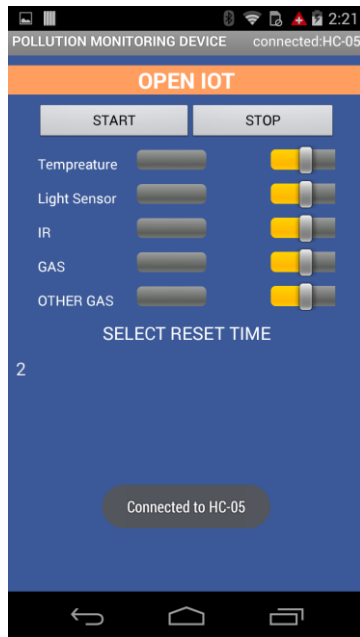


Screenshot 4: List of paired devices window after scanning

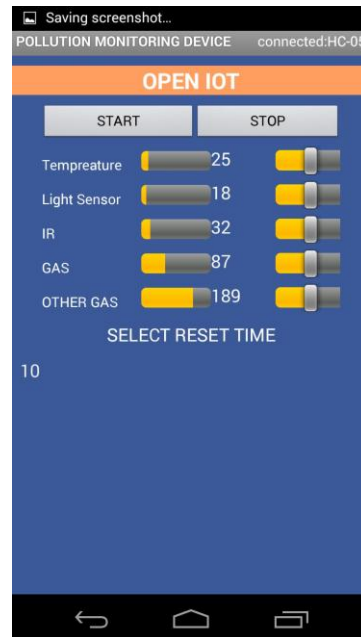
After selecting bluetooth module device from the given list, a new window i.e. monitoring device window will be open and shows the message "Connected to HC-05" as shown in screenshot 5. Screenshot 5 shows main monitoring device window. Here we can see that, it includes two buttons i.e. start button and stop button. Start button is used to start the monitoring activity and it will read/received all sensors values from the hardware module. And stop button is used to stop the monitoring activity. Here, all sensor values will be display i.e. temperature, light sensor, IR, Gas, other gas, etc. as shown in screenshot 5. Also, here we provide the thresholding just side to the progress bar of sensor value to set threshold value like : normal, low, medium, high, etc. for respective sensor values. And finally reset time is provided to

reset time for resetting/updating sensor values after a particular interval of time.

Screenshot 6 shows actual result of our proposed module. Here we can see that, temperature value is 25, light sensor's value is 18, IR's value is 32, Gas value is 87 and other gas value is 189. In this manner all sensor values will be display on developed android application.



Screenshot 5: Connected to HC-05



Screenshot 6: After clicking on start button all sensor values will display

5 Conclusion

After considering facts presented in introduction section, there is a vital need of research in ITS. We have presented vehicle traffic congestion control and monitoring system in IoT to develop an real-time software for tracking, broadcasting, managing traffic and weather conditions. This system contains a server and an Android client application for reporting and displaying traffic related events (traffic condition, traffic jams, traffic density, pollution/weather condition, etc.). It also includes a web application for the system administrators, data management and analysis. The interface of client application is intuitive and it is easy and safe to use while driving. Also, here we can dynamically manage traffic signal depending on traffic density. For further research, we can focus more on efficiency and reliability of traffic density using ITS and IoT technologies.

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