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Impaired Driving and Explosion Detection on Vehicle for Ubiquitous City

Sandip Roy*[1], Rajesh Bose[2] and Dr. Debabrata Sarddar[3]

[1]Research Scholar, [2]SeniorProject Engineer, [3]Assistant Professor

[1, 3]Department of Computer Science & Engineering,
University of Kalyani, Kalyani, West Bengal, India
[2]Simplex Infrastructures Ltd. Kolkata, West Bengal, India

Abstract

A vehicle with alcoholic driver on steering, or outage of fuel could be cause of disaster. A smart control system that identifies such a vehicle with an inebriated driver in control, and/or leakage of AutoGas (LPG) vehicle fuel system is in demand. Our proposed work in this manuscript enlightens towards smart traffic control model and safe cab booking system built on the principle of Internet-of-Things (IoT). An inexpensive XBee 64-bit module consuming very low power mounted on top of the vehicle. The system component is an inexpensive XBee 64-bit modules are mounted on top of vehicle to transmit sensor data. We have used Xively and Google Cloud Services to stream the live sensor data. MQ-2 and MQ-3 type sensors used as components to read AutoGas (LPG) and alcohol concentration levels. These sensors transmit data to nearest XBee controller attached to traffic signaling light post. The traffic lights play a major role based on real-time analysis of the sensor readings. The proposed safe cab booking system that enables passengers to decide whether to hire a cab based on its driver's breath tests and concerned authorities have ability to check out. This system transmits real-time data continuously to a cloud platform and enables users to access them using mobile apps or any internet browser. Our working prototype tested successfully and test results enlisted. Real-time graphical information on remote public cloud platform affirms that our proposed system is able to deliver satisfactory results under varying conditions.

Keywords –Area Traffic Control System (ATCS), Blood Alcohol Content (BAC), Impaired driving, Internet of Things (IoT), Google Cloud Platform, Xively Cloud Service, ZigBee Technology.

1. INTRODUCTION

As the world's second largest populous nation, India's GDP has been growing at a steady clip [1]. Keeping pace, the number of vehicles running on roads has multiplied. "Indians Road Safety", a NGO, noted in 2015 that a person dies every 4 minutes due to road accidents [2]. This report brought sharp focus on the count of road fatal which stand at 135,000 in a single year. A report from the National Crime Records Bureau (NCRB) confirms that drunken drivers play major [2]. The Center for Development of Advanced Computing (C-DAC), one of Indian Government's R&D organizations, come up with sophisticated vehicle tracking and traffic control system driven by solar power viz. Wireless Traffic Controller (WiTraC), the first of its kind in the country. It is part of an "Intelligent Transportation System Endeavour (InTranSe) for Indian cities" [3]. An instance of the kind of peak hour traffic that can be seen in our daily life, concerning different kinds of circumstances; especially breathalyzer tests one of the alarming issues for today, is shown in Figure 1. Emergence of inexpensive technologies such as ZigBee, RFID, and GSM has made it possible to design advanced traffic control systems. Our paper covers two important issues involving detection of leaks in vehicle LPG fuel systems, and safe booking of cabs after ensuring that the driver is not in an inebriated condition.

Figure 1. Real time on road breathalyzer tests was checked by officers Source: News is accumulated from 1. The IndianEXPRESS, January 8, 2016, 2. STARWEEKLY, October 12, 2015, 3. Irish News, May 10, 2016, 4. The Daily Telegraph, December 18, 2014.

1.1 Detecting LPG leakage inside the vehicle

To combat the rise in pollution caused by vehicles, the Ministry of Road Transport & Highways, in 2000, allowed Liquefied Petroleum Gas (LPG) as a fuel source. However, this is not without risks. A leaking LPG fuel system can cause explosions, and can cause depletion of oxygen levels inside vehicles. Further, LPG explosions can lead to traffic congestions if these occur, without warning, in the midst of peak traffic conditions.

1.2 Drinking and driving

Road accidents caused as a result of driving in an impaired state are a major problem in India. Studies have established that around 40 percent of all road accidents have been caused by drivers under influence of either alcohol or drugs [4]. Although, equipment is available to conduct checks for traces of alcohol in blood, the process involved is often time-consuming [6]. Spot checks conducted, often causes traffic to slow down. Automatic testing of a driver's breath is one of the prime objectives of our work.

1.3 The IoT based Cloud Connection

We employ IoT-based approach to connect vehicle-mounted sensors to devices, which collect and store sensor data on a remote cloud storage system. The XBee wireless module placed on top of vehicle roof to transfer sensor data. Once configured, a module transmits sensor data to remote XBee controller device. In our project, we have relied on two different cloud services viz. Xively and Google Cloud to remotely visualize sensor data. Roy et al. proposed architecture composed of layers to store sensor data on remote cloud [7].

2. STATE OF THE ART REVIEW

For developing country like India, traffic congestion is an issue that needs to be examined as number of vehicles increasing rapidly. Countless man-hours can be saved with an effective traffic management system. Allowing unhindered passage to emergency vehicles is almost impossible in rush hour. Mittal and Bhandari have suggested use of PIC microcontroller-based system to clear way for emergency vehicles [8]. The authors also put forth a technique termed "green wave". The authors states about the synchronization so that a finding a decongested route in emergency is easy. Sundar et al. not only proposed an intelligent traffic control system to reduce traffic congestion and clear routes for passage of emergency vehicles, but also talked about stolen vehicles detection [9]. A software tool named TraMM, developed by C-DAC, allows remote management of WiTrac traffic signal controller with an intuitive interface that can also generate reports for analysis [10]. Hashim et al. talked about traffic light control system to ensure smooth passage for emergency vehicles utilizing RF technology [11]. While Nellore and Hancke have examined current traffic management schemes, Zhou et al. has demonstrated that it is possible to implement

intelligent transportation system by incorporating ZigBee wireless network [12, 13]. An intelligent driver assistance system has also been discussed which can reduce road accidents by around 20 to 30 percent using an assistance system based on ZigBee modules [14]. The system alerts drivers when entering immediate vicinity of school or hospital zones, and other designated accident-prone zones. Employing both RFID and ZigBee-based wireless sensor technologies, Chao and Chen have demonstrated a traffic control system [15]. All these promising research works encouraged us to come up with Zigbee-based design of a smart traffic control system that has a number of advantages. In order to contribution in this area, we have used MQ-2 and MQ-3 sensors to detect LPG leakage and alcohol traces, respectively. The sensor data is transmitted to a remote cloud hosted by different Cloud Service. A vehicle is uniquely identified by unique media access control address (MAC address) of an on-board XBee module. Thus, authorities can easily track a vehicle from remote locations. Our system automatically monitors vehicular movement, thereby, facilitating in easing traffic congestions. Chances of accidents, result of impaired driving, can be reduced to a significant extent just by taking precaution with proposed system. Our proposed model is capable of ensuring a safer journey in LPG-powered vehicles. It encourages public to grow reliant on a fuel system that is cheaper and environment-friendly [16]. The rapid growth in numbers of vehicles, in Kolkata, have led to pollution and traffic congestion in an almost equally undesirably measures [17, 18]. Use of new and innovative solutions involving ZigBee, RFID, and GSM can resolve this issue. A traffic light may no longer be solely relied on to handle traffic congestion. Our paper contributes significantly in this direction, and has the potential to improve the situation.

3. PROPOSED MODEL

From a perusal of the existing literature, the existing traffic control systems do not have built-in intelligent mechanisms to guard against LPG leakages on a remote public cloud platform [19]. Considering the fact that a sizeable chunk of three-wheeled mass transport in India run on LPG, it becomes imperative that an effective system to detect LPG leaks put in place. In addition to the feature which detects alcohol, and thus identifying possible impaired driving, we have collated sensor data relating to LPG leaks on a public cloud platform [20]. This enables two crucial features of an intelligent vehicle management system to combine into a robust and agile framework capable of saving lives. The system can control traffic signals based on current status of any vehicle and can set off alarms after identifying vehicles with either LPG leaks, or an intoxicated driver at the wheel. Using our proposed model cab booking without driven by drunken drivers can be possible [21, 22]. Our proposed system is demonstrated in Figure 2.

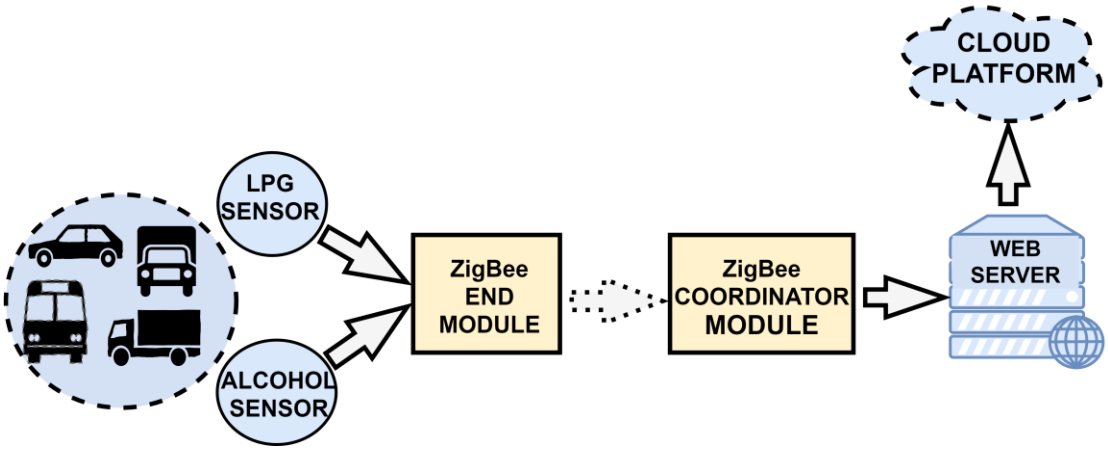

Figure 2. Proposed System Block Diagram

3.1 ZigBee Technologies

ZigBee standard is based on the IEEE 802.15.4 high-level communication protocol used to create personal area network (PAN) for data transmission amongst devices viz. computers, mobile and personal digital assistants (PDA). Table 1 demonstrates the comparison between most popular technologies used for wireless communication. Table suggests that both Bluetooth and Wi-Fi have higher bit rates than ZigBee, but lower battery life and small number of devices connected for making up the network. Therefore, ZigBee technology is the most suitable for our proposed road network because we have considered the data communication in remote high-way traffic and battery power consumption as low as possible.

Table 1: ZigBee vs. some other wireless technologies

Specifications	BLUETOOTH	WI-FI	ZIGBEE
IEEE Standard	802.15.01	802.11b/g	802.15.04
Number of connected devices	7	32	Up to 65,000
Bit rate	720 kb/s	11/54 Mb/s	20-250 kb/s
Range	10 m	100 m	100 m
Battery life	1-7 days	1-5 days	100-1000 days

3.2 ZigBee-based proposed intelligent traffic system for unsafe vehicle detection

In this section, we discuss the configuration of XBee modules as per our proposed model. The integral part of our system to send the sensor information of the vehicle to the remote traffic control system for identifying the vehicle status. For vehicle identification, we have considered the unique 64-bit MAC address of the XBee module connected with each vehicle [23]. Figure 3 illustrates the MAC address of the XBee module marked by rectangle box. Each XBee module can operate in either transparent mode (AT) or packet-based application programming interface (API) mode. In

transparent mode, the sensing data directly transmitted over the air to the intended XBee module without any modification whereas in API mode the data wrapped in a frame structure that considers addressing on per packet based and requires delivery confirmation for every successfully transmitted packet. An XBee module can operates either as a full-function device (FFD) or reduced-function device (RFD). Depending upon the network requirement XBee modules configured as three different types: Coordinator, Router and End-Device. Additionally, ZigBee Gateway (ZG) has a build-in ZC that is responsible to start the overall network. Each type has its own functionality as discussed below:

3.2.1 ZigBee Coordinator (ZC)

ZigBee Coordinator is the most capable device operating on FFD responsible forming the overall network. There is one and only one coordinator. Each coordinator must select a unique PAN ID, appropriate channel for data communication and the extended network address. Furthermore, ZC also authorizes routers and end-devices to join the network. ZC acts as a Trust Center and store security information of overall network.

3.2.2 ZigBee Router (ZR)

ZigBee router is an FFD. The basic function of a router is to find the best path to the intended destination. ZR also performs all the functionality to a coordinator except establishing of a network. A ZR can start operation when it establishes connection with coordinator.

3.2.3 ZigBee End-Device (ZED)

ZED acts as a child connected to a ZC or ZR (parent). It can only consume power while transmitting information to ZC or ZR. ZC is an RFD operates at low duty cycle power. Therefore, it gives a significant amount of battery life and it requires least amount of memory than ZC or ZR. Thus, it can be less expensive to manufacture than ZC or ZR.

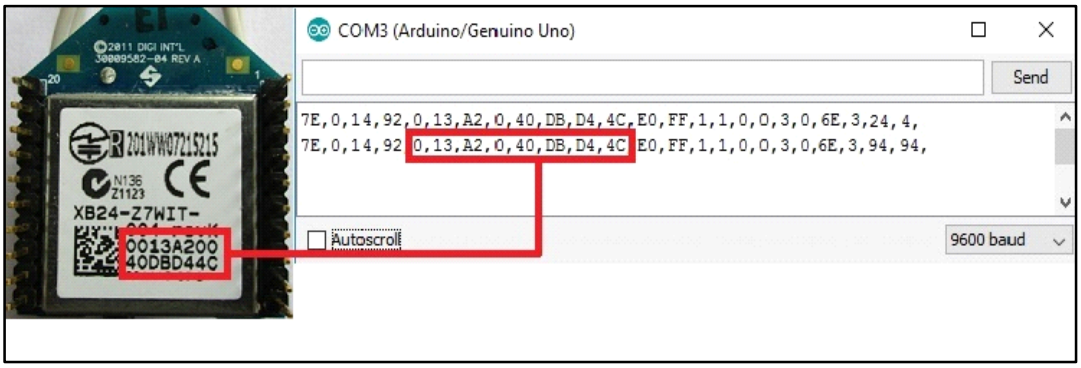

Figure 3. XBee API frame with 64-bit MAC address marked by red rectangular box

3.2.4 ZigBee Gateway (ZG)

ZigBee Gateway connects different types of ZigBee networks to the Internet or service providers performing the protocol conversion.

In Figure 4 shows ZigBee End Device (ZED) classification and placements as follows. Each ZED, configured as AT mode or Router AT and mounted on top of the vehicle to send sensor data to the nearest ZigBee Routers (ZR) or ZigBee Coordinators (ZC), configured as API mode are connected at the traffic light post. The ZR can act as an intermediate that can pass sensor data to other ZR or ZC node, attached within the range of the other ZR or ZC. Each ZigBee network must have a ZC node acts as a gateway which streams data to the remote cloud storage server.

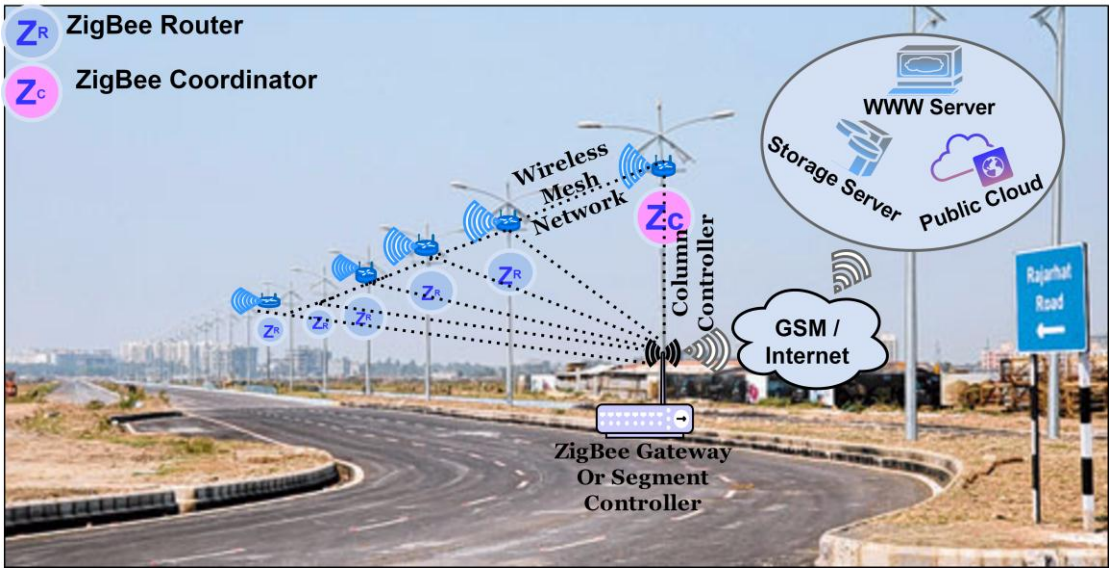

Figure 4. ZigBee-based communication overview between Rode Side Unit (RSU)

3.2.5 XBee API frame

XBee modules communicate with each other over the air via wireless messages and communicate with intelligent devices through serial interface. There are two types of communication process: 1) Serial communication and 2) Wireless communication.

In case of serial communication, the communication takes place between the XBee module and the intelligent device connected via serial interface. Whereas in wireless communication, all the modules communicated wirelessly within the same network, same PAN ID and must use the same radio frequency.

The Application Programming Interface (API) is a frame-based protocol for sending and receiving data to and from a radio's serial universal asynchronous receiver/transmitter (UART). API frame consists of seven major parts. 1) the start delimiter which is always start with "0x7E"; 2) the length of the data frame that has two bytes value identifying the number of bytes contained in the frame data field; 3) the frame type which identifies the type of the sending or receiving frames; 4) the 64-bit

source address of the XBee module that sent the data sample; 5) the frame data portion that is formed by the API identifier and specific data; 6) the specific data content will change according to the API identifier and finally, 7) the checksum that is a byte specifics the hash sum of the API frame.

In Table 2 gives information about the received data sample of our proposed model, where data part identifies the analog data of MQ-2 and MQ-3 sensors accordingly.

Table 2: Parameter of XBee API frame with sample analog sensor data

7E 00 14 92 00 13 A2 00 40 DB D4 4C E0 FF 01 01 00 00 03 00 6E 03 24 04	
7E	Start delimiter
00 14	Length of frame
92	Frame type
00 13 A2 00 40 DB D4 4C	64 bit source address
E0 FF	16 bit network address
01	Receive options
01	Number of sample
00 00	Digital channel mask
03	Analog channel mask
00 6E	Sample data of MQ-2 sensor
03 24	Sample data of MQ-3 sensor
04	Checksum

In this manuscript, our main focus is to detect LPG leakage and the drunken driver for public safety. ZigBee wireless communication protocol is used for intermittent data transmissions from vehicle to traffic junction or segment controller. Received data further judges the concentration of LPG gas and alcohol level. If it outstretches the standard limit, then filter them and store to the remote cloud server along with the 64-bit MAC address which is required for vehicle identification. When the passengers want to hire cars, he or she enquires about the status of the vehicles.

3.3 Intelligent traffic light

When the respective sensors detect abnormal concentration levels of either alcohol or LPG, nearest traffic lights turns to red, automatically. The traffic lights stay on red for specific time period required to response following detection of a potential hazard [9].

3.4 Safe cab booking system

To ensure safe trip without drunken driving, we propose a safe cab booking system [24]. Our proposed model enables detection of drunken driver, and identifies the particular vehicle being driven by one through the unique 64-bit device address of an on-board ZigBee module. The store information displayed to users by third party through mobile apps or web browsers. In this manner, a driver's condition ascertained before an online booking is made.

3.5 Experiment setup and methodology

For our experiments, two XBee wireless modules were configured as End device (ZED) AT or Router (ZN) AT mode at the vehicle side and Coordinator API (ZC) mode at RSU side. MQ-2 and MQ-3 sensor modules and Atmel ATmega328P microcontroller were used for developing mobile sensing box (MSB) which attached specified position of the vehicle to keep track the concentration level of LPG and alcohol gas. The sensor data is transmitted to the input pin of XBee transmitter and the XBee transmitter then transmits out the data in the form of API frames including the 64-bit address of the XBee transmitting module with sample sensor data. On the other hand, the Coordinator End consists of a microcontroller-ATmega328P, a XBee receiver module and a display system to track the vehicle and also change the traffic light accordingly. The XBee receiver module which attached on Road Side Units (RSUs) receives the data from the transmitting XBee module in the form of API frame which 64 bit address of the sender XBee sender module. Furthermore, the data now is streamed to cloud services viz. Xively and Google Cloud Services. The information now can be viewed on any smart devices and monitored by competent authority by accessing the cloud services from anywhere of the specified urban city. System control flow is shown in Figure 5.

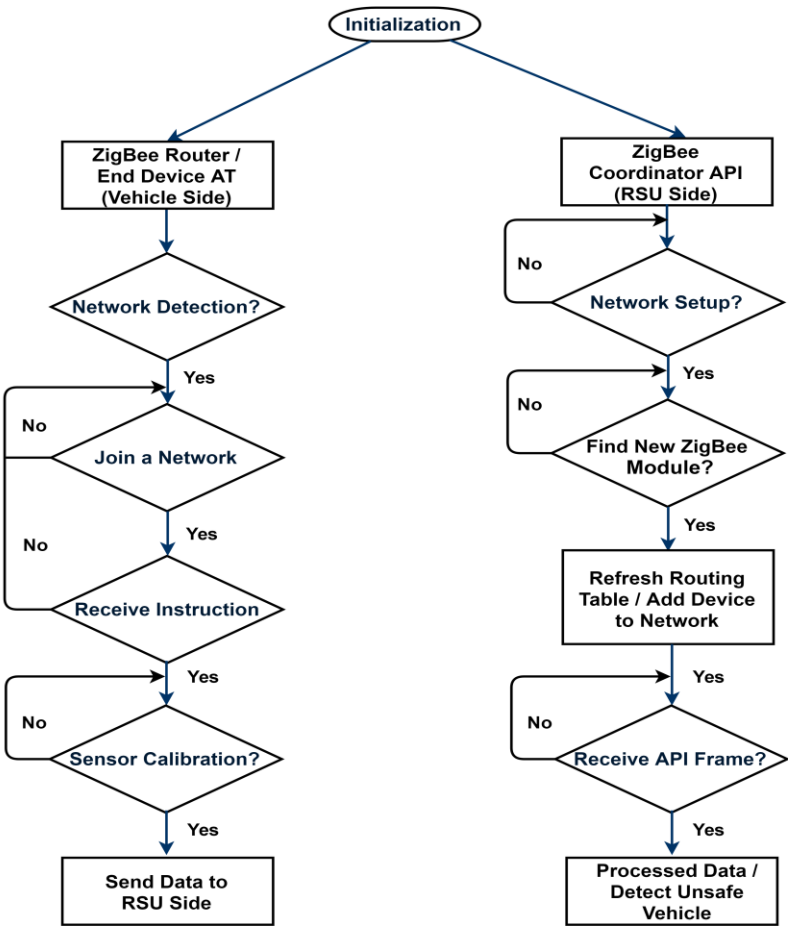

Figure 5. System control flow

3.6 Circuit diagram for our proposed model

In our proposed model, we have discussed two scenarios: At first, send analog sample data using XBee I/O pin where we don't need any microcontroller. Here unsafe vehicles are detected at nearest traffic signal point.

Secondly, our aim is to identify the vehicle using remote cloud services. Additionally user can also check the vehicle status using Map API. So, we have attached GPS module to send RF data using TX port of microcontroller which is connected to the RX port of XBee. The circuit diagrams of both scenarios are illustrated in Figure 6 and 7.

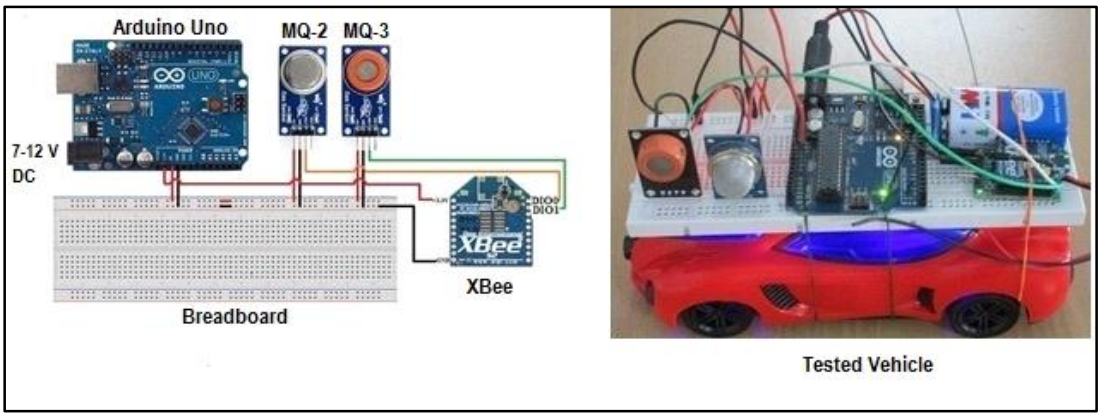

Figure 6. Circuit diagram and its implementation as a ZED without GPS module

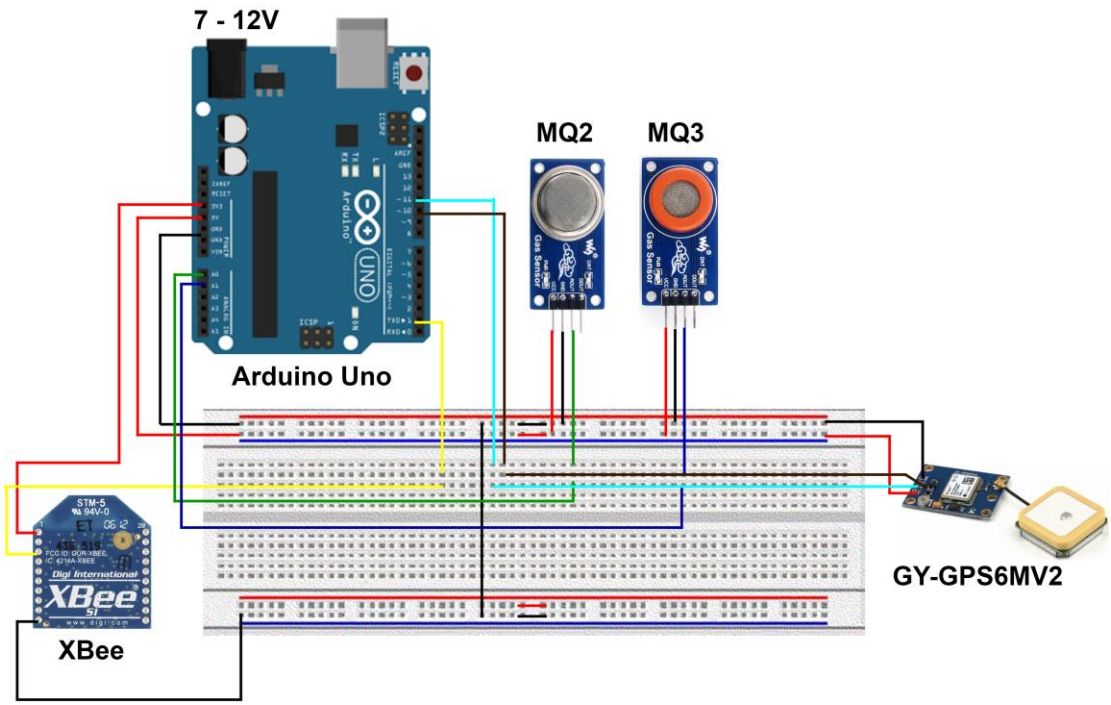

Figure 7. Circuit diagram and its implementation as ZED with GPS module

Furthermore, here we address the benefit using our proposed model for the safe cab booking system. When a passenger want to book a cab using the Maps Navigation panel displayed on screen mobile app authorized by the specified cab authorities. A GSM module is required to tell the current position of the vehicle. Therefore, using our proposed method the vehicle is tracked and sends the driver's state and also the information about the vehicle fuel system to the remote cloud server through the ZigBee gateway node or segment controller point which is demonstrated in Figure 8. Here each vehicle is monitored by the remote traffic control room.

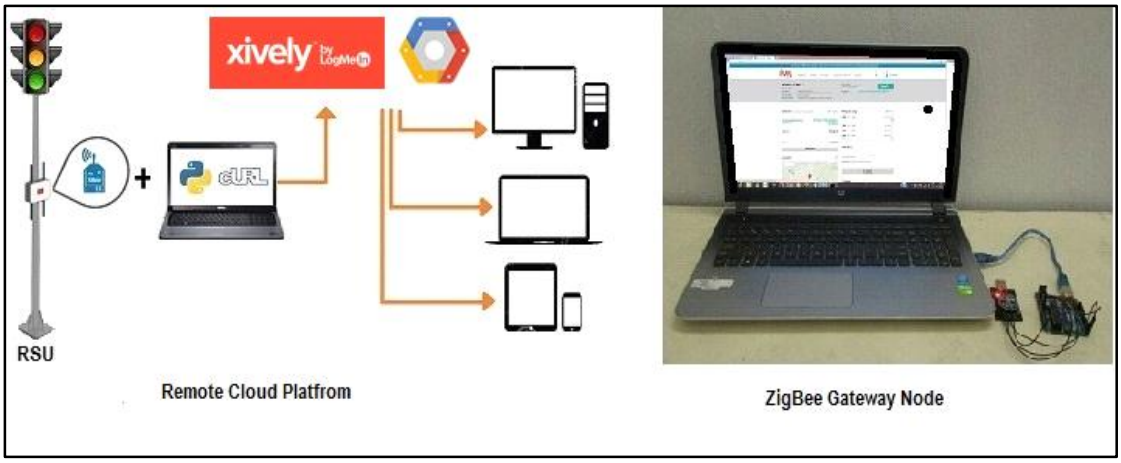

Figure 8. Graphical representation and its implementation as ZC to stream data at remote cloud end

4. EXPERIMENTAL RESULTS

In our experiment, we have tested our proposed system in two scenarios: 1) Smart traffic control model and 2) Safe cab booking system. Firstly, our model tested by installing sensors and XBee transmitter module on a LPG driven vehicle. Figure 6 shows the side views of the vehicle, which acts as an End-Device and sends data to the nearest RSU. After receiving the sensor data, traffic signal point checks the data along with the standard limits. By default, red and green lights are set to glow for 10 seconds; the yellow for only 2 seconds. Depending on the state of the vehicle detected by our proposed system, the timings will change to signal an emergency.

Secondly, we discuss the integral part of our manuscript that to steam data to the remote cloud server through segment controller or ZigBee gateway. Here we have used two cloud services viz. Xively and Google Cloud Platform [25, 26].

To stream the sensor data to the Xively Cloud Service, we configure our segment controller a secure socket layer enabled environment. To enable SSL, we install cURL, which is free software that runs under various operating systems. As per the customization is need at the client end, so the segment controller is fully programmable. We use python program and creates a JSON (JavaScript Object Notation) file to exchange sensor data between Xively browser and segment controller. Each vehicle was identified by the API frame 64-bit serial number of its on-board XBee module.

Figure 10 - 13 demonstrate the display of sensor data on Xively IoT web page under varying conditions. MQ-2 (#adc-0) and MQ-3 type (#adc-1) sensors have been used to detect presence of LPG and alcohol trace levels inside vehicles [27, 28]. As per the requirement this information can share to the client web portal. Therefore third-party cab providers, displaying information using sensor data stored through Xively Cloud is easy. Thus, alerts can be issued to signal the presence of a drunken cab driver at the time of online booking.

Secondly, to track each vehicle, a GPS module is used and each vehicle's location is identified by the users using Google Map API [29]. Our aim to track all vehicle of a specific region of a unban city. So to sketch our database, we temporally store every timestamp of all passing vehicles in Google Sheet as a CSV file format and after specific time instance we permanently keep only the unsafe vehicle's data to the Google Cloud SQL for further decision supports.

For making a cost-effective cloud storage planning, Google Sheets is a limited free service, it has a limit of 4,00,000 cells and 256 columns per sheets so we can easily kept data of all vehicles passing a particular traffic junction for a specific time period, but it can't manage the data of all traffic junctions of an urban city so Google Cloud SQL is best fit. It is a fully-managed database, offers high performance and scalability with up to 10TB of storage capacity, 208GB of RAM per instance and 25,000 IOPS but it pays per use services, so we can only store the unsafe vehicle data. Below we explain the blueprint of this scenario.

This process has integrated into three parts. At first, at the controller ends run python program and also enable OAuth 2.0 security credential which is the industry standard protocol for users' authorization for accessing Google APIs and receive the XBee API frame from end-device node and store the RF data along with timestamp because each rows in a sheet can contain multiple versions of same data which is indexed by timestamp. Secondly, Google Apps Script is used as automatically triggered and synchronized only the unsafe vehicles data to the Google Cloud SQL. Lastly, these data is now available to the third-party cab provider to alert the cab users for booking the safe vehicles. As well as user can also visualize the available cab along with the vehicle status using Google Map API through their smart phone app.

The standard safety measured analog value of alcohol is fixed at 150 (0.03% BAC limit) and LPG gas is in between 60 to 120 (LPG detecting concentration scope 200 ppm – 5000 ppm) [27, 32]. This limit may vary depending upon the vehicle type and road traffic conditions; some cases the LPG concentration level is too high due to high traffic (the measures below 1000 ppm to 1500 ppm are for safety condition and above 2000 ppm for alarming condition). The graphs showcase two types of conditions which occurs when automobile installed with the system passes across the RSU unit and sends data regarding LPG gas leakage and alcohol detection simultaneously to the remote cloud service. The two conditions are considered; Normal condition and deviant condition. The next section we discuss the sensor calibration method for our proposed model.

4.1 Sensor Calibration Method

Sensor calibration is a method by removing structural errors in the sensor outputs. Structural errors are the difference between the expected output of sensors and its measured output. Each sensor module is required to be calibrated in known reference/standard value. For calibration of each sensor module, we have measured the sensitivity characteristic of each sensor. Each sensor gave the analog data (0 - 1023) as output. This analog value (d_1) is converted back to their analog voltage (V_{out}) using the following equation 1 [30].

$$V_{out} = 5.0 \times d_1 / 1023 \tag{1}$$

Various gases are usually represented by PPM or parts per million is the mass of chemical per unit volume of water also the same as mg/L. The following equations 2 and 3 are required to convert the data from V_{out} to PPM value. Each sensor represents its sensitivity characteristic using Rs/Ro and PPM value, where Rs is the resistance of target gas with different concentration and Ro is the value of sensor resistance in clean air.

$$R_s / R_o = (V_c - V_{out}) / V_{out}, where V_c = 5V \tag{2}$$

Now, to find the concentration of gas present in clean air is given by the power series equation 3

$$y = a \times x^b \tag{3}$$

where a and b are constants; y represents the concentration of gas in PPM and x represents the corresponding resistance values calculated by the equation 2. Table 2 presents the LPG concentration level in ppm with the corresponding analog value. The detecting concentration scope of LPG gas level lies in between 200 ppm – 5000 ppm [27].

Table 3: Sample Results for LPG value in ppm

Analog Value	Ratio	Expected Output	Output	Deviations
85	1.12	509.81 ppm	531.12 ppm	4.01%
111	0.84	914.45 ppm	966.92 ppm	5.42%
123	0.74	1182.94 ppm	1223.55 ppm	3.32%
136	0.66	1492.39 ppm	1545.52 ppm	3.44%
185	0.46	3106.49 ppm	3240.47 ppm	4.13%
203	0.41	3924.72 ppm	4089.39 ppm	4.02%

Similarly, alcohol content in a volume of breath or blood is represented as mg/L. Each commercial breathalyzers measured the alcohol concentration in Blood Alcohol

Content (BAC); the conversion is required from driver's breath alcohol content (BrAC) to the corresponding BAC level using the equation (4). BrAC and BAC differ by a factor of 2100 [31].

$$\%BAC = (d_2/1023) \times 0.21 \tag{4}$$

where d_2 represents the analog value of MQ3 sensor module

Every country has its own regulations for the BAC level of the drives for operation of a vehicle. The BAC limit of India is 0.03% except for the state of Kerala [32]. Figure 9 shows the BAC (%) value with corresponding to the alcohol analog value.

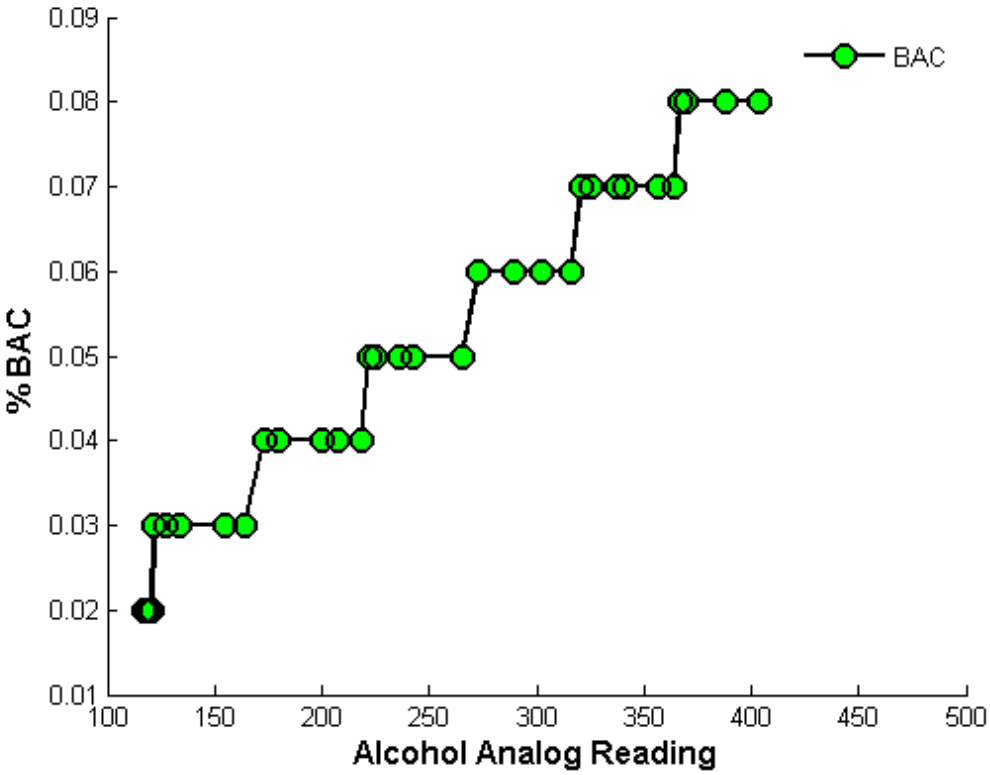

Figure 9. Scatterplot of BAC vs. Alcohol Analog Reading

4.2 Analog Data Streaming to the Xively Cloud Service

4.2.1 Normal Condition

At normal condition both the readings of MQ-2 and MQ-3 gas sensors are in low state which assures that the vehicle is in safe condition. The level of gas and alcohol in the vehicle does not pass the standard safety measures. So it is not required to take any safety measures for that vehicle. Figure 10 demonstrates that the vehicle is in normal condition and the analog value of LPG gas in the vehicle is 25 and the analog value of alcohol detected is 54 which do not pass the standard safety measures.

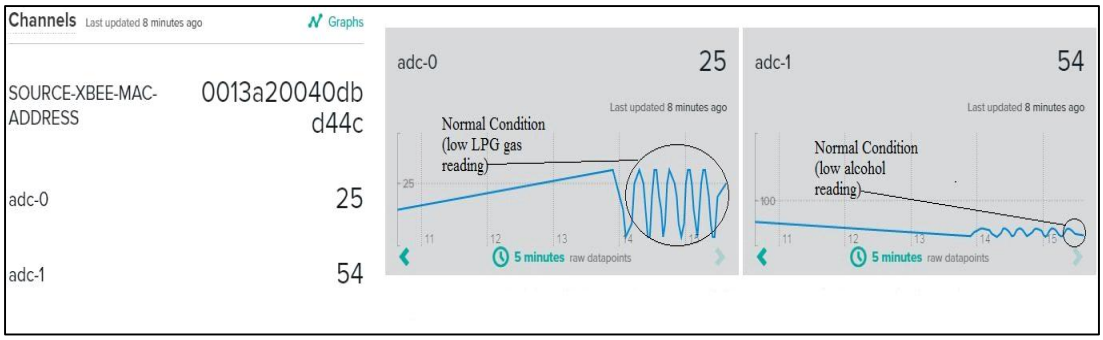

Figure 10. Normal condition with low LPG gas and alcohol reading

4.2.2 Deviant condition

In deviant conditions both the readings of MQ-2 and MQ-3 gas sensors are in high state which assures that the vehicle is in unsafe condition. It may also occur that the analog value of alcohol is high and the analog value of LPG gas is low in the vehicle and simultaneously the analog value of LPG gas is high and the analog value of alcohol is low in the vehicle. Figure 13 demonstrates that the vehicle is in unsafe condition because the value of alcohol detected in the vehicle is 896 which are much higher than the standard safety alcohol measures.

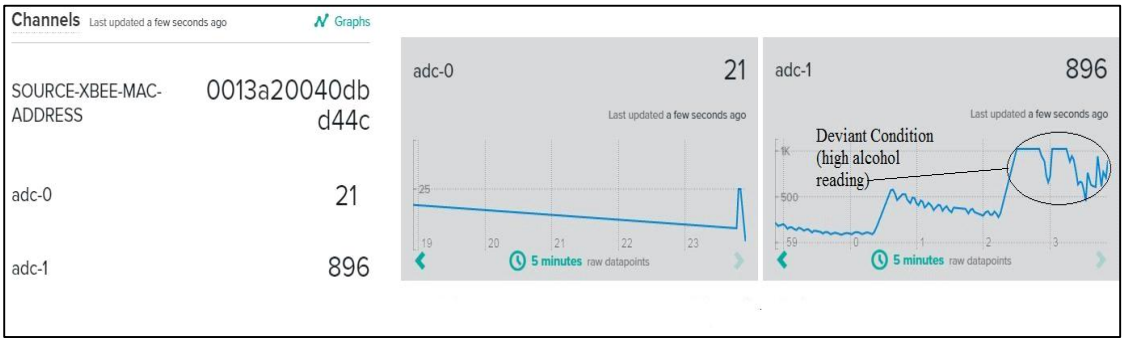

Figure 11. Deviant condition with high alcohol reading

In Figure 12 demonstrates that the vehicle is in unsafe condition because the value of LPG gas leakage detected in the vehicle is 801 that are much higher than the standard safety measures. So the vehicle is marked as unsafe. Figure 13 demonstrates that the vehicle is in deviant condition and the value of LPG gas in the vehicle is 801 and the analog value of alcohol detected is 306 which are much higher than the standard safety measures. So the vehicle is also marked as highly unsafe.

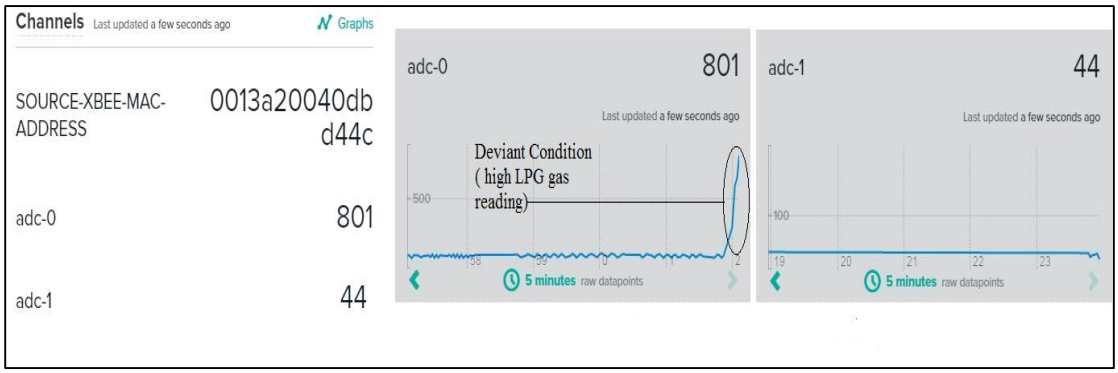

Figure 12. Deviant condition with high LPG gas reading

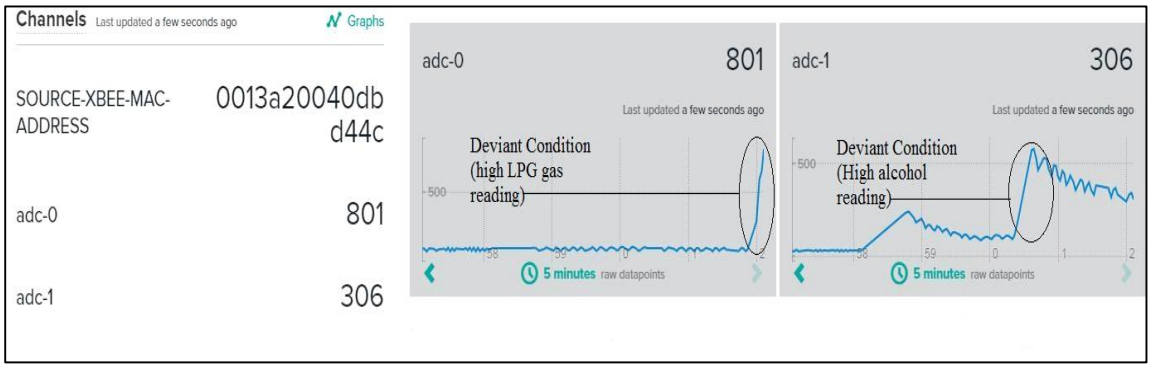

Figure 13. Deviant condition with high LPG gas reading and alcohol reading

4.3 Real-Time GPS data streaming to the Google Cloud Platform

In our proposed model the BAC value of the driver is measured and also checked LPG concentration value of vehicle fuel system. These values are sent to the nearest RSU through XBee API frame. After receiving API frame, each coordinator XBee module, connected at the RSU which stored RF data at remote cloud app such as Google Spreadsheet API. After specified time instance automate triggers have called and judge whether the receive BAC value which violets the traffic rules of the state or country. Then those values are filtered and stored to Google Cloud SQL database. Then BAC value of the identified vehicles is notified through the cab booking authority. Therefore each passenger can use the mobile app and get to know the BAC level of the driver prior to cab booking.

Figure 14 show the BAC (%) level of each car which is tracked by its corresponding GPS module and visually represented using marker graph. When the BAC value outstretches the limits 0.03% (for India), the marker value of the corresponding vehicles have shown by red color and is identified by arrow which marked as victim vehicle otherwise green marker is specified the safe vehicle.

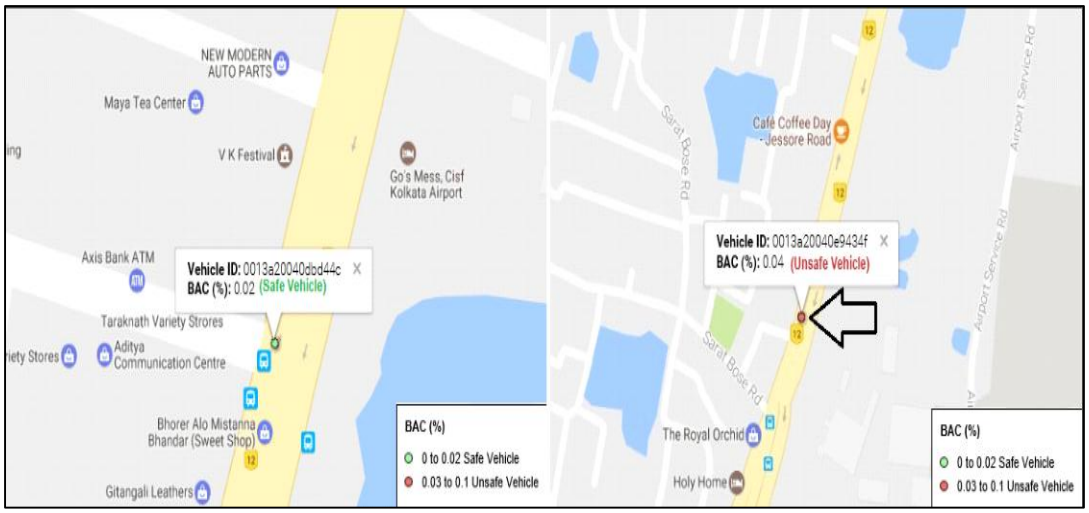

Figure 14. BAC (%) level of safe or unsafe vehicle detected using Google Map

4.4 Throughput measurements

Throughput is useful test to measure the transfer ratio from XBee radio module to another module in the same network.

We have configured one XBee as Coordinator API mode (RSU side) and other XBee as End-Device or Router AT mode (Vehicle side). We checked the transfer ratio (Kbps) in varying speed of the tested vehicle using X-CTU software. Figure 15 shows the front view of our tested vehicle, data communication between RSU and vehicle and the RF data frame format. The results explain that around 40 km/h speed (average speed limit of all vehicles) the average transfer ratio 2.8 Kbps (average) in unidirectional mode and average transfer ratio 1.07 Kbps (average) which determines the merit of our proposed model.

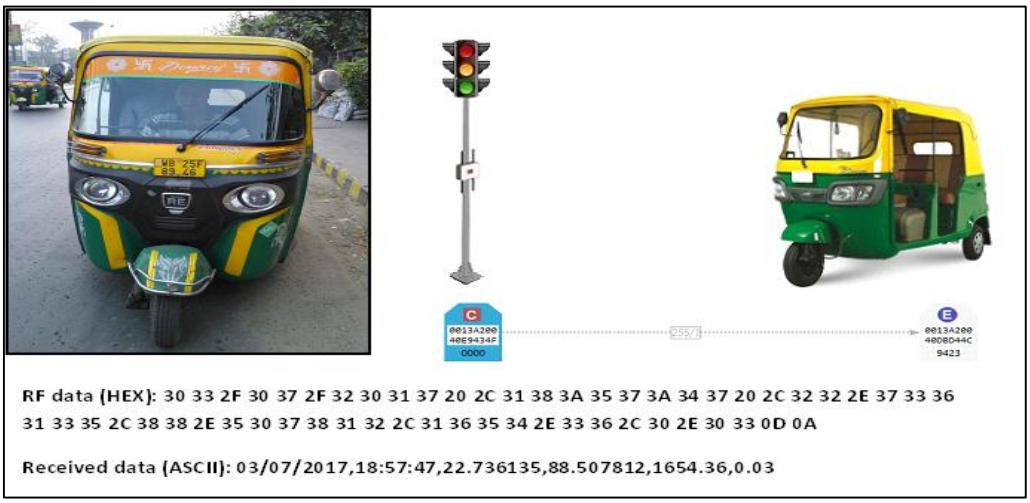

Figure 15. RF data frame format

We have measured in real environment; not in noise-free laboratory. Because we wanted to check XBee modules when they would be working when deployed in real working environment. Firstly, we discuss the two types of throughput process which we have checked in different speed measures of the tested vehicle; i) Unidirectional and ii) Bidirectional – Cluster ID 0x12.

In the unidirectional throughput process, the sends data from the local XBee coordinator module to remote XBee end-device module; the local XBee module waits for sending the next packet of data until it receives the transmission status of the previous packet. Secondly, in the bidirectional process same as unidirectional process but here local XBee module waits for the data receipt from the remote XBee module.

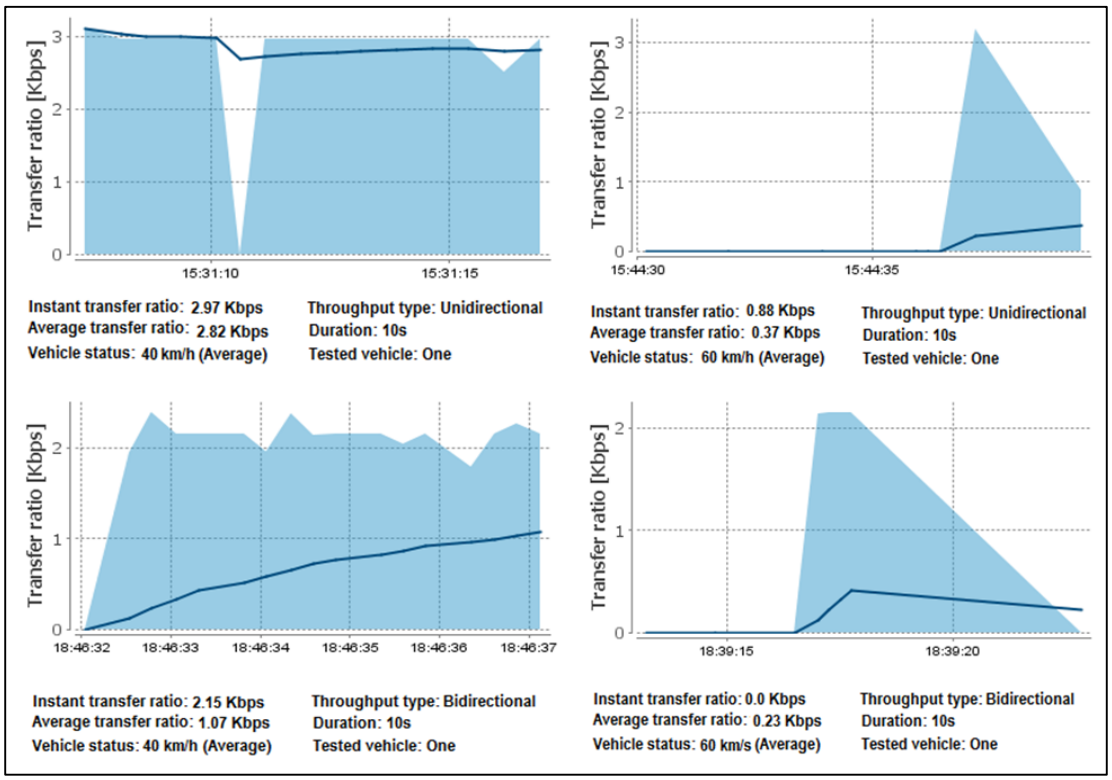

Figure 16. Throughput measurements in unidirectional and bidirectional mode

4.5 Range Test

Range Test is another important measure to check the RF range between coordinator and end-device XBee module in the same network.

In our proposed model, we plan to connect a coordinator module at the RSU end and another XBee end-device module is attached in the top of the vehicle roof. Some XBee modules are also connected at the RSUs acting as router to extend our network. So distance between RSUs are the integrate part of our proposed model. We have tested the received signal strength for different distance of the XBee module. If the XBee end-device module is moved closer to the XBee coordinator module; the strength of the

transmitted signal by the end-device module at the receiving antenna increases which is demonstrated in Figure 17. We have also examined two XBee modules around 20m distance in a real road environment at the peak hour and get average 57% signal strength. Figure 18 shows the on-road signal strength statistics between two XBee modules.

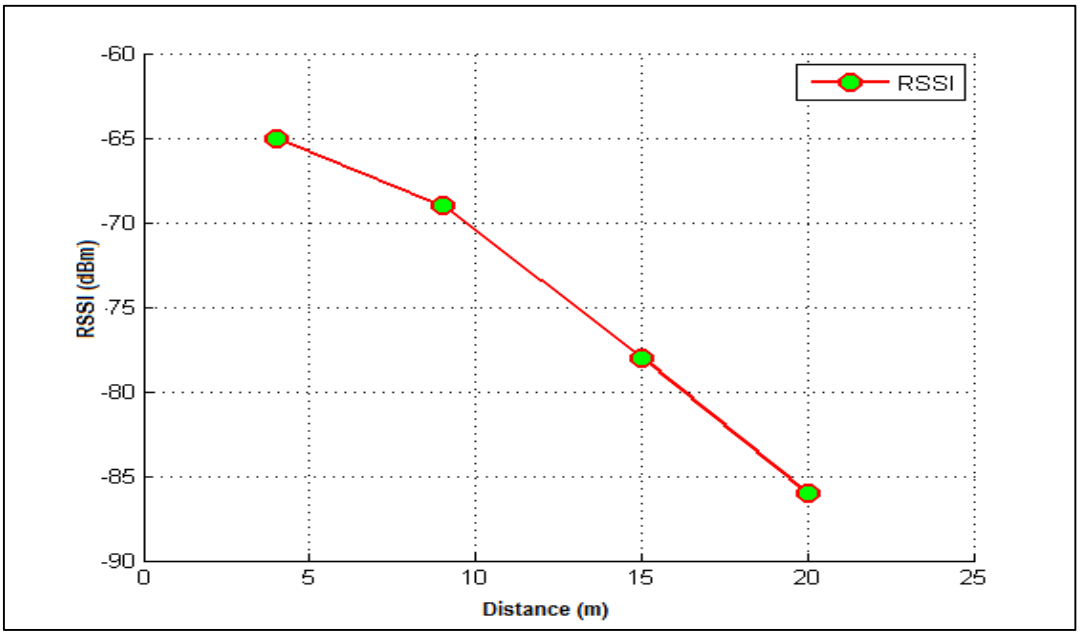

Figure 17. Distance (m) vs. RSSI (dBm) between two XBee modules

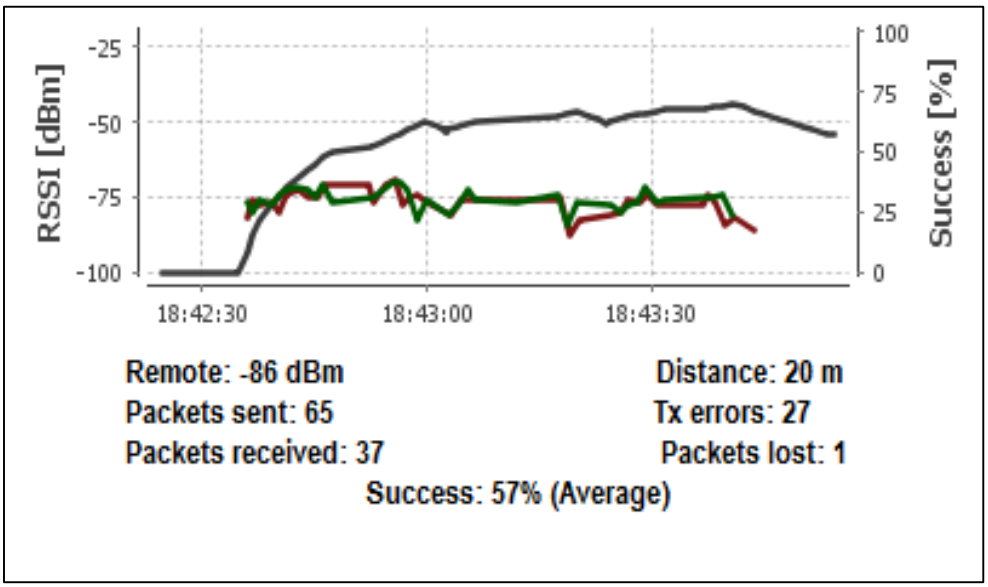

Figure 18. On-road signal strength statistic between two XBee modules around 20m distance

5. CONCLUSION

In this paper detection of drunken driver and LPG leakage has discussed. As the entire system is automated, very little human effort is required to detect and isolate vehicles through described process. Our proposed intelligent traffic system monitors concentration of LPG in real-time. In case the sensor readings exceed the threshold mark, nearest traffic lights are turned red so that the vehicle can be stopped and inspected for leaks. Law enforcement officials can track a vehicle using data streamed live from a public IoT-based cloud platform. Our model also solves the problem of booking a cab online. A prospective passenger can use a mobile app to detect the driver's state prior to making cab booking. Experiments, conducted at a single road and traffic junction, reveal that our proposed model has the potential to protect and save countless lives. The design can be improved by extending its reach over several roads and traffic junctions along with multiple vehicles. Proper working delay management can make the system more efficient.

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AUTHORS PROFILE

Sandip Roy is currently pursuing Ph.D from University of Kalyani. He is an Assistant Professor of SDET-Brainware Group of Institutions, Kolkata, West Bengal, India. He received M.Tech in Computer Science & Engineering under WBUT in 2011 and B.Tech in Information Technology from WBUT in 2008. His main areas of research interest are Cloud Computing, Internet of Things, Cloud of Thighs and Smart Technologies. He acquired Best Paper Award from ICACEA in 2015.

Rajesh Bose is currently pursuing Ph.D. from Kalyani University. He is an IT professional employed as Senior Project Engineer with Simplex Infrastructures Limited, Data Center, Kolkata. He received his degree in M.Tech. in Mobile Communication and Networking from WBUT in 2007. He received his degree in B.E. in Computer

Science and Engineering from BPUT in 2004. He has also several global certifications under his belt. These are CCNA, CCNP-BCRAN, and CCA (Citrix Certified Administrator for Citrix Access Gateway 9 Enterprise Edition), CCA (Citrix Certified Administrator for Citrix Xen App 5 for Windows Server 2008). His research interests include Cloud Computing, Wireless Communication and Networking.

Dr. Debabrata Sarddar, Assistant Professor in the Department of Computer Science and Engineering, University of Kalyani, Kalyani, Nadia, West Bengal, India. He has done Ph.D. from Jadavpur University. He completed his M. Tech in Computer Science & Engineering from DAVV, Indore in 2006, and his B.E in Computer Science & Engineering from NIT, Durgapur in 2001. He has published more than 144 research papers in different journals and conferences. His research interest includes Wireless and Mobile System and Wireless Sensor Network and Cloud Computing.