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Sensor Network based IoT Solutions for Smart and Safe Logistics

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Abstract
The online shopping is the trend of the day and the need for door delivery of products is increasing day by day. To satisfy the increase in demand for online shoppers there is a huge increase in logistic services. Logistic services include transporting of varied items which includes costumes, electronic gadgets, furniture, cosmetics, Jewellery etc. Also, perishable food materials are also being transported daily using its refrigerated trucks. It is Hence it is necessary to have systems that monitors and alerts the physical parameters of the truck continuously. The dealers are been put in punitive action due to retard in matter, destruction of substance and theft. They are dealing with difficult situation for rigorous supervising of the entire issues, however owing to the continuous evolution in cloud computing, communication technologies, big data security solutions, visualizing techniques and Internet of things [IOT] it is very well possible to deal these issues in a smart way. Hence this paper proposes smart ways of sensing the variation in ambient conditions of the truck and alerting the end user when the truck enters an unauthorised area by way of Geofencing and also banging of doors for theft attempts are identified by REED switches. The concept of Geo-fencing has also been introduced to track the boundaries of the movement of the truck. A fencing mechanism using Geofencing along with an altering system has been attached to the system to alert the concerned person if the truck crosses the predefined boundaries. Thus the ultimate smart way of doing logistics is discussed in this paper.

Keywords: *Internet of Things (IoT), Geo fencing, Sensor Network, Cloud Computing.*

I. INTRODUCTION

Owing to multitasking and prompt development of the ecosphere's changing scenarios in provisions of technology, the societal human difficulties today are becoming more composite day by day. As a result of the hectic routines people prefer online shopping and door step delivery of things. Hence in recent days there is a huge increase in logistics and issues and challenges related to logistics [1]. There are many complex scenarios exclusively when transporting perishable goods. The physical parameters like temperature, humidity, and lighting are few essentials that will contribute to the quality of the goods to be delivered. It is also equally important to identify the theft attempts being made on the transported goods [2]-[4]. This paper recommends a smart process for calculating precise atmospheric circumstances inside the truck operating different sensor data, and correspondingly Geofencing is used to track the boundaries of vehicle movement. By directing remote sensing technologies, necessary factors within the truck can be observed periodically and a smart alarm system has been established that can create a truck safer and is free from using REED switches.

To capture relative data, consumer-connected devices (IOTs) using sensors would be mounted on the trucks, are stored in the cloud. To read the data from cloud in truck, a web service was assembled in a NO SQL database [clouding db], scan and study

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the truck sensor records by regaining data from the database. This network can be trained by Convolution Neural Networks with multiple positive images of any number of subjects besides if and only if delivered with certain negative images to require good accuracy.

IOT devices with sensors and Geo-fencing are installed in the trucks to capture relevant data and information about the trucks entering the undefined locations or deviating from the original route. The GSM/GPRS module attached to the system will enable communication with Axelta OSMOSIS Platform on the cloud and will initiate alarm conditions when an abnormality occurs. A REST web facility was designed to read the cloud truck information and accumulate the truck data in a NO SQL database.

II. HARDWARE DESCRIPTION

The objective of maintaining quality in logistics is ensured by monitoring the temperature, humidity and other parameters. Also, theft attempt is monitored by ensuring the opening of truck door by authorized people. The sensors are linked to the GPIO pins of node MCU. The NodeMCU is based on Arduino programming which runs on ESP826 wifi connectivity. NodeMCU, a development Kit based on ESP8266 integrates GPIO, I2C, PWM, ADC and 1-Wire in a single board.

Power consumption is a major constraint in massive driving force in the IoT, as a huge majority of it counts on wireless and battery-powered embedded devices. The data from sensors integrated with IoT is not accessible to user directly. Hence, it depends on machine- to-machine (M2M) communication protocols to acquire the data to a position where they can be processed as well as analyzed. The most common and reliable M2M protocol handled by IoTgadgets is called MQTT (Message Queuing Telemetry Transport). An ESP8266 development board NodeMCUDevkit V1.0., connects the NodeMCU firmware to a MQTT-cloud. The NodeMCU- Devkit gets connected to a single RGB LED, which forms the effective low power means of communication. A digital temperature sensor LM35, digital humidity sensor, LDR and a read switch are connected to the input pins of Node MCU. Superintending the cold logistics parameters such as temperature, power supply, water vapour in the atmosphere, door condition (open/close) for container by online connection is accomplished using different sensors. NodeMCU obtain the sensor measures to detect as well as to compute the environment and bring out to MQTT broker and java client subscribe it to the sensor value and produce LED status [5]. The NodeMCU receives LED status and thereby analyzing its status, LED glows to designate, if there is an alert.

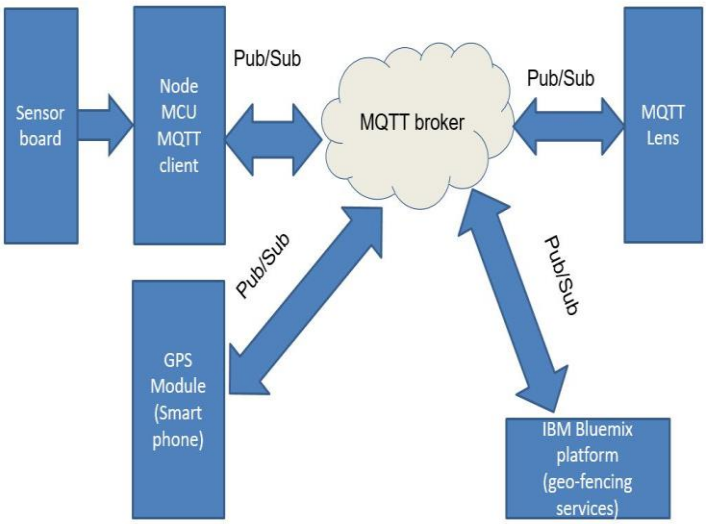

Figure 1: Sensor Data Integration and Processing

The details of sensors used are as follows:

- An Ultra low-cost digital temperature sensor (Sensor: DHT11) monitors the temperature by keeping a continuous record of the temperature of the surroundings.
- An Ultra low-cost digital Humidity sensor (Sensor: DHT11), senses the moisture level of the environment.
- A Photo conductive cell is operated for calculating the light entering the truck

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- A magnetically operated Reed Switch is utilized to know the open/close status of door. An alarm is initiated when an attempt is made to open the door.

III. SENSOR DATA FUSION

The sensor board is connected to the Node MCU microcontroller. The microcontroller receives all sensor readings from the sensor board and then publishes to the MQTT broker. Finally, through MQTT lens, the Sensor values can be published. Further, using the Geo-location data the analysis on path deviation can be done and indicated.

The smartness in logistics is implemented in two different phases. Initially, a series of sensor integration to Node MCU microcontroller for data acquisition was done. The microcontroller takes all sensor readings from the sensor board and then allocates it to the MQTT broker. In the end through MQTT lens, the sensor values can be subscribed under the publish topic.

In second phase, smart phone publishes geolocation and speed readings to the MQTT broker and through IBM cloud, we subscribe them and do the location analysis such as deviation from the defined path or dwelling time analysis etc. An android app will connect to the IBM Watson server and publish location and speed values to the Watson IoT platform and to the geo spatial program in the cloud server. The IoT platform receives the values and stores them into the respective databases. If there is any trigger, the IoT platform sends back to the android app saying “entering the defined region” or “leaving the defined region” which is been defined by the user.

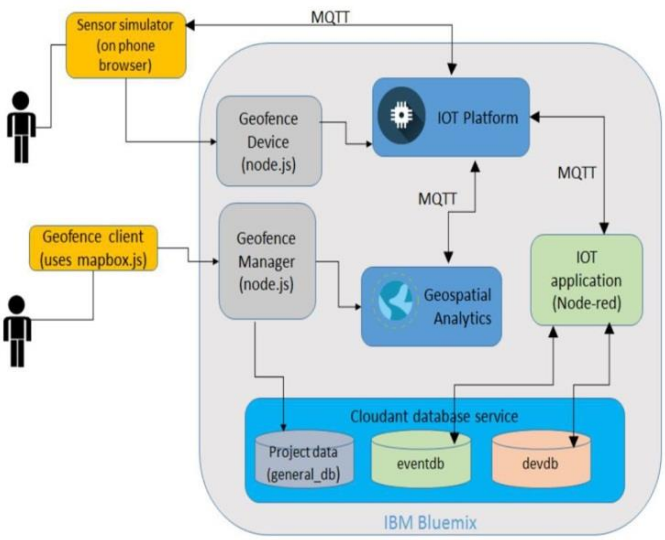

Figure 2 Flow of Geofence tracking process

NodeMCU obtains the sensor measures and allocate to MQTT broker as well as java client subscribe to its sensor measure and allocate the LED status. This is the steps involved in the whole process of sensor data publishing.

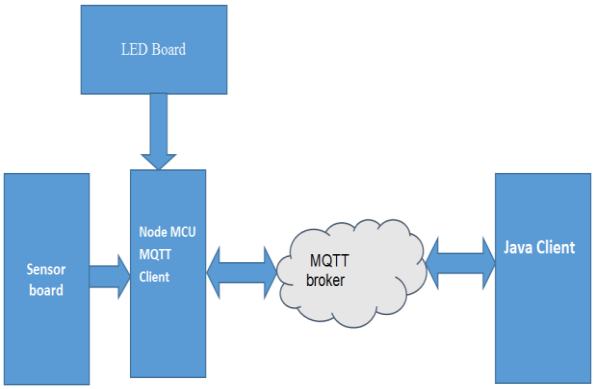

Figure 3: Sensor Data Publishing process

a) Sensor notations onthesensorboard:

L –LightDependentResistor(LDR)

H–TemperatureandHumiditySensor

R–MagneticallyoperatedReedSwitch

P–PowerSwitchbasedonOptocoupler

Table 1: Sensor board pin configurations

Sensor	Sensor Board	GPIO	NodeMCU

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Light	L	A0	A0
Temperature and Humidity	H	0	D3
Reed (Door)	R	4	D2
Power	P	5	D1

LDR output pin named as L on sensor board is connected to A0 pin of NodeMCU and H,R,P output pins are connected on sensor board to D3, D2, D1 respectively on NodeMCU board as mentioned in the above table.

b) Led Notations On The Led Board

A4 – Red LED

A3 – Green LED

A2 – Yellow LED

Table 2: LED board pin configurations

LED	LED Board	GPIO	NodeMCU
1 - Red	A4	13	D7
2 - Green	A3	12	D6
3 - Yellow	A2	14	D5
GND	GND		GND

A2, A3, A4 output pins are connected on LED board to D5,D6,D7 respectively on NodeMCU board as mentioned in the above table using 1-pin F-F connecting wires.

IV. RESULTS AND DISCUSSIONS

The results presented below are simulated under three different conditions under the assumptions of different atmospheric conditions and power supply mode.

Case 1: Consider the case where the power inside the container is OFF, light condition is slightly above its defined threshold and the door condition is open

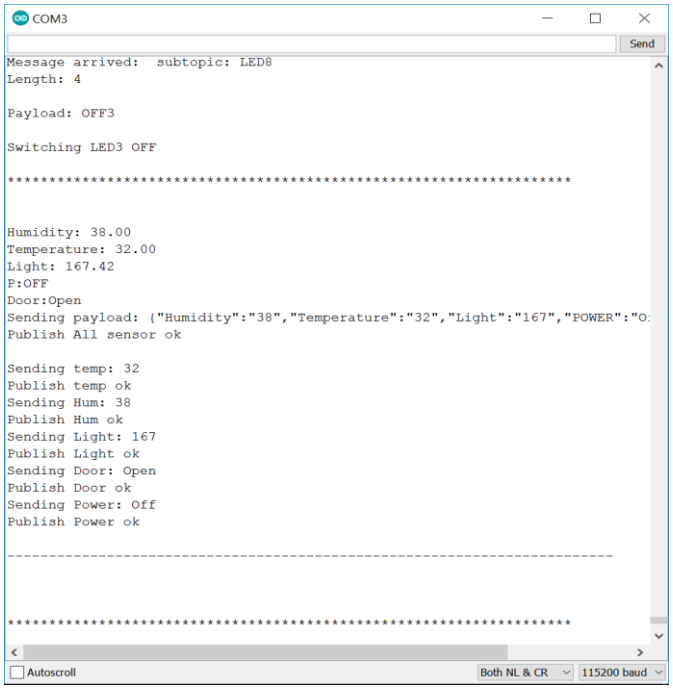

Figure 4: Case1: sensor readings while publishing

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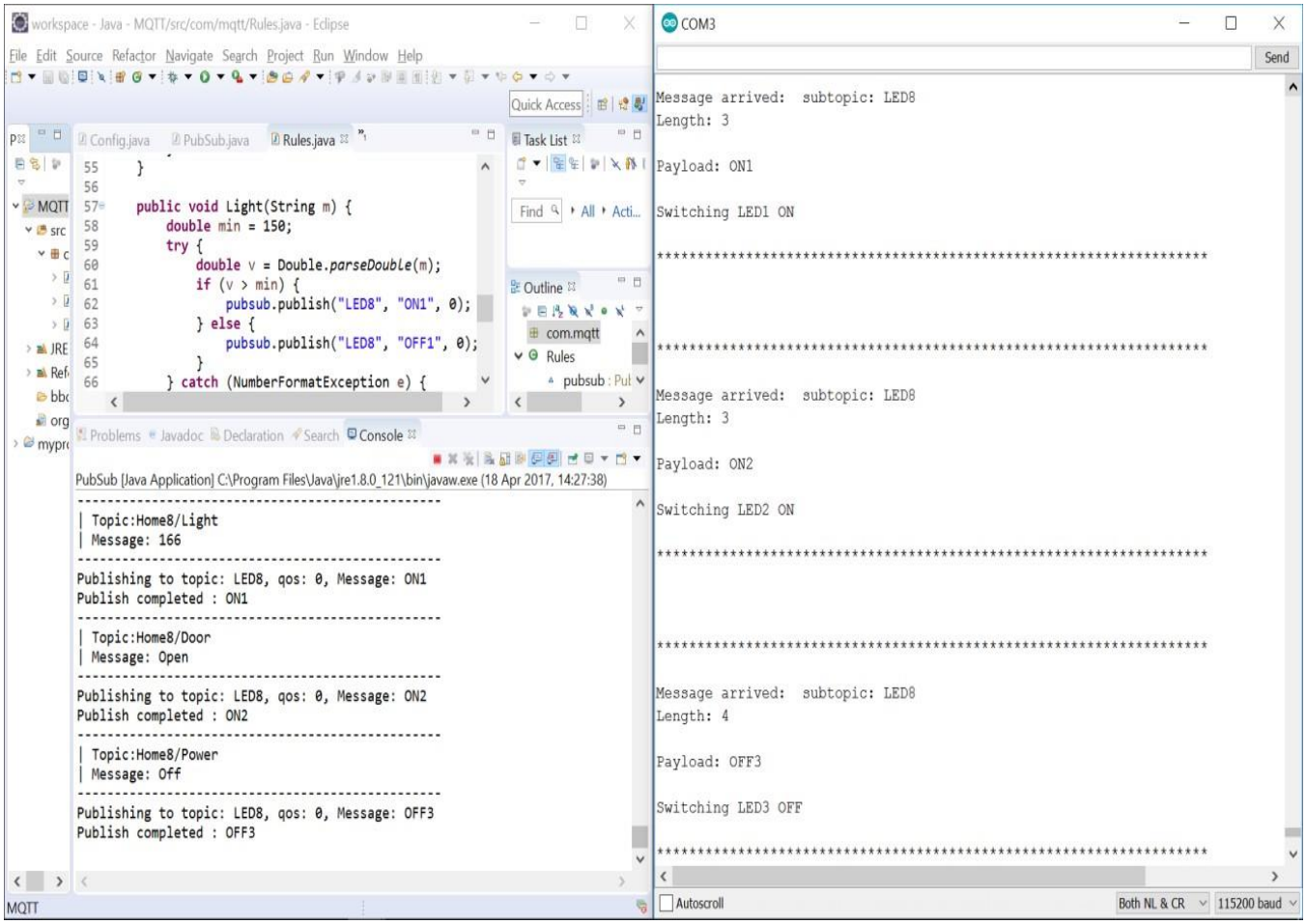

Figure 5: Case1: NodeMCU subscribing Javaclient published values

Case 2: Consider the case where the power inside the container is OFF, light condition is little above its defined threshold and as a consequence the container door will be opened

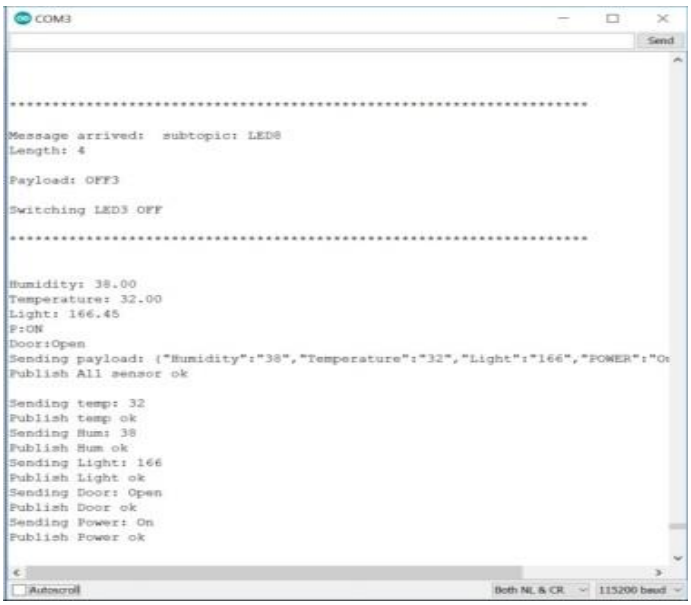

Figure 6: Case 2: Published Sensor readings

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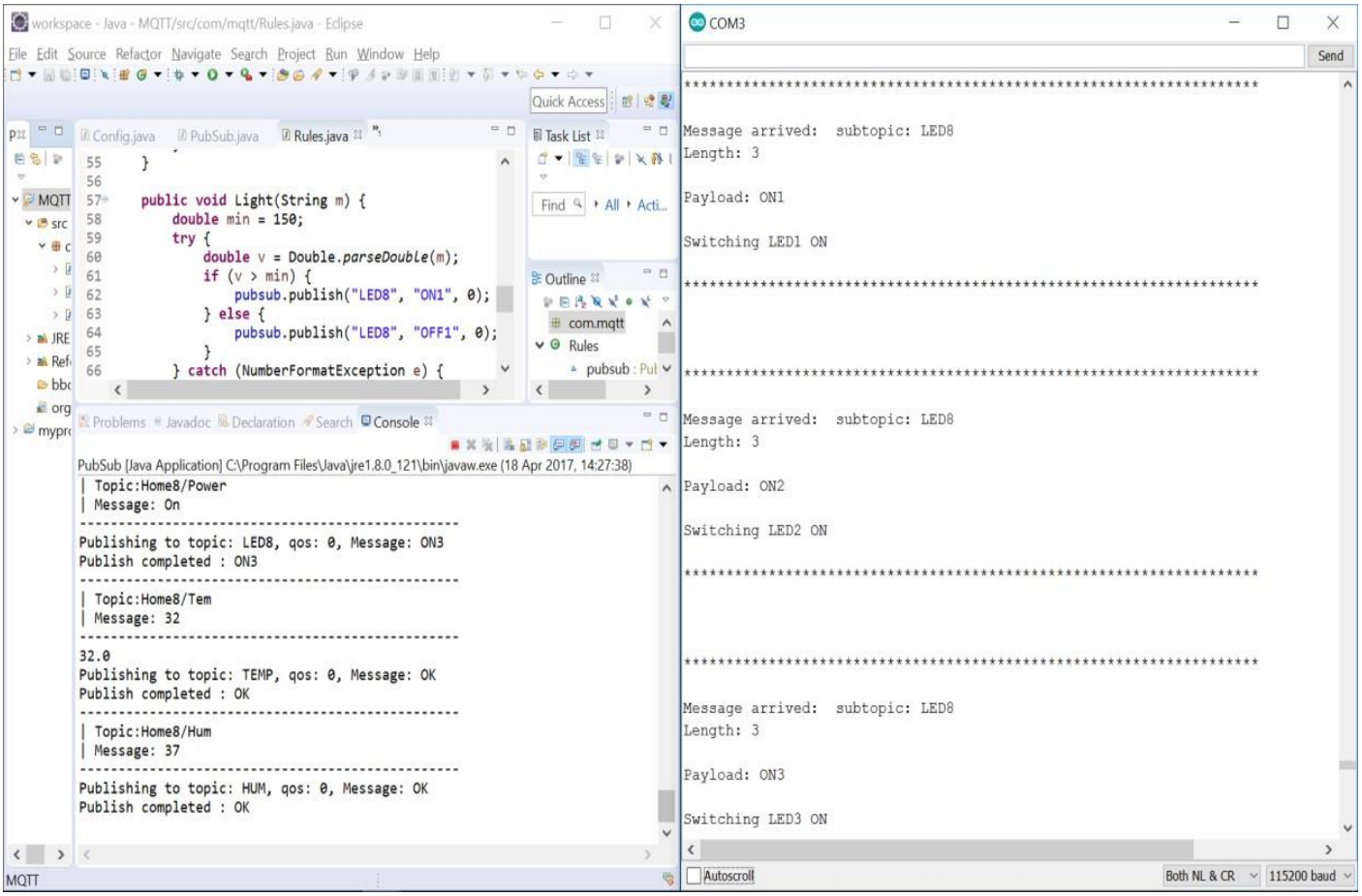

Figure 7: Case 2: NodeMCU subscribing Javaclient published values

Case 3: When power within the container is ON, light condition will be below its defined threshold and as a consequence the container door will be opened

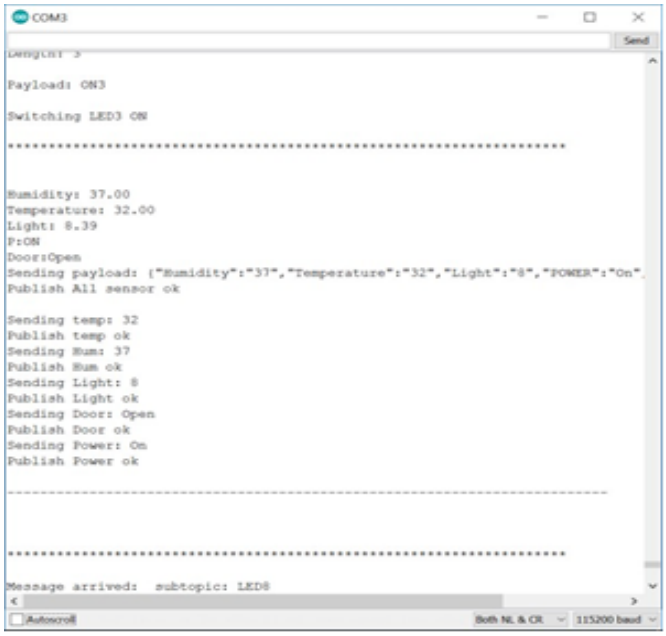

Figure 8: Case3: Sensor readings while publishing

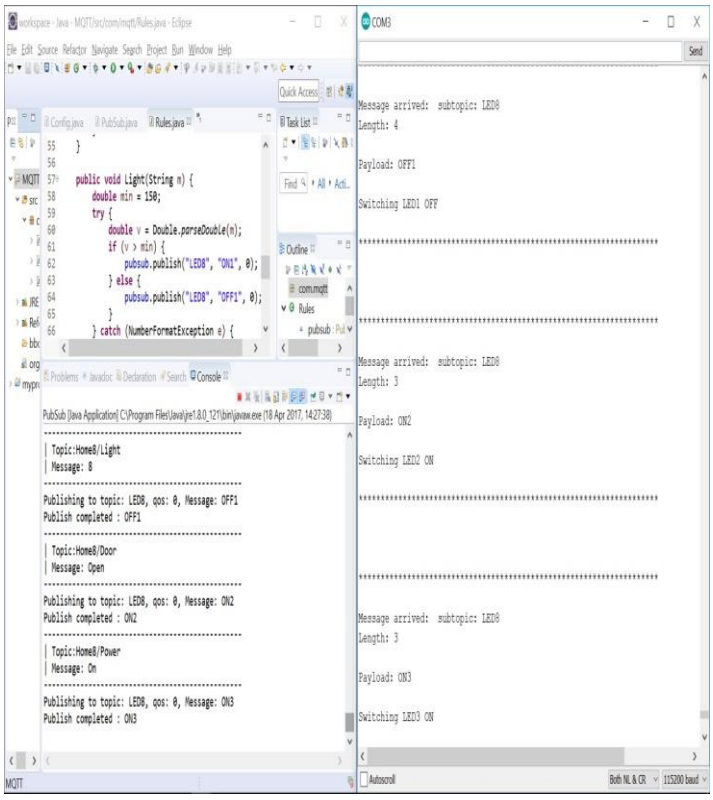

Figure 9: Case3: Node MCU subscribing Java client published values

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Geofencing Resluts:

Case 1: Let us assume that the power is OFF, light condition is above its defined threshold and as a result the door will be closed and when truck is moving in a defined boundary or frontier

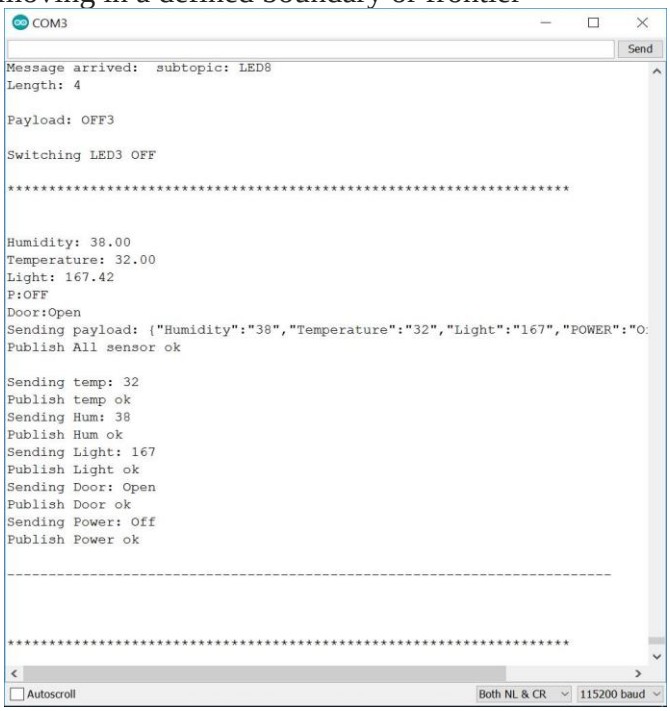

Figure 10: Sensor Output Screen for Case1

Figure 11: Geo-fencing Output Screen for Case1

Case 2: Let us assume that the power is ON, light condition is above its defined threshold and assume that some intruder is trying to open the door

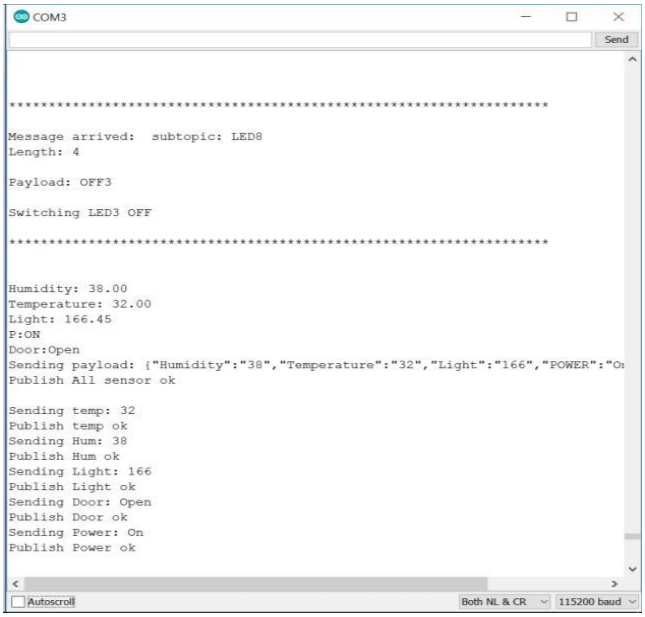

Figure 12: Sensor Output Screen for Case2

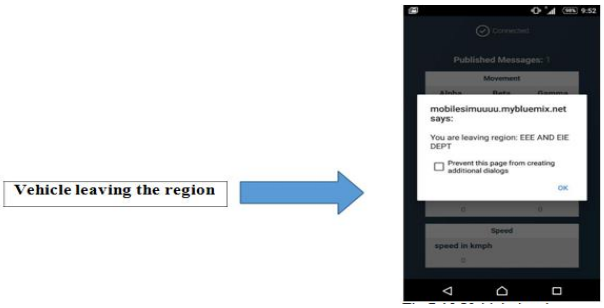

Figure 13: Geo-fencing Output Screen for Case2

V. DISCUSSION AND CONCLUSION

The smart remote sensing along with alarming system uses CNN, Geo-fencing as well as sensor Networks has demonstrated as a well-organized, systematic, effective and greatly user friendly also. The adopted approach and algorithms are simple as well as efficient. The recommended method surpasses entire disadvantages and limitations of the prevailing system and makes it very efficient.

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