

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 Geofencing 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.

Article History Article Received: 24 July 2019 Revised: 12 September 2019 Accepted: 15 February 2020 Publication: 09April 2020

Article Info Volume 83

Page Number: 8778 - 8785

Publication Issue:

March - April 2020

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



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 NodeMCUDevkit connects board V1.0., 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, condition (open/close) door 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



• 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-Temperature and Humidity Sensor
- R-MagneticallyoperatedReedSwitch
- $P-\!PowerSwitch based on Opto coupler$

Table 1: Sensor board pin configurations

Sensor	Sensor	GPIO	NodeMCU
	Board		



Light	L	A0	A0
Temperature and Humidity	Н	0	D3
Reed (Door)	R	4	D2
Power	Р	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

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			Send
Message arrived: subtopic: LED8			~
Length: 4			
Payload: OFF3			
Switching LED3 OFF			
******	******		
Humidity: 38.00			
Temperature: 32.00			
Light: 167.42			
P:OFF			
Door:open		DOMED !!	
Sending payload: {"Humidity":"38", "Temperature":"32", "Light"	10/ ,	POWER	: 0:
Publish All Sensor Ok			
Sending temp: 32			
Publish temp ok			
Sending Hum: 38			
Publish Hum ok			
Sending Light: 167			
Publish Light ok			
Sending Door: Open			
Publish Door ok			
Sending Power: Off			
Publish Power ok			
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Figure 4: Case1: sensor readings while publishing



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px: D Configjava D Rulesjava 10 Rulesjava 11 ** D Task List 11 == 1 Find S S S S * MOIT 57 public void Light(String m) { Imak List 11 == 1 * S double min = 150; Find All + Action * S try { Go double.parseDouble(m); Switching LEDI ON * E outne 11 D Switching LEDI ON * E pubsub.publish("LED8", "ONI", 0); Switching LEDI ON * E Outne 11 Switching LEDI ON * B Payload: ONI Switching LEDI ON * E Outne 11 Switching LEDI ON * E Outne 11 Switching LEDI ON * E Outne 11 Switching LEDI ON * B Ref Pubsub.publish("LED8", "OFF1", 0); Switching LED2 ON * * * * Pubsub [AavaAcc B Declaration #Search Console 11 * * * * * * * * * * <		
S5 } * MOII 56 public void Light(String m) { 58 double min = 150; * Site * fid * Ge 60 double.parseDouble(m); 51 if (v > min) { 62 pubsub.publish("LED8", "ON1", 0); > @ Outline !! > @ Rules * @ Pubsub.publish("LED8", "OFF1", 0); > @ Pubsub [Pul * # pubsub:Pul * # pubsub:Pul		
<pre>\$7 = public void Light(String m) { double min = 150; for double v = Double.parseDouble(m); for do</pre>		
<pre>Source Source Sour</pre>		
61 if (v > min) { 9 62 pubsub.publish("LED8", "ON1", 0); 9 63 } else { 9 8 Pubsub.publish("LED8", "OFF1", 0); 66 } catch (NumberFormatException e) { * * * * % Pubsub:Pult * * * * % Pubsub [lava Application] C\Program Files\Java\jre18.0_121\bin\javaw.exe (18 Apr 2017, 14:27:38) * * * * * * * * * * * * * * * * * * * * * * * * * * *		
<pre>> 0 63 } else { > ms /RE > a Ref 64 pubsub.publish("LED8", "OFF1", 0);</pre>		
> m Reh 66 } catch (NumberFormatException e) {		
PubSub [Java Application] C\Program Files\Java\jre1.8.0, 121\bin\javaw.exe (18 Apr 2017, 14:27:38) Payload: 0N2 I Topic:Home8/Light Switching LED2 ON		
Topic:Home8/Light Message: 166		
Publishing to topic: LED8, qos: 0, Message: ON1 Publish completed : ON1		
Topic:Home8/Door Message: Open		
Publishing to topic: LED8, qos: 0, Message: ON2 Message arrived: subtopic: LED8 Publish completed : ON2 Length: 4		
Topic:Home8/Power Message: Off Payload: OFF3		
Publishing to topic: LED8, gos: 0, Message: OFF3 Bublish completed : OFF3		
v ************************************		~
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MQTT Both NL & CR 🗸 1	And doctory and a	_

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

COM3	- 🗆 ×
	Send
•••••••••••••••••••••••••••••••••••••••	*****
Message arrived: subtopic: LED8	
Length: 4	
Payload: OFF3	
Switching LED3 OFF	
Humidity: 38,00	
Temperature: 32.00	
Light: 166.45	
PION	
Door:Open	
Sending payload: ("Humidity":"38", "Temperature	":"32","Light":"166","PONER":"O:
Publish All sensor ok	
Sending temp: 32	
Publish temp ok	
Sending Hum: 38	
Publish Hum ok	
Sending Light: 166	
Publish Light ok	
Sending Door: Open	
Publish Door ok	
Sending Power: On	
Publish Fower ok	
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Figure 6: Case 2: Published Sensor readings

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E 8 2	55 }	₫ ▼ 1 % % \$ ¥ \$ 1 ?	Length: 3	
✓ MQTT	57- public void Light(String m) { 58 double min = 150;	Find 4 + All + Acti	Payload: ON1	
× ⊕ c	59 try { 60 double v = Double.parseDouble(m);		Switching LED1 ON	
> U > U	61 if $(v > \min)$ {	🛢 Outline 🖾 🦷 🗖	*****	
> 12 > 🛋 JRE	63 } else { 64 pubsub.publish("LED8", "OFF1", 0);			
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and org	Problems # Javadoc & Declaration # Search Console #	- 0	Message arrived: subtopic: LED8	
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	Message: On	(C)		
	Publishing to topic: LED8, qos: 0, Message: ON3		Switching LED2 ON	
	Publish completed : ON3		*******	
	Topic:Home8/Tem Message: 32			
	32.0 Publishing to topic: TEMP, qos: 0, Message: OK Publish completed : OK		***************************************	
			Message arrived: subtopic: LED8	
	Topic:Home8/Hum Message: 37		Length: 3	
	Publishing to topic: HUM, qos: 0, Message: OK		Payload: ON3	
	rubiish compieted ; ok	~	Switching LED3 ON	~
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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

Сомз — 🗆	×
	Send
LANGUNI 3	~
Payload: CN3	
Switching LED3 ON	
Bumidity: 37.00	
Temperature: 32.00	
P:ON	
DoortOpen	
Sending payload: {"Numidity":"37", "Temperature":"32", "Light":"8", "POWER"	:"0n".
Publish All sensor ok	
Sending temp: 32	
Publish temp ok	
Sending Hum: 37	
Publish Hum ok	
Sending Light: 8	
Publish Light ok	
Sending Door: Open	
Publish Door ok	
Sending Power: On	
Publish Power ok	
	-
Message arrived: subtopic: LED8	~
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Figure 8: Case3: Sensor readings while publishing

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56		Payload: OFF1		
MQTT 57° public void Light(String m) {	Find A + All + Acti			
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<pre>double v = Double.parseDouble(n);</pre>				
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Ref 55 }	v v nules	*****		
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Topic:Home8/Light		Switching LED2 ON		
Pressage. 0				
Publishing to topic: LEDB, qos: 0, Message: OFF1				
Publish completed : OFF1				
Topic:Home8/Door				
Message: Open				
Publiching to tonic: (EDR one: A Maccage: ON)				
Publish completed : ON2		Message arrived: subtopic: LED8		
		Length: 3		
Topic:Home8/Power				
riessage. on		Payload: ON3		
Publishing to topic: LED8, qos: 0, Message: ON3		Cutable 1993 or		
Publish completed : ON3		Switcuid TPD2 ON		
		<		>

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



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

COM3	- 🗆 ×
	Send
Message arrived: subtopic: LED8	
Length: 4	
Payload: OFF3	
Switching LED3 OFF	
*****	*****
Humidity: 38.00	
Temperature: 32.00	
Light: 167.42	
P:OFF	
Door:Open	
Sending payload: {"Humidity":"38", "Temperature"	:"32","Light":"167","POWER":"0:
Publish All sensor ok	
Sending temp: 32	
Publish temp ok	
Sending Hum: 38	
Publish Hum ok	
Sending Light: 167	
Publish Light ok	
Sending Door: Open	
Publish Door ok	
Sending Power: Off	
Publish Power ok	
***************************************	*****
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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

COM3	- 0 ×
	Send
*****	******
Message arrived: subtopic: LED8	
Length: 4	
Payload: OFF3	
Switching LED3 OFF	
******	*****
Humidity: 38.00	
Temperature: 32.00	
Light: 166.45	
P:ON	
Door:Open	
Sending payload: {"Humidity":"38","Temperature	e":"32","Light":"166","POWER":"On
Publish All sensor ok	
Sending temp: 32	
Publish temp ok	
Sending Hum: 38	
Publish Hum ok	
Sending Light: 166	
Publish Light ok	
Sending Door: Open	
Publish Door ok	
Sending Power: On	
Publish Power ok	
c	

Figure 12: Sensor Output Screen for Case2

		a o'⊿	(996) 9
		Movement	
		mobilesimuuuu.mybluemix. says:	net
		You are leaving region: EEE AND DEPT	EIE
	N	Prevent this page from creating additional dialogs	10
ehicle leaving the region			OK
<i>b b</i>		6 0	
		Speed	
		speed in kmph	

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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