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IoT Enabled Shipping Containers with Location Tracking and Environment Monitoring

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Abstract: The Internet of Things (IoT) is a network of physical devices and objects that connect to provide services to users. Up to 50 billion IoT devices are expected to be deployed by 2020, according to estimates.
new products and services For example, integrating IoT into traditional transportation systems provides increased visibility and traceability, allowing for remote monitoring of transported products. Containers carrying donated organs should be tightly sealed, kept below a particular temperature, and positioned in a physically safe location in traditional shipping and freight systems to reduce the risk of harm from jerking and unintentional dropping. This paper describes a smart shipping container system that incorporates the Internet of Things (IoT), cloud computing, the Message Queuing Telemetry Transport (MQTT) protocol, and Docker images for shipping container surveillance that is both effective and remote.
Keywords: IoT, Shipping Containers, Arduino, DHT11 Sensor, LDR Sensor, MQ2 sensor, LCD, Cloud, GPS.

I. INTRODUCTION

Due to the convergence of technology in the recent era, digital information may now reach a destination placed over a long distance with reasonable simplicity and reliability. However, due to carrier speed and capacity limits, the same cannot be said for physical items. For example, shipping cargo between New York and Los Angeles takes a long time and effort. Typically, these containers convey things that could be damaged in a variety of ways during transportation, including excessive temperatures, humidity, sunlight exposure, or, more historically, unexpected jolts or shocks to fragile items of the ship.

This paper proposes a monitoring and tracking system to keep customers informed about their purchases by providing information on the state of the environment in which they are being transported, independent of the mode of transportation until the item is delivered. The proposed system is intelligent, cost-effective, and secure.

II. EXISTING SYSTEM

According to our extensive research, the cost of the system used for monitoring purposes is high, and it necessitates the supervision of a skilled professional. According to our market research, we discovered that all previous systems on the market are a little bit expensive and not user-friendly because technological integration has not yet entered the shipping industry, making the system complex and difficult to understand by newcomers. Our system, on the other hand, will provide a user-friendly interface and be cost-effective, making it superior to all other systems on the market.

III. PROPOSED SYSTEM

In our proposed system, we will monitor the environmental conditions using several sensors. We use temperature and humidity sensors, gas sensors, and LDRs to continuously monitor the weather conditions and reports are transferred onto the website using IoT technology.

The temperature and humidity sensor is a DHT11 sensor that calculates and monitors the values in the atmosphere and uploads them to the website. Similarly, a gas sensor is used to monitor any gas leaks in the container, and an LDR is used to assess the container's light intensity.

The location and values of the sensors will be updated to the cloud server if the parameters cross the limitations so as to send the warning triggered message to the concerned authorities. The reports of the weather condition will also get constantly updated in the database and get visible to the users in our website.

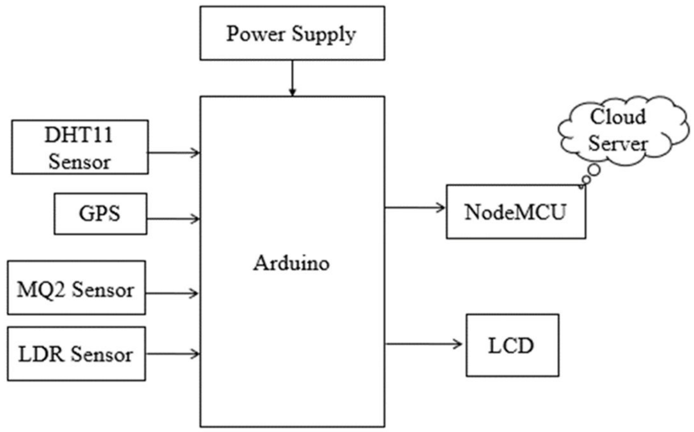

Fig: System Block Diagram.

IV. HARDWARE REQUIREMENTS

1) *Arduino:* The ATmega328-based Uno with Cable is a microcontroller board. It contains 14 digital input/output pins (including 6 PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. The Atmega8, 168, or 328 can be used in the Uno R3 reference design. Current versions use an ATmega328, although an Atmega8 is shown in the schematic for reference. On all three processors, the pin arrangement is the same.

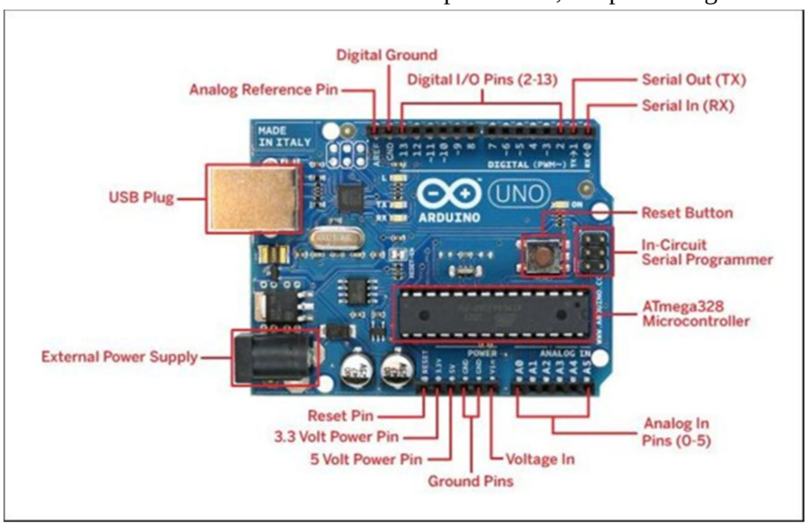

Fig: Arduino Board.

2) *DHT11 Sensor (Temperature/Humidity):* The DHT11 is a basic digital temperature and humidity sensor with a modest price tag. It measures the ambient air with a capacitive humidity sensor and a thermistor and outputs a digital signal on the data pin (no analogue input pins needed). It's simple to use, but data collection necessitates careful timing. The only major disadvantage of this sensor is that it only provides new data every 2 seconds.

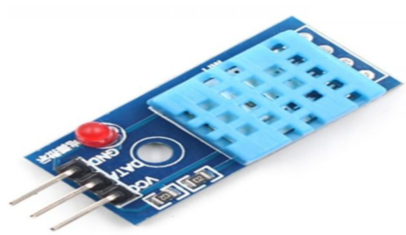

Fig: DHT11 Sensor.

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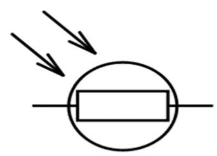
3) *LDR Sensor:* The resistivity of a Light Dependent Resistor (also known as a photoresistor or LDR) is a function of the incident electromagnetic radiation. As a result, they are photosensitive devices. Photoconductors, photoconductive cells, and simply photocells are other names for them. They are made composed of high-resistance semiconductor materials. A photoresistor or LDR is denoted by a variety of symbols, one of the most frequent of which is depicted in the figure below. Light is falling on it, as shown by the arrow.

Fig: LDR Sensor.



Symbol of a Photoresistor (or LDR)

4) *MQ2 Sensor:* The gas sensor module is made up of a steel exoskeleton that houses a sensing element. Through connecting leads, current is applied to this sensing element. The gases that come close to the sensing element become ionised and are absorbed by the sensing element as a result of this current, which is known as heating current. This modifies the resistance of the sensing element, resulting in a change in the value of the current leaving it.

Fig: MQ2 sensor.

Fig: Image Showing Various Parts of a Gas Sensor.

5) *NodeMCU:* NodeMCU is an open-source firmware and development kit that let you create your own Internet of Things device with just a few Lua script lines. The board has many GPIO pins that can be used to link it to other peripherals and can generate PWM, I2C, SPI, and UART serial communications.

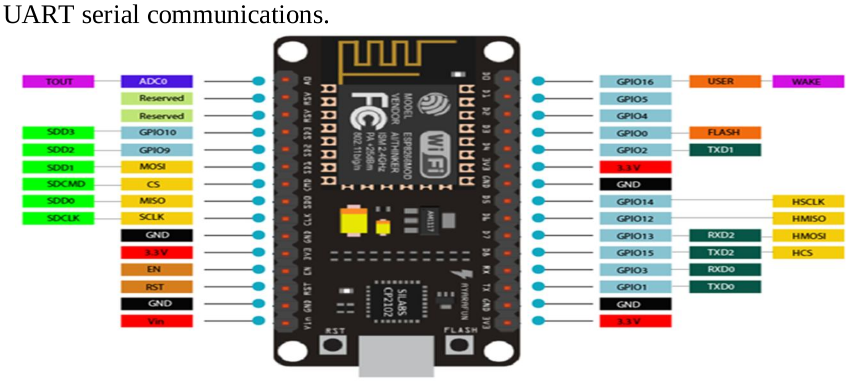


Fig: NodeMCU Pinout.

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6) *LCD:* A 16x2 LCD display is a common component found in a variety of devices and circuits. These modules, which include more than seven parts, as well as other multi-fragment LEDs, are popular. The grounds for this are as follows: LCDs are inexpensive; they are easily programmable; they have no restrictions on displaying unique and even custom characters (unlike in the seven fragments), movements, and so on.

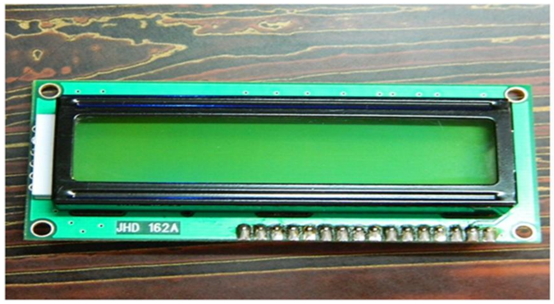


Fig: LCD – Front View.

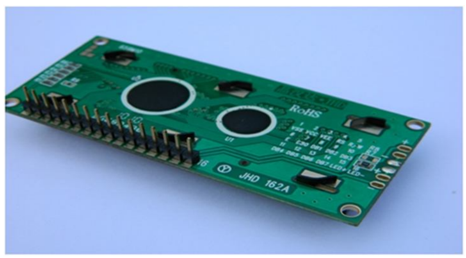
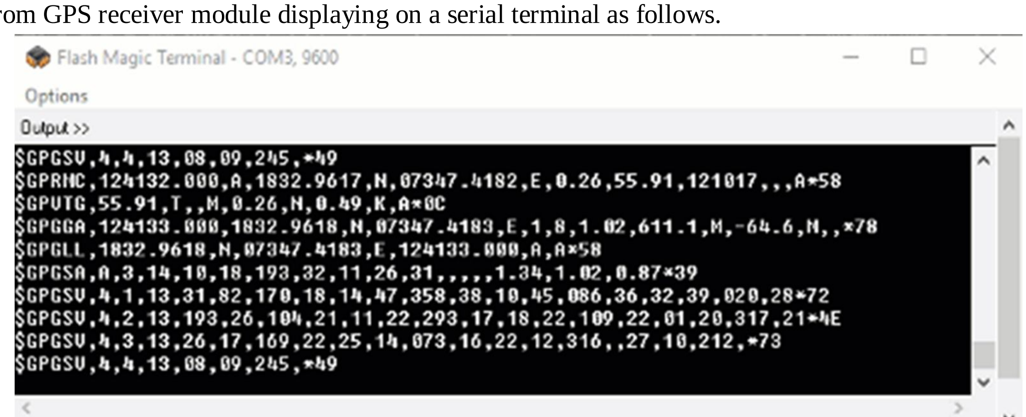


Fig: LCD – Back View.

7) *GPS:* The Global Positioning System (GPS) is a satellite-based system that measures and computes its position on Earth using satellites and ground stations. Navigation System with Time and Ranging (NAVSTAR) GPS is another name for GPS. For accuracy, a GPS receiver must receive data from at least four satellites. The GPS receiver does not send any data to the satellites. This GPS receiver can be found in a variety of applications, including cellphones, taxis, and fleet management.

Fig: GPS Receiver.

The output data from GPS receiver module displaying on a serial terminal as follows.



Flash Magic Terminal - COM3, 9600

Options

Output >>

```
$GPGSV,4,4,13,08,09,245,*49
$GPRMC,124132.000,A,1832.9617,N,07347.4182,E,0.26,55.91,121017,,,A*58
$GPVTG,55.91,T,,M,0.26,N,0.49,K,A*0C
$GPGGA,124133.000,1832.9618,N,07347.4183,E,1,8,1.02,611.1,M,-64.6,M,,*78
$GPGLL,1832.9618,N,07347.4183,E,124133.000,A,A*58
$GPGSA,A,3,14,10,18,193,32,11,26,31,,,,,1.34,1.02,0.87*39
$GPGSV,4,1,13,31,82,170,18,14,47,358,38,10,45,086,36,32,39,020,28*72
$GPGSV,4,2,13,193,26,104,21,11,22,293,17,18,22,109,22,01,20,317,21*4E
$GPGSV,4,3,13,26,17,169,22,25,14,073,16,22,12,316,,27,10,212,*73
$GPGSV,4,4,13,08,09,245,*49
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V. SOFTWARE REQUIREMENTS

1) *Arduino IDE:* The Arduino IDE (Integrated Development Environment) is an official software developed by Arduino.cc that is primarily used for authoring, compiling, and uploading code to an Arduino device. Almost all Arduino modules are compatible with this open-source software, which is simple to install and begin compiling code on the fly.

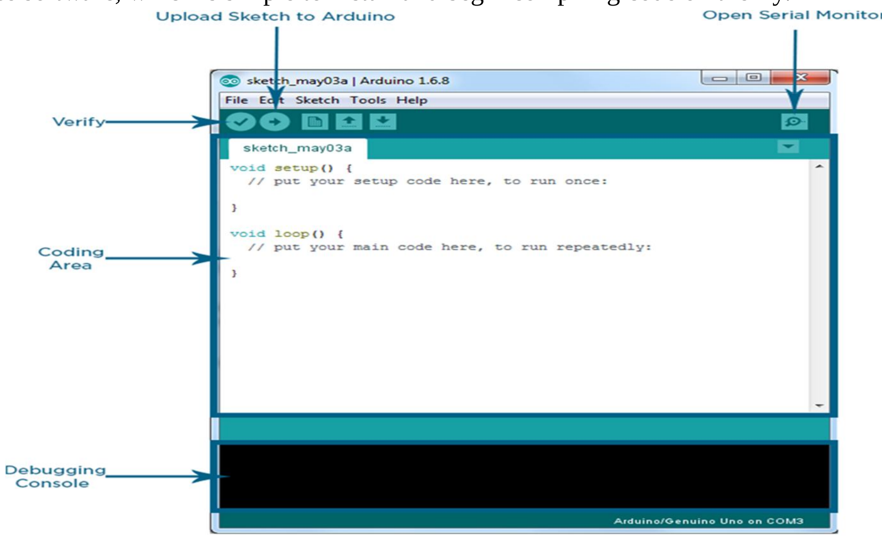

Fig: Overview of Arduino IDE.

VI. EXPERIMENTAL RESULTS

We had tested the project under different scenarios under different circumstances and it was clearly visible that our project was working with 90% accuracy and the data collected by the sensors were constantly stored in our cloud servers and transmitted through the mobile application. The format of the data stored in the cloud is attached below along with the app.

temperature	humidity	luminousity	openclose	latitude	longitude	timestamp
23.50	66.50	831	0	24.42	54.51	"18/03/12 20:15:47+00"
23.50	66.50	831	0	24.42	54.51	2018-03-19 18:16:25
23.50	66.50	831	0	24.42	54.51	2018-03-19 18:24:20
24.70	51.30	797	1	24.416462	54.499798	2018-03-19 18:31:53
24.70	51.70	777	1	24.416462	54.499798	2018-03-19 18:32:28
24.70	52.00	787	1	24.416462	54.499798	2018-03-19 18:33:03
24.70	52.20	778	1	24.416462	54.499798	2018-03-19 18:33:38
24.70	52.50	781	1	24.416462	54.499798	2018-03-19 18:34:13
24.70	52.90	776	1	24.416462	54.499798	2018-03-19 18:34:48
24.70	53.00	778	1	24.416462	54.499798	2018-03-19 18:35:23
24.70	53.10	784	1	24.416462	54.499798	2018-03-19 18:36:54
24.70	53.10	802	1	24.416462	54.499798	2018-03-19 18:38:24
24.70	53.00	780	1	24.416462	54.499798	2018-03-19 18:38:35
23.60	52.00	793	1	24.416462	54.499798	2018-03-19 18:39:07
24.70	52.60	785	1	24.416462	54.499798	2018-03-19 18:40:58
24.70	52.80	789	1	24.416462	54.499798	2018-03-19 18:41:32
24.70	51.20	793	1	24.416462	54.499798	2018-03-19 18:42:04
24.70	50.30	800	1	24.416462	54.499798	2018-03-19 18:43:49
24.70	50.80	811	1	24.416462	54.499798	2018-03-19 18:44:21

Fig: Logged Data at Cloud Server.

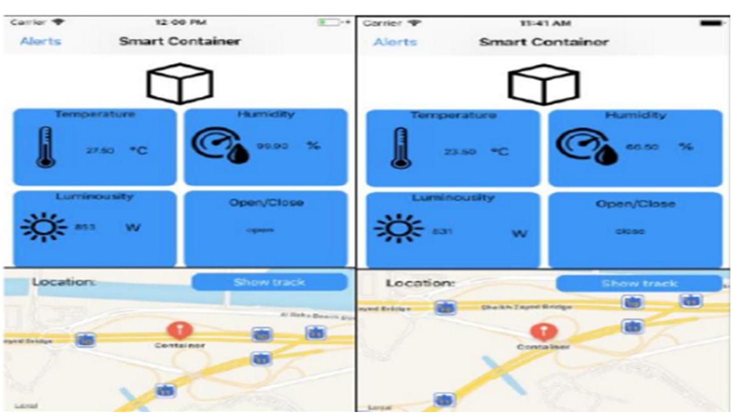

Fig: Data Shown on Smartphone Application.

VII. CONCLUSION

The concept of environmental monitoring using IoT was proposed in this project to monitor the city from the cost of damage that may influence the people's way of life. We implemented an IoT of a proposed system as a proof of concept. We demonstrated that our system can access data without the need for an embedded system. There are a few disadvantages to our strategy. It can only detect 90% of the time at the moment. We also need to make sure that correct detection is enforced. We may look into improved exploration methodologies in the future to lessen the possibility of missing breaches.

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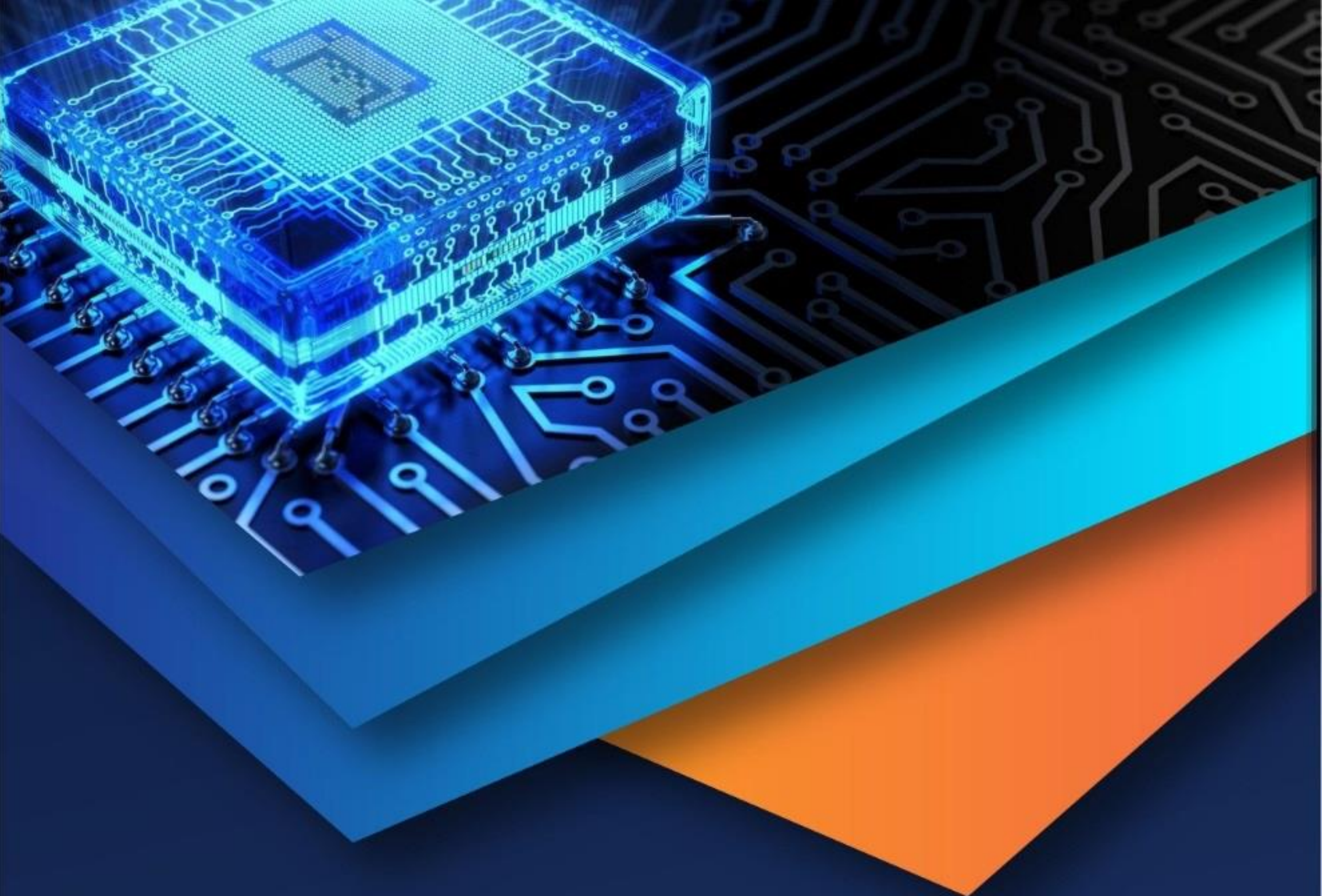

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