Environment Surveillance and Analysis using IoT

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***Abstract*—The system proposed in this paper is an advanced solution for monitoring the weather conditions at a particular place and make the information visible anywhere in the world. The technology behind this is Internet of Things (IoT), which is an advanced and efficient solution for connecting the things to the internet and to connect the entire world of things in a network. The system deals with monitoring the environmental conditions like temperature, relative humidity and Propane, Hydrogen, Methane and Carbon Monoxide level and Soil Moisture with sensors and sends the information to the web page and then plot the sensor data as graphical statistics. The data updated from the implemented system can be accessible in the internet from anywhere in the world.Due to growing populations in urban and rural areas alike, basic physical and organizational structures must be in an acceptable state. It becomes vital to keep track of a location's current weather from another location. The measurement of Propane, Hydrogen, Methane and Carbon Monoxide also reveals a crucial environmental parameter at the same time. IoT, with the aid of sensor networks covering our environment, plays a significant role in measuring these factors. Data from electronic sensors is compiled by IoT. The generated data is being transmitted through this system and kept on the cloud so that the data can be examined by many apps. This article demonstrates the use of the Internet of Things (IoT) on the ThingSpeak cloud to monitor temperature, relative humidity and Propane, Hydrogen, Methane and Carbon Monoxide level and Soil Moisture in real-time. Analysis of the time-series data can be helpful for future.**

***Index Terms*—Environment monitoring, Environmental Temperature, Environmental Humidity, Environmental Propane, Hydrogen, Methane and Carbon Monoxide Level, Soil Moisture Level, Internet of Things(IoT), Esp8266, Cloud Environment Monitoring, ThingSpeak.**

I. Introduction

Environment can be defined as a sum total of all the living and non-living elements and their effects that influence human life. While all living or biotic elements are animals, plants, forests, fisheries, and birds, non-living or abiotic elements include water, land, sunlight, rocks, and air the circumstances, objects, or conditions by which one is surrounded. It is nature's gift that helps in nourishing life on Earth.Our environment provides a wide range of benefits, such as the air we breathe, the food we eat and the water we drink, as well as the many materials needed in our homes, at work and for leisure activities. Environment plays an important role in healthy living and the existence of life on planet earth. Earth is a home for different living species and we all are dependent on the environment for food, air, water, and other needs. Therefore, it is important for us to monitor the quality. For our project we have chosen to monitor the essential elements of environment, which are temperature, humidity, soil moisture, air component level and rain condition. These are vital for us to live in the biosphere. We are monitoring the bioshpere which consists of all the regions on Earth where life exists. For online monitoring and its connected operations, the Internet of Things (IoT) offers a potential key. It greatly expands the connectivity's range beyond computers and phones to include almost any item with a chip and a radio interface. Thus integrating IoT with our project is enabling our project to be monitored or discovered from anywhere in the world. Environmental conditions of any surroundings are monitored and data is transmitted to the cloud most importantly it will transmit the real time environment. Any abnormalities in environment can be updated in cloud and the condition can be viewed by everybody with the help of internet. The combination of Internet and the emerging technologies such as near-field communications, real-time localization, and embedded sensors could help us to understand and react to environment. This system allows taking actions if the condition of environment goes abnormal.This system is mainly composed of ESP8266 microcontroller with Wi-Fi module, humidity sensor, gas sensor and power supply source. The figure shows the flow of the system functionality where the DHT gives the live reading of humidity which gives the concentration of gas in environment, simultaneously to the

ESP8266 microcontroller with W i-Fi module over the internet through ThingSpeak cloud. Entire data transmitted from these sensors are stored in ThingSpeak database where it is analyzed and monitored for futher reactions.

II. Proposed System

A. Objective

This environment surveillance and analysis can get update of temperature, humidity, Propane, Hydrogen, Methane and Carbon Monoxide level and soil moisture rate analysis. Sometime weather climates can change unfortunately or soil needs more water or remove water, so this device can detect this problem and give updates.

B. Concept

The NodeMCU ESP8266 microcontroller with a Wi-Fi module, AM2301 temperature and humidity sensors, gas sensors, soil moisture sensors and a power supply source make up the majority of this system. The functionality of the system is depicted in Figure 1 where the AM2301 provides real-time readings of temperature and humidity, the MQ2 provides the environment's gas concentration and the soil moisture sensor provides the soil's moisture content to the NodeMCU ESP8266 microcontroller with WiFi module over the internet through ThingSpeak cloud. The complete data sent by these sensors is kept in the ThingSpeak database, where it is evaluated and watched for subsequent responses.

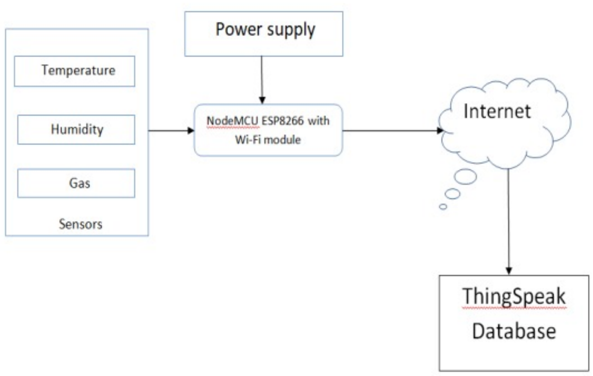

Fig. 1. Hardware block diagram

C. Hardware

Components used to build this project are as follows:

1) NodeMCU ESP8266 Micro-controller with WiFi module
2) AM2301 capacitive humidity sensing digital temperature and humidity module
3) Soil Moisture Sensor
4) MQ2 Gas Sensor
5) Mini Breadboard and
6) Connecting Wires and USB Cables

Fig. 2. NodeMCU ESP8266 Micro-controller with WiFi module

1) NodeMCU ESP8266 Micro-controller with WiFi module: The ESP8266 is a low-cost Wi-Fi microchip, with built-in TCP/IP networking software, and microcontroller capability, produced by Espressif Systems in Shanghai, China. The ESP8266 module enables microcontrollers to connect to 2.4 GHz Wi-Fi, using IEEE 802.11 bgn. It can be used with ESP-AT firmware to provide Wi-Fi connectivity to external host MCUs, or it can be used as a self-sufficient MCU by running an RTOS-based SDK. NodeMCU is an open source IoT platform which runs on ESP8266 Wi-Fi SoC and the hardware is based on ESP-12 module. It refers to firmware rather than the development of kits that provides access to these GPIOs of ESP8266 and it is widely used in various IoT applications. It provides access to the GPIO (General Purpose Input/Output) of the module and It can be either input pin or the output pin, whose behavior can be controlled at the time of running.

2) AM2301 capacitive humidity sensing digital temperature and humidity module: AM2301 is a temperature and humidity composite sensor which is humidity Capacitive Digital Temperature and Humidity Module and a calibrated digital signal output. It uses a dedicated digital module acquisition technology and temperature and humidity sensing technology to ensure that products with high reliability and excellent long-term stability. The sensor includes a capacitive wet sensor and a high-accuracy temperature sensor connected to a high-performance 8-bit microcontroller. Therefore, the product has excellent quality, fast response, anti-interference ability, cost-effective and so on. Each sensor is calibrated in a very accurate humidity calibration room. The calibration coefficients are stored in the form of a program in the microcontroller, and the calibration coefficients are called within the sensor during signal processing. Standard single bus interface makes

Fig. 3. AM2301 capacitive humidity sensing digital temperature and humidity module

system integration easy and quick. Ultra-small size, low power consumption, signal transmission distance up to 20 meters, making it the best choice for all kinds of applications and even the most demanding applications. Products for the 3-lead (single bus interface) easy to connect. Special package can be provided according to user needs. Its highlights are: Ultra-low energy consumption, long transmission distance, all automatic calibration, capacitive humidity sensor, fully interchangeable, standard digital single bus output, excellent long-term stability, high-precision temperature measurement components.

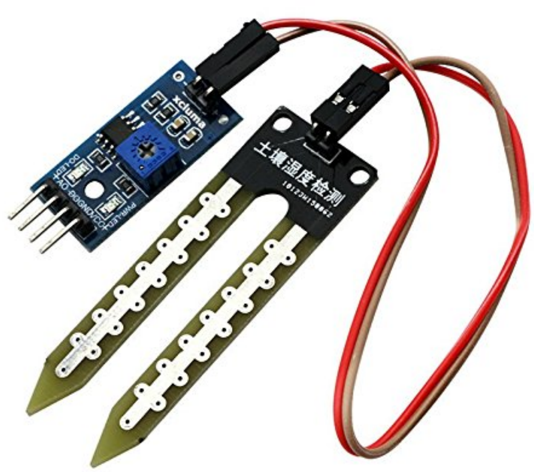

Fig. 4. Soil Moisture Sensor

3) Soil Moisture Sensor: The soil moisture sensor's operation is rather simple. The two exposed wires on the fork-shaped probe serve as a variable resistor (much like a potentiometer) whose resistance changes in response to the amount of water in the soil. The relationship between this resistance and soil moisture is inverse: The soil will have better conductivity and less resistance the more water it contains. Less water in the soil will cause it to have poor conductivity, which will increase resistance. By monitoring the output voltage that the sensor generates in accordance with the resistance, we may calculate the moisture content. A typical soil moisture sensor has two components. They are the Probe and the Module. The module produces an output voltage according to the resistance of the probe and is made available at an Analog Output (AO) pin.

Fig. 5. MQ2 Gas Sensor

4) MQ2 Gas Sensor: One of the MQ sensor series' most widely used gas sensors is the MQ2. As the detection is dependent on a change in the resistance of the sensing material when the Gas comes into contact with the material, it is a Metal Oxide Semiconductor (MOS) type Gas Sensor, also known as Chemiresistors. Concentrations of gas can be found using a straightforward voltage divider network. The 800mW MQ2 Gas Sensor consumes 5V DC power. Between 200 and 10,000 ppm, it can detect LPG, smoke, alcohol, propane, hydrogen, methane, and carbon monoxide.

5) Mini Breadboard: It gets its name from the long-dead practice of using a wooden board (an actual bread-board if it was handy) to prototype circuits. Hobbyists would hammer small nails or thumbtacks into the board and wind wires around them to prototype a circuit. The 170pt breadboard is named for its 170 tie points. It has 17 columns of 10 holes, which are separated into two pairs by a central notch, and labelled 1 to 17. Each column is also labelled, with a letter

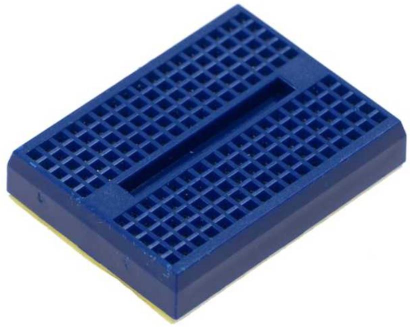

Fig. 6. Mini Breadboard

from A to J to that they can be easily referenced in instructions (like the squares on a chess board). These holes contain small metal clips which both secure components to the breadboard and form electrical connections between them.

D. Software

Fig. 7. ThingSpeak

1) ThingSpeak: ThingSpeak is an open-source software written in Ruby which allows users to communicate with internet enabled devices. It facilitates data access, retrieval and logging of data by providing an API to both the devices and social network websites.ThingSpeak enables sensors, instruments, and websites to send data to the cloud where it is stored in either a private or a public channel. ThingSpeak stores data in private channels by default, but public channels can be used to share data with others.ThingSpeak is an IoT analytics platform service that allows us to aggregate, visualize, and analyze live data streams in the cloud. You can send data to ThingSpeak from your devices, create instant visualizations of live data, and send alerts using web services like Twitter and TwilioIoT. The system provides a simple but powerful capability to work on different kind of devices and applications by exchanging information. IoT services are responsible for distributing messages to the clients connected with the platform. ThingSpeak is an Internet of Things (IoT) platform that gathers and stores the sensor data in the cloud and develop the IoT applications. The ThingSpeak IoT platform provides apps that let you analyze and visualize your data in MATLAB, and then act on the data. Sensor data can be sent to ThingSpeak from NodeMCU ESP8266 Wi-Fi module.

Fig. 8. Arduino IDE

2) Arduino IDE: The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. The ESP8266 was interfaced with this software along with the sensors.

III. Working Procedure

The working procedure of this project are as follows:

1) The hardwares were assembled and connected to internet.
2) The ThingSpeak channel was created and configured.
3) The sensors take the environmental values and send to the dedicated ThingSpeak channel at an interval of 30 seconds.
4) The data is stored in the ThingSpeak channel for further analysis.

Once sensor data is uploaded to the cloud, we can use the IoT analytics service of ThingSpeak to aggregate, visualize and analyze live data. The Wi-Fi module sends data to the cloud through its assigned IP. Once connected to ThingSpeak, an API key is assigned to monitor the readings. After every devices connected we can see the login page where the user has to login with particular API key and the token which is given by the cloud so that the privacy is maintained by the server. This data can also be analysed by exporting in csv format.

A. Assembling Hardwares

The hardwares were assembled is the following way-

Fig. 9. ThingSpeak Channel Creation

B. Configuring Software

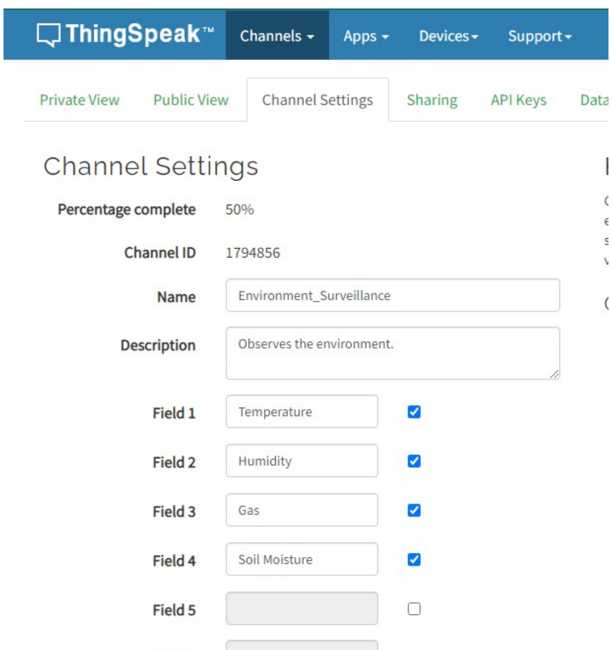

Fig. 10. ThingSpeak Channel Creation

Thus, we created a ThingSpeak account first and then created the channel in the following way.

C. Receiving Data to Cloud

The data were successfully being received in the cloud database. As we know, a time series is a sequence of information that attaches a time period to each value. The value can be pretty much anything measurable that depends on time in some way, like prices, humidity, or a number of people. As long as the values we record are unambiguous, any medium could be

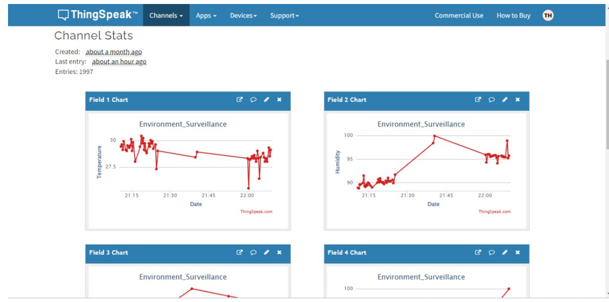

Fig. 11. ThingSpeak Channel Dashboard

measured with time series. These data can be considerd as time-series data.

IV. RESULTS

- Temperature(Field1)

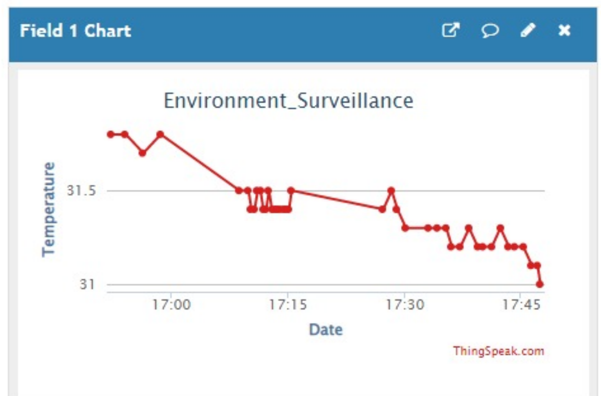

Fig. 12. Temperature vs. Time

- Humidity(Field2)

Fig. 13. Humidity vs. Time

- Gas(Field3)
- Soil Moisture(Field4)
- Location(Field5)

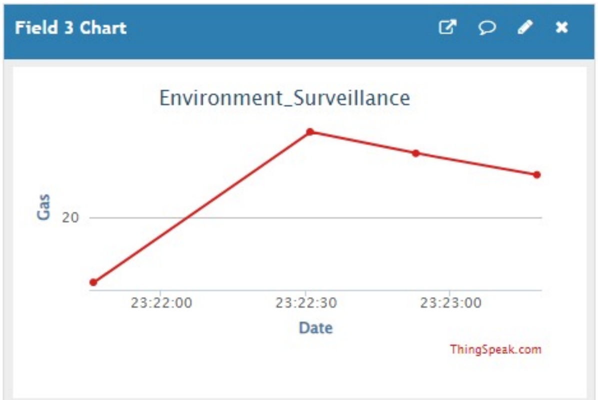

Fig. 14. Gas vs. Time

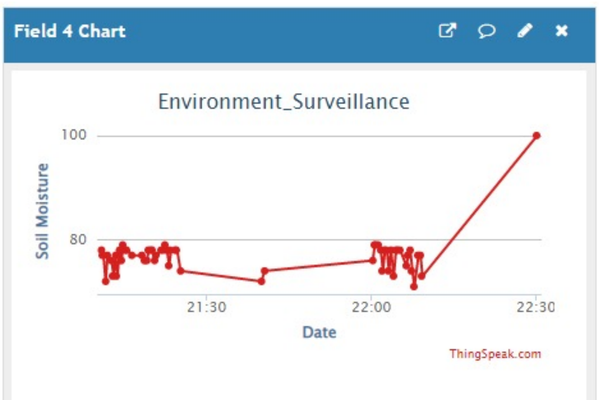

Fig. 15. Soil Moisture vs. Time

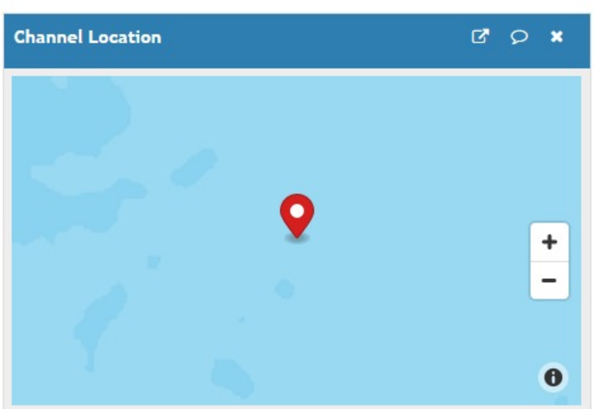

Fig. 16. Current Location of Project

The result of different environmental conditions such as temperature, humidity, gas, soil moisture can be measured, based on the inputs from different sensors. In this paper we have selected four fields on ThingSpeak. We have assigned temperature in the first field, humidity in the second field, gas in the third field and the fourth field is for the soil moisture sensor. The above graphs in Fig.(9) to Fig(12) show field data vs. time where the changes in field data are updated after an interval of 30 seconds.

A. Analysis

Discover insights

Count of 'field1'

field1	Count of field1
28.8	69
30.3	56
30.6	55
30.5	55
28.9	55
...	...

+ Insert PivotTable

Fig. 17. Temperature Data Analysis

A	B	C
2022-08-09T22:07:29+06:00	1988	28.3
2022-08-09T22:07:51+06:00	1989	28
2022-08-09T22:08:35+06:00	1990	29.3
2022-08-09T22:08:57+06:00	1991	28.5
2022-08-09T22:09:19+06:00	1992	29.1
2022-08-09T22:30:13+06:00	1993	
2022-08-09T23:21:46+06:00	1994	
2022-08-09T23:22:31+06:00	1995	
2022-08-09T23:22:53+06:00	1996	
2022-08-09T23:23:18+06:00	1997	
Max		34.9
Min		23.9
Avg		30.37998

Fig. 18. Temperature Data Analysis

Here we can see some sample analysis being performed on the data by using Microsoft Excel on a csv file. We can see, the mode is 28.8 degree celsius, maximum 34.9 degree celsius, minimum 23.9 degree celsius and average 30.37998 degree celsius on a day in August.

V. Advantages

Environmental observing is an essential IoT application which occupies monitoring the neighboring environment and accounting this data for efficient short term measures such as remotely controlling the devices and long term data analysis and measures. It helps to determine future climate changes. Environmental conditions of any surroundings are monitored and data is transmitted to the cloud most importantly it will transmit the real time environment. Any abnormalities in environment can be updated in cloud and the condition can be viewed by everybody with the help of internet. The combination of Internet and the emerging technologies such as near-field communications, real-time localization, and embedded sensors could help us to understand and react to environment. This system allows taking actions if the condition of environment goes abnormal.

VI. Future Scope and Conclusions

The proposed real time environment monitoring based on IoT is a consistent and rapid system that helps to monitor the environment parameters such as temperature, humidity, air quality, soil moisture and so on. This paper shows the result of real-time variation of temperature and humidity with the help of AM2301 sensor, gas presence by using MQ2 Gas sensor and soil moisture level using soil moisture.This paper demonstrates Design and Implementation of environment surveillance monitoring used for controlling the devices as well as monitoring the environmental parameters. Machine learning can be applied on the data, which will enable a new vision on the data.

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VII. Appendix

A. For First ESP8266

```
#include <LiquidCrystal_I2C.h>
#include <ESP8266WiFi.h>
#include <DHT.h>;

String apiKey = ”EL4J3CBXX9VQIU69”;
const char *ssid = ”Tasnima”;
const char *pass = ”12345678”;
const char* server = ”api.thingspeak.com”;
WiFiClient client;

float hum;
float temp;

#define DHTPIN 14
#define DHTTYPE DHT21
DHT dht(DHTPIN, DHTTYPE);

#define rainpin 13
#define soilpin A0

void setup()
{
lcd.begin(16,2);
Serial.begin(115200);
delay(10);
Serial.println(”Connecting to ”);
```

```
Serial.println(ssid);                          }
WiFi.begin(ssid, pass);
while (WiFi.status() != WL_CONNECTED)
{
delay(500);
Serial.print(".");
}
Serial.println("");
Serial.println("WiFi connected");
dht.begin();
}
void loop()
{
float hum = dht.readHumidity();
float temp = dht.readTemperature();
int soil_value = map(analogRead(soilpin), 0, 1024, 0, 100);
int rain_value = digitalRead(rainpin);
  Serial.print("Humi: ");
  Serial.println(hum);
  Serial.print("Temp: ");
  Serial.println(temp);
  Serial.print("Moist: ");
  Serial.println(soil_value);
  Serial.print("Rain: ");
  Serial.println(rain_value);

if (client.connect(server, 80)) // "184.106.153.149" or api.thingspeak.com
{
String postStr = apiKey;
postStr += "&field1=";
postStr += String(temp);
postStr += "&field2=";
postStr += String(hum);
postStr += "&field4=";
postStr += String(soil_value);
postStr += "&field5=";
postStr += String(rain_value);
postStr += "r\n";
client.print("POST /update HTTP/1.1\n");
client.print("Host: api.thingspeak.com\n");
client.print("Connection: close\n");
client.print("X-THINGSPEAKAPIKEY: " + apiKey + "\n");
client.print("Content-Type: application/x-www-form-urlencoded\n");
client.print("Content-Length: ");
client.print(postStr.length());
client.print("\n\n");
client.print(postStr);

Serial.println("Data Send to Thingspeak");
}
delay(1500);
client.stop();
Serial.println("Waiting...");

// thingspeak needs minimum 15 sec delay between updates.
delay(20000); //1 min delay
```