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IOT BASED DESIGN IMPLEMENTATION OF MUSHROOM FARM MONITORING USING ARDUINO MICROCONTROLLERS & SENSORS

Parvati Bhandari[*] Megha Kimothi

M. Tech Scholar[*] Dept. of Wireless Mobile Communication Engg, GRD IMT, Dehradun, India
Asst. Prof., Dept. of Wireless Mobile Communication Engg, GRD IMT, Dehradun, India

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ABSTRACT

In India large percentage of population depends on agriculture. Agriculture techniques improve day by day. Wireless sensor used in agriculture has importance in modern agriculture. The use of wireless sensors in various agriculture sectors have huge positive impact on crops, helps in increasing yield and saving cost of operation. Mushroom industry is new and small scaled as compare to other agriculture industry in India.

The white button mushroom is very popular throughout the world and is the most important mushroom of commercial significance in India. It can be successfully cultivated in places where the environmental conditions are favorable but it is cultivated in North India in winter seasons due to the favorable conditions. The optimum temperature for mycelia growth is 22°C- 25°C and that for fruit body formation 14°C -18°C and a high percentage of relative humidity. The mushroom cultivation rooms should have facilities for temperature control and pasteurization processes. The main aim of this paper is to minimize the human care needed for the mushroom plant by automating the mushroom production plant and monitor the crop room environment status. With the introduction of IoT, Agriculture industries also upgraded. In this thesis presents an environmental monitoring and controlling system to monitor and control the environmental conditions in a mushroom farm. It enables user to monitor temperature, humidity, carbon dioxide concentration and light intensity in a mushroom farm on an android device by using thing Speak online platform.

The controller used in the sensors station which ensures that the plant parameters stay within pre-defined values as determined and set by the user is the Arduino prototyping platform. The current status of parameters is transmitted to the remote monitoring station via a pair of low power ESP8266 as Wi-Fi modem. The codes for the controller were written in the Arduino programming language, debugged, compiled, and burnt into the microcontroller using the Arduino integrated development environment (IDE).

Keywords: Mushroom, Arduino, Agriculture Monitoring, IDE.

I. INTRODUCTION

In India large percentage of population is dependent on agriculture. Agriculture techniques improve day by day. Modern agriculture in amalgamation of agriculture and technology. Wireless sensor utilized in agriculture has importance in modern agriculture. Having wireless sensors in a variety of agriculture sectors have huge positive result on crops, facilitates increasing yield and saving price of operation. Mushroom publication rack new and small scaled as can rival other agriculture industry in India. Mushroom farming is low investment Since most of the mushroom farms in India are small-scaled, their production capability is restricted to inadequate environmental control system and the deficiency of savings to upgrade the systems. The white button mushroom is increasingly popular in India also in the world. These mushrooms have commercial significance in India. They mostly farm in north India as the temperature condition is favorable. They are following parameters for mushroom growth, temperature for mycelia growth is 22°C- 25°C for fruit body formation 14°C -18°C and also a significant number of relative humidity. The chief goal of this paper is always minimize the human beings care essential for the mushroom where environmental condition for mushroom farming are certainly not fully supported we design a control and monitoring system determined by required parameter values. These automatic system but not just create the perfect environment but in addition helps in plant growth. This particular control product is design with various technologies such as, with PLC Naxgene 1000,ARM7, ATmega and latest Arduino. Wireless sensor is accustomed in system as outlined by measuring parameter. Out of your tender we design system which is certainly an environmental monitoring and controlling system to and control

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environmentally friendly conditions in a very mushroom farm. It enables user to temperature and humidity, co2 fractional laser concentration level, Atmospheric pressure and quality of air in a very mushroom farm upon an android device by utilizing Thing Speak online platform. The control algorithm has the capacity to control devices in a very mushroom farm automatically determined by feedback from sensors to take care of the environment in the optimum condition for mushroom growth.

The controller used inside sensors station which signifies that the rose parameters stay within pre-defined values as determined and hang by the operator will be Adriano prototyping platform. The prevailing status of parameters is transmitted into the remote monitoring station via some low power ESP8266 as Wi-Fi modem. The codes for ones controller were written inside Arduino programming language, debugged, compiled, and burnt within the microcontroller utilizing the Arduino integrated development environment (IDE). This method significantly cuts down on the labor involved inside the maintenance thus making the device ideal for rural farmers, small-scale agriculture, and agricultural researchers.

WSNs are at the forefront of innovative projects and emerging industry standards and as a result are becoming increasingly pervasive in society. For instance, WSNs are a leading part of the IoT and key to healthcare applications such as BT's Telecare, and SAPHE (Smart & Aware Pervasive Healthcare Environment) projects. A vast amount of valuable, high-quality data can be processed by Arduino processors and captured such as proximity, vibration, light, humidity and temperature by an array of sensor network nodes, prior to being stored and analyzed. The potential of WSNs became apparent to the author while surveying WSNs, identifying the domains and developing the "bubble" diagram (Figure 1.1) from 2007. The diagram continued to be revised to represent key domains as new WSN projects commenced. As illustrated in Figure 1.1, WSNs are already pervasive in the majority of domains due to their versatility across applications and relatively cheap deployment costs. A varied array of exciting WSN projects were identified during the survey which already had proven benefits for society and encompass the following domains and critical applications:

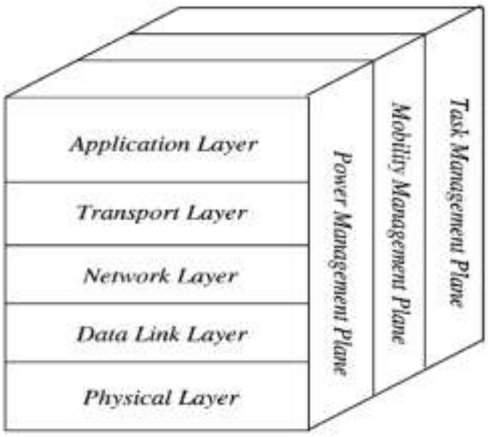

Figure 1: Protocol Stack of data processing by Sensors

II. MATERIALS AND METHODS

IOT Based Wireless Sensor Networks for Monitoring

Nodes in a wireless sensor network may be equipped with different types of sensors including video sensor, audio sensor, infrared sensor, seismic sensor, radar sensor and low sampling rate magnetic sensor. With the corresponding sensors, a wireless sensor network is able to monitor a large number of environmental parameters which includes the followings:

(1) Air temperature and humidity
(2) Soil temperature and humidity
(3) Air pressure
(4) Lighting condition
(5) Soil moisture
(6) Presence, absence, and movement of specific objects
(7) Parameter of objects such as speed, direction and size

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With the development of these new wireless sensors that can be used in data sensor, data processing, data storing and wireless network connections, a wireless sensor network is able to be deployed in many new application areas including environmental application, home application, health application, military application and other commercial applications. In the environmental area, a wireless sensor network can be used for detection of floods and forest fires, bio-complexity mapping of the environment, precision agriculture and tracking the movements of animals. Forest fire detection needs wireless sensor nodes that are able to be left in forest for months and even years, so sensors are equipped with effective power modules like solar panels. Besides, wireless sensor nodes should ignore the obstacles which block the wireless sensor's line of sight like rocks and trees and communicate with each other nodes in short distance. An example of wireless sensor network used in the detection of the flood is the ALERT system deployed in US. The rainfall, water level and weather sensors deployed in ALERT system collect and send information in a programmed way to the centralized server. In precision agriculture, wireless sensor network can be used for monitoring the development of crops, level of soil erosion and level of air pollution in real-time. Wireless sensor network can be used in home applications including smart environments and home automation. In smart environment areas, furniture and other appliances are equipped with wireless sensor nodes that are able to communicate with each other nodes and users. Theses self-organizing wireless sensor nodes should be integrated with existing embedded devices, provide communication among room users to share information and services they offered such as printing and faxing. In home automation, smart sensor nodes are embedded in home appliances and devices like refrigerators and micro-wave ovens. Residents are able to control the home devices outside of home. Wireless sensor network applications related to health include tracking and monitoring doctors and patients inside a hospital, drug administration and control in hospitals, tele monitoring of human physical data and etc. The installed wireless sensor network can be used to monitor and detect the behavior of elderly people and the disability like a fall and store the collected physical and biological data for a long period of time for the medical exploration.

An example of applying wireless sensor network in health field is the Health Smart Home deployed in the Faculty of Medicine in Grenoble in France to validate such system. Because of the specific characteristics of wireless sensor network including rapid deployment, self-organization of network, high fault tolerance, high sensitivity and etc., wireless sensor networks have a wide range of applications in military field. Wireless sensor networks have been applied in fields such as monitoring of nuclear power stations, detection and reconnaissance of biological and chemical attack, battlefield surveillance, monitoring of friendly forces, equipment and ammunition, reconnaissance of opposing forces and terrain. Some of the commercial applications of wireless sensor network include environmental control in office buildings, interactive museums, detecting and monitoring car parking places, managing inventory control and vehicle tracking and detection. In interactive museums, people are able to interact with objects in museums that are able to respond to people's action to learn more about the exhibition. The real time cause-and-effect environment is already provided and deployed for people to take part in. An example of such a museum is the San Francisco Exploratorium that combines data measurement and cause-and-effect experiments. Regarding the communication architecture of wireless sensor network, in a wireless sensor network each node is able to collect data and transmit data by a multi-hop infrastructure less architecture to the sink and terminals. The sink node can communicate with end users on a PC or mobiles by Internet or satellite. The communication architecture of wireless sensor network is shown in Figure 2.

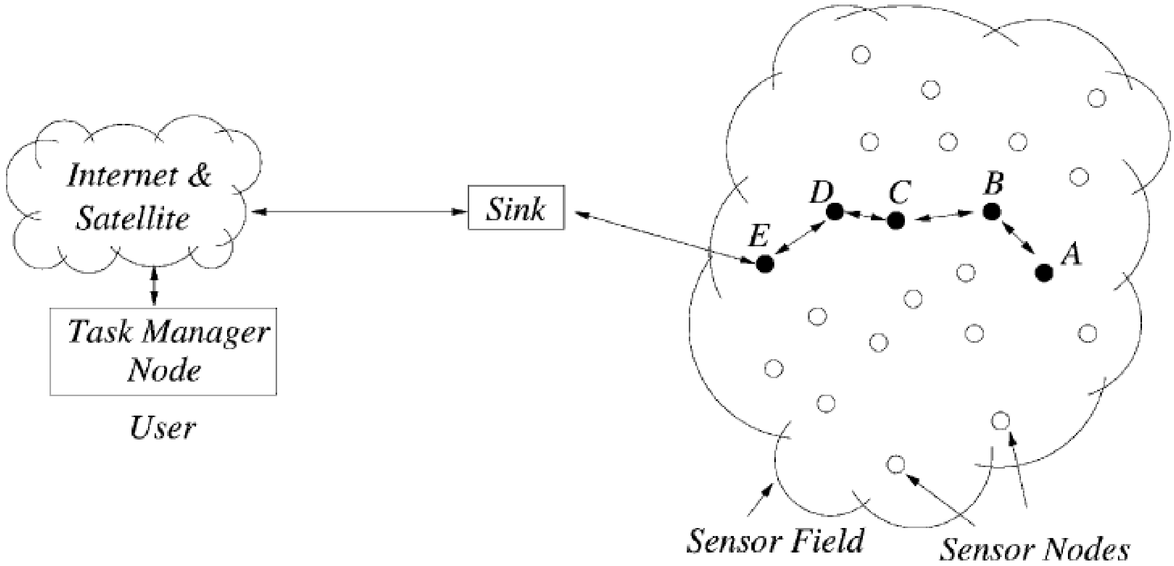

Figure 2: IOT Based Communication Architecture of Wireless Sensor Network

Monitoring Parameters

The Arduino System has two benefits, real-time and traceability. On one hand, it can be used to monitor environment in real-time, which could help vineyard technicians to take actions according to the impact of disease in the vineyard to minimize the time and money cost due to the phenomenon. On the other hand, the Arduino System monitors and controls the grape and transmits the collected environmental parameters from the vineyard to the end users in real time. In this way technicians could stay in their offices while monitoring mushroom in real time from plantation to wine manufacturing. Also, technology is used to improve viticulture. The Arduino Sensor System nodes consist are able to collect different data as follows:

(1) Ambient temperature and humidity
(2) Atmospheric pressure
(3) Pluviometer
(4) Anemometer
(5) Ultraviolet radiation
(6) Solar radiation
(7) Soil temperature
(8) Soil moisture
(9) Leaf wetness

The Arduino System uses smart agriculture sensor board extension to connect different types of sensors. This sensor board contains the electronics needed to implement an easy hardware integration of these sensors. With the help of these various measured parameters, statistical prediction models can be implemented in the Arduino System. The sensor is used to control air conditioning in the wine cellar and irrigation systems in the vineyard. For example, turning them on or off according to the real-time weather conditions. The Arduino module can be used in the traceability of the mushroom, adding a new feature to this Smart Agriculture system.

IOT Based Arduino Microcontrollers and Sensors

In this paper we have used MQ Sensor protocol to connect the device with IOT cloud. And we also use Sensor protocol for transferring data between circuit application and cloud by using Post method. There are several mushroom monitoring and data communication protocol used by IoT. They are:

1. Temperature and humidity Sensor
2. MQ135 Sensor
3. BMP 180 Sensor

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4. Ultrasonic as Water Level Sensor
5. MQ6 Sensor
6. ESP8266 WiFi Modem
7. Cloud Server for recording and forecasting
8. And Mobile Apps

IoT Hardware

To build an IoT framework there are need some hardware combination. For this microcontroller, Ethernet shield, sensors are one of them. The short description about hardware is given below Microcontroller**:** We have used most popular Arduino UNO as a microcontroller. Arduino Uno has some specific I/O pin. It includes Power, GND, Serial Pin, Analog Pin, Control, INT, Physical Pin, Port Pin, Pin function, Internet Pin, PWM Pin, Port Power. The figure 3 shows the full pin diagram. Here the Pin diagram is given below-

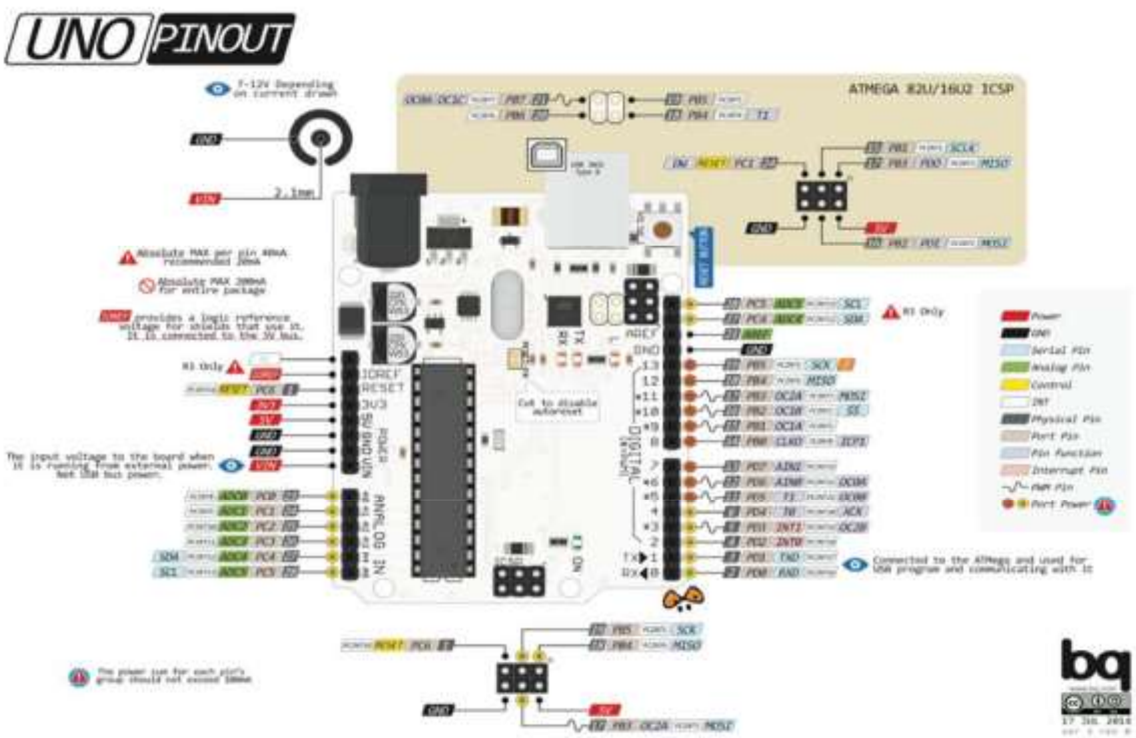

Figure 3: Aurduino Microcontroller Pin Out Diagram

Basic Functions of Arduino Technology

- Digital read pin reads the digital value of the given pin.
- Digital write pin is used to write the digital value of the given pin.
- Pin mode pin is used to set the pin to I/O mode.
- Analog read pin reads and returns the value.
- Analog write pin writes the value of the pin.
- Serial. Begins pin sets the beginning of serial communication by setting the rate of bit.

Advantages of Arduino Technology

- It is cheap
- It comes with an open supply hardware feature that permits users to develop their own kit
- The software of the Arduino is well-suited with all kinds of in operation systems like Linux, Windows, and Macintosh, etc.
- It also comes with open supply software system feature that permits tough software system developers to use the Arduino code to merge with the prevailing programing language libraries and may be extended and changed.

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- For beginners, it is very simple to use.

Working Architecture of the Aurduino Model for Mushroom Plant Monitoring

Fig 4 shows the block diagram of automatic monitoring and controlling system-using internet of things (IoT) for mushroom plant. The temperature, humidity, MQ3 (Gas sensor) replaced by the MQ6 Gas Sensors, MQ135 (Air quality), BMP180 (Air pressure and attitude) and water level are sensed by Arduino Nano by writing appropriate code in Arduino IDE. According to water level, the water pump will ON/OFF. Further data packet will transfer to ESP8266 as Wi-Fi modem to make it in cloud. With the help of cloud sever and mobile APP, data will be forecasting.

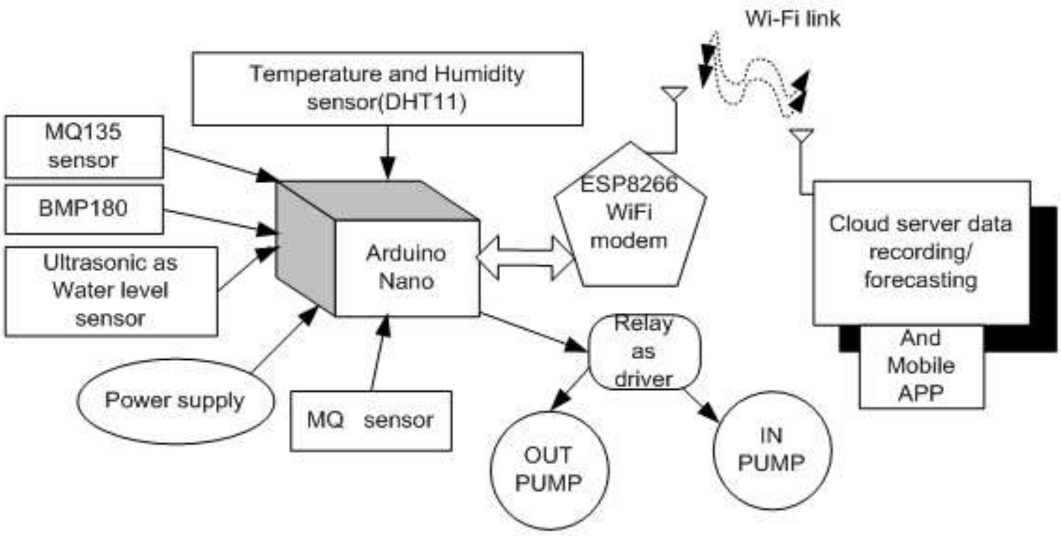

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Figure 4: Block diagram of the proposed Work

Data Normalization

In this project we have taken some sample and store in a arraylist, then we take average of those data for efficient result. The formula is

$$(X) = \sum_{i=1}^{n} (Xi)$$

Where the refine data and *i* is the sample number and *n* is the total number of sample.

Monitoring Algorithm

Mushroom plant monitoring algorithm have been developed based on soil factor that soil factor is collected by sensors. But among three factors it has two types-

1. Primary factors (pH)
2. Secondary factors (Humidity, Moisture & Temperature)

Here is classification diagram:

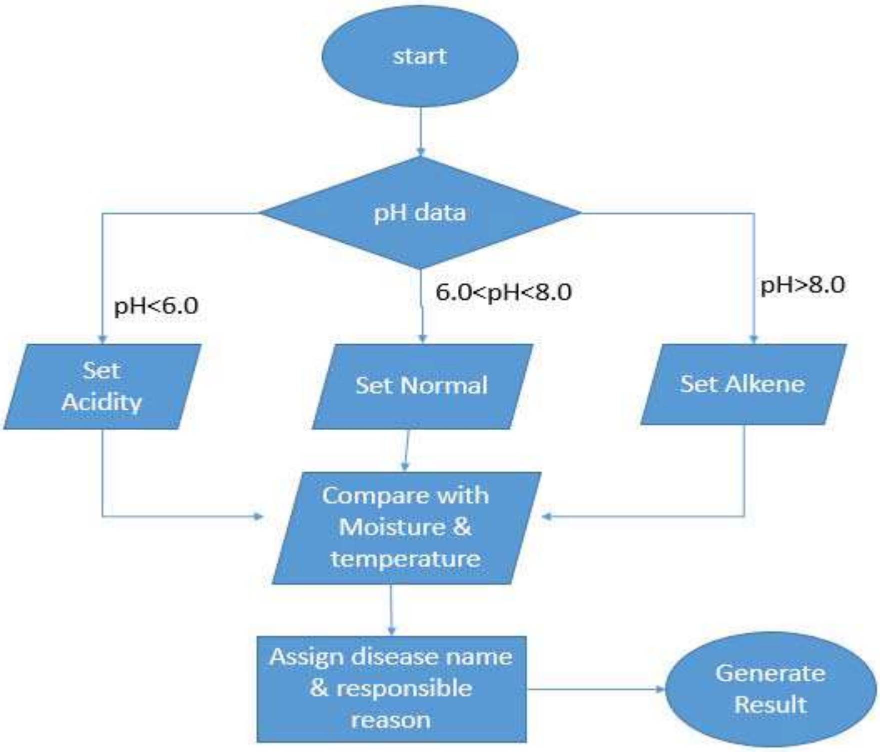

Figure 5: Flow chart of Monitoring Algorithm

Pseudocode of the Monitoring Algorithm

Monitoring Algorithm (pH, moisture, temperature):

Step 1: pH data = normalize pH data
Step 2: Moisture data = normalize Moisture data
Step 3: Temperature data = normalize Temperature data
Step 4: Check pH data with category range
Step 4.1: If pH data < 6.0 then set category level to Acidity
4.1.1 set Disease name according to pH range
4.1.2 get confirmation with moisture data range
4.1.3 set more accurate with temperature data
Step 4.2 Else If pH data > 6.0 and pH<8.0 then set category to Normal Level
4.2.1 skip the moisture and temperature comparison
Step 4.3 Else If pH data> 8.0 then set category to Alkene Level
4.3.1 set Disease name according to pH data range
4.3.2 get confirmation with moisture data range
4.3.3 set more accurate with temp data
END IF.
Step 5: Else set alert for INVALID data execution
END IF.
END Monitoring Algorithm.

III. RESULTS AND DISCUSSION

In this paper the result of the classification algorithm of Mushroom crop monitoring with disease detection system are presented and also we tried evaluating the experimental result through analysis. For this we have shown the result through some scenario or cases. In every scenario we have taken the sensor data and put in an array list, then we have taken average value of that data then we push those data to algorithm and we have a result layout for that. At the end of the result we also have shown the used data lists from the array list. And shown the category, its type, disease name, pathogens name and status. The data list, sensor data list, graph representation and result are given below for different scenarios.

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	A	B	C	D	E	F	G	H	I	J	K
1	created_at	entry_id	F1-Humidity	F2-TEMP	F3-WL	F4-C02	F5-Air Qualit	F6-Air Pre	F7-Altitude	F8-Motor	
2	2018-04-29 04:46:38 UTC	1	34.34.00	28	180	3	93742	651.38	26	1	
3	2018-04-29 04:47:02 UTC	2	34.33.00	29	127	3	93744	651.2	26	1	
4	2018-04-29 04:47:26 UTC	3	34	28	134	3	93739	651.38	25	1	
5	2018-04-29 04:47:51 UTC	4	3335	28	133	3	93761	651.29	25	1	
6	2018-04-29 04:48:14 UTC	5	34.36.00	28	178	3	93737	651.73	25	1	
7	2018-04-29 04:48:38 UTC	6	34.34.00	28	180	3	93758	651.56	25	1	
8	2018-04-29 04:49:00 UTC	7	3435	28	133	3	93736	655.37	24	1	
9	2018-04-29 04:49:25 UTC	8	3434	28	3503	3	93739	651.64	24	1	
10	2018-04-29 04:49:48 UTC	9	34.034.00	28	133	3	93745	651.47	23	1	
11	2018-04-29 04:50:12 UTC	10	34.34.00	28	179	3	93739	653.77	23	1	
12	2018-04-29 04:50:36 UTC	11	34	28	132	3	93742	651.64	23	1	
13	2018-04-29 04:50:59 UTC	12	34.34.00	28	16	3	93742	653.6	23	1	
14	2018-04-29 04:51:49 UTC	13	34.33.00	29	15	3	93739	651.38	23	1	
15	2018-04-29 04:52:11 UTC	14	34.34.00	28	179	3	93739	651.64	23	1	
16	2018-04-29 04:52:35 UTC	15	34	28	133	3	93695	651.38	22	1	
17	2018-04-29 04:52:58 UTC	16	34.34.00	28	3491	3	93700	650.93	22	1	
18	2018-04-29 04:53:38 UTC	17	34	28	182	3	93736	651.82	22	1	

TABLE 1: LIST OF SCENARIO'S SENSOR DATA.

SIMULATION GRAPH REPRESENTATIONS AT OUTPUT RSULTS:

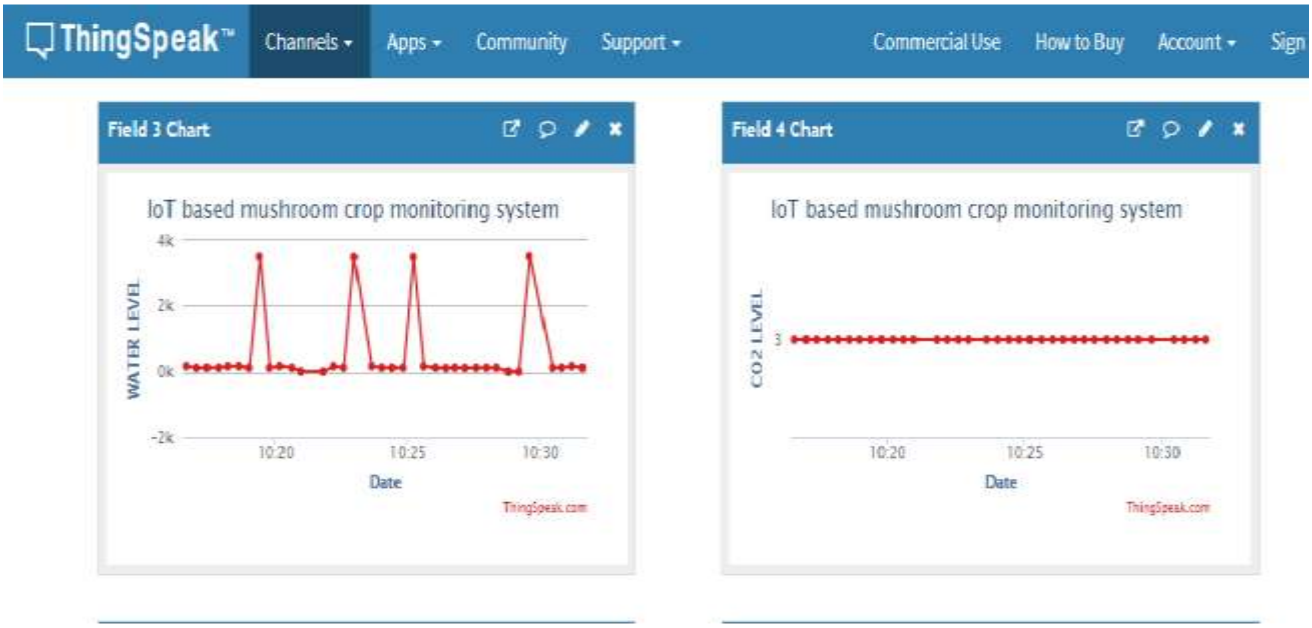

Figure 6: Output Results Analysis Graph Representation A

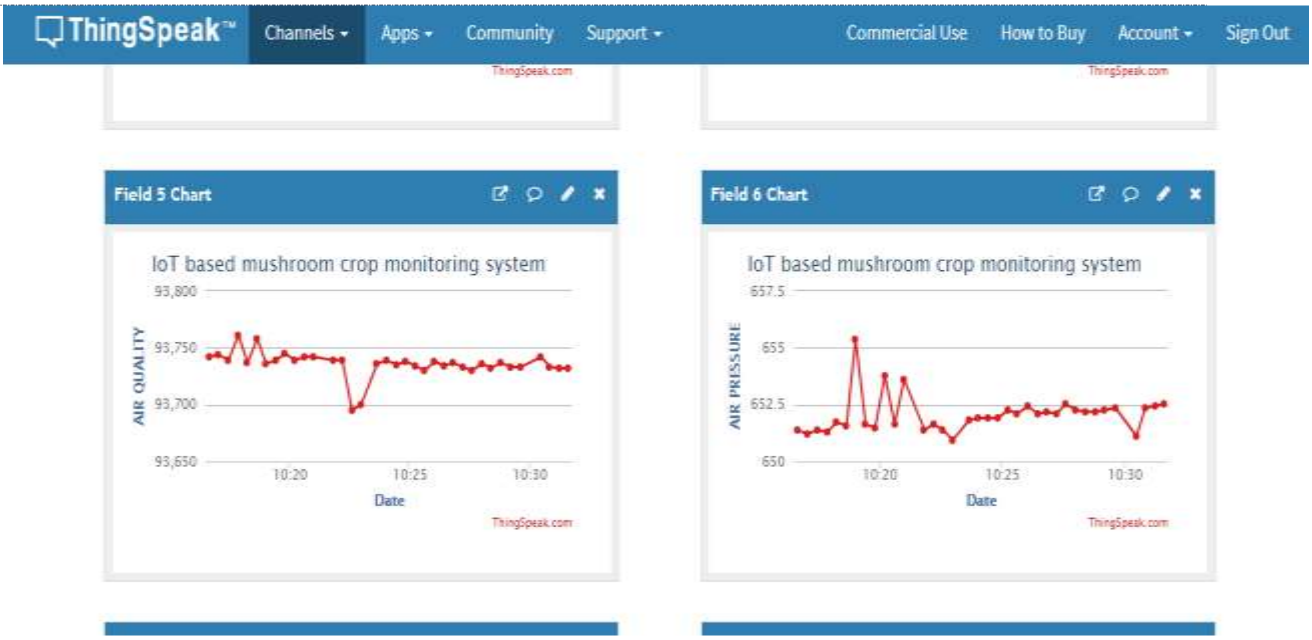

Figure 7: Output Results Analysis Graph Representation B

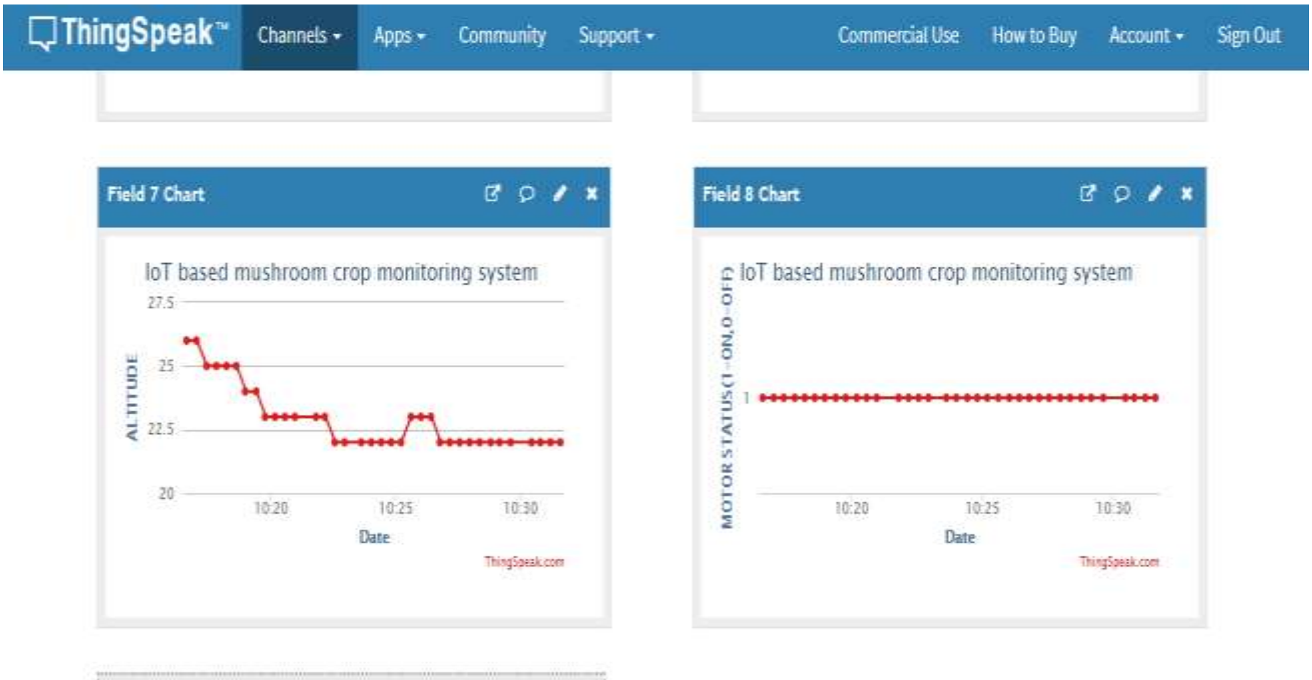

Figure 8: Output Results Analysis Graph Representation C

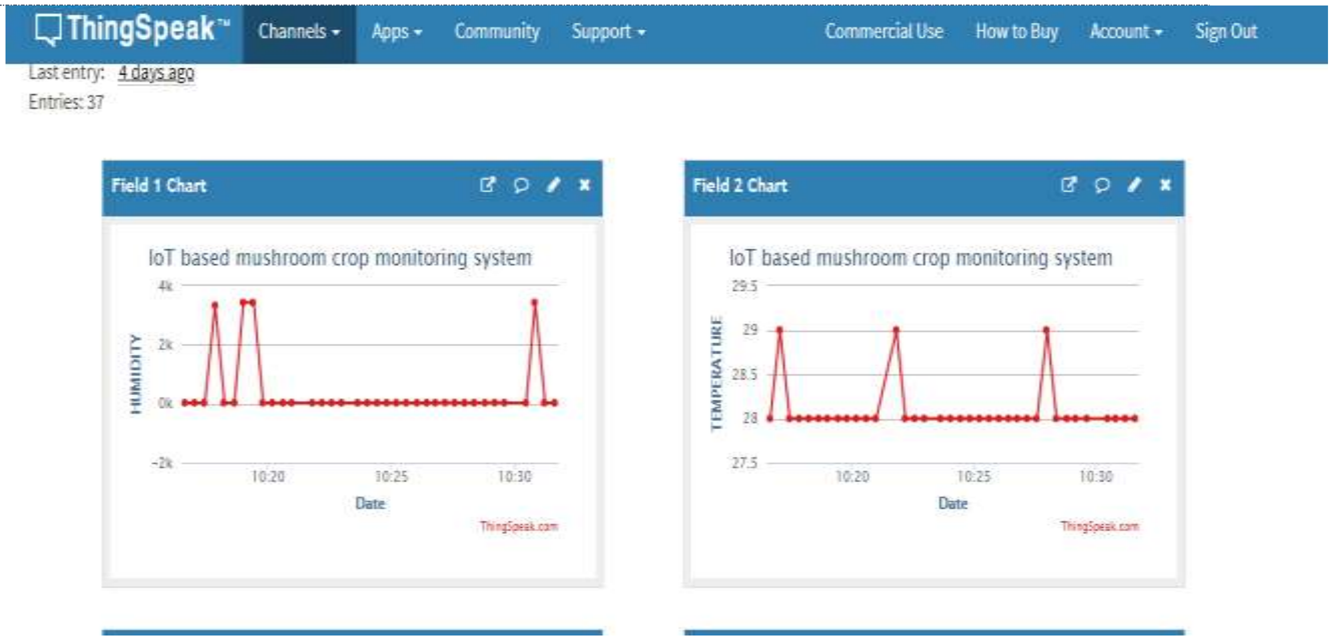

Figure 9: Output results Analysis Graph Representation D

IV. CONCLUSION

So therefore we can say that IoT has brought revolutionary change in monitoring, management and data analysis sector. Our framework can successfully detect soil borne disease for fungus, bacteria and nematode which will be great useful of agriculture sector. It is also efficient and cost effective. It is affordable. By using this framework sensor data can be stored and can be used for further analysis. Our classification algorithm provides result with great accuracy about 77.45% which is good for pH, moisture and temperature data. Besides we are successful in our test case scenario. We have successfully detect fungus, bacteria and nematode related disease in the soil and have shown the test result as evidence. This framework provides services as we expected, though there is some lacking because every soil borne disease can't be identified only based on this data. By implementing more set of sensors we can solve this problem and more features.

A Novel Smart Farming Enabled of IoT Based Agriculture for mushroom production plant Sticks for Live Monitoring of Temperature and Soil Moisture has been proposed using Arduino, Cloud Computing and Solar Technology. The stick has high efficiency and accuracy in fetching the live data of temperature and soil moisture. The Agriculture stick being proposed via this paper will assist farmers in increasing the agriculture yield and take efficient care of food production as the stick will always provide helping hand to farmers for getting accurate live feed of environmental temperature and soil moisture with more than 99% accurate results.

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