A Comprehensive Study on IoT Based Smart Farming System

Kartik Arora[1], Anmol Singh[2], Ankit Maithani[3]
[1]*DBIT Institute Dehradun*
[2]*DBIT Institute Dehradun*
[3]*Assistant Professor DBIT Institute Dehradun*
(E-mail: ka340689@gmail.com[1] , anmolking29@gmail.com[2], ankitmaithani2518@gmail.com[3])

***Abstract*—**In India 80% of the population is dependent on agriculture, but in the past few decades it has been observed that a large amount of farmers have started migrating from rural to urban areas and have left their practices in the field of agriculture. The main reason for this migration is the amount of efforts that a farmer needs to provide in order to grow his crops. Acknowledging, this era of smart work, a smart farming system by crop monitoring and smart irrigation has been developed by the use of microcontrollers, GSM, sensors, IoT, WiFi and wireless sensor network, to overcome the difficulties in farming, using this system a farmer can monitor his farm in a more accurate and précised way. The paper explores the concept of smart farming which is a boon for the farmers.

Keywords*—Microcontroller, Sensors, GSM, IoT, WiFi.*

I. Introduction

The world population is set to touch 9.6 million by 2050, In order to fulfil the requirements of this upcoming generation, It is believed smart farming is the accurate way. Smart farming and Smart water management is the technique which is adopted to reduce the efforts of the farmer which the farmer faces in the growth of his crops against the natural calamities such as rising climatic changes due to global warming. Smart farming can be achieved by using microcontroller, sensors, IoT and other modern day technologies.

Microcontroller is a device which is basically used to perform a specific task. The programming for microcontroller is considered to be quite easy. The microcontroller helps us to monitor all the devices such as GSM Module, Soil moisture sensor, PIN sensor, Temperature sensors in the farm.

Sensors are the electronic devices using which we can detect the changes occurring in our environment. It senses these changes and acts as per the programmed design.

[1] The Internet of Things (IoT) has the capability to transform the world by providing more-efficient industries, connected cars, and smarter cities which have upgraded the humans. By the use of IoT-based smart farming, we can monitor the crop field and provide an automating the irrigation system.

This paper aims at providing smart and worthy solutions to the farmers by providing a review of the techniques, which would help the farmers. The technology such as automation of the resources, taking a step forward towards smart irrigation system and smart monitoring system using which the farmers could monitor the temperature, humidity and other secondary operations in their farm. In this paper we are going to elaborate how IoT based farming can help farmers to produce crop and operate their fields more efficiently. The rest of the paper is organized as follows: Section II provides the relevant Literature review, Section III deals with the algorithms and the tools which have been implemented to design efficient way to monitor, Section IV provides the overview of increasing IoT based farming system and its applications, Section V provides the proposed frame work and at last the conclusion is provided by Section VI.

II. Literature Review

Joaquin Gutierrez et al. (2014) generated the paper that aims at providing solution for generating control over usage of water in the agriculture field, By using the brink values of temperature and humidity in soil, an algorithm was developed that was programmed into a microcontroller-pins to control the amount of water in the fields. The photovoltaic panels were used to power the system and had a paired communication link developed using IoT that allowed for the analysis of data and irrigation cataloguing to be programmed by using a web page. But it was observed that the investment in electric power supply was of a very high level that would not be affordable for the farmers [2].

Nikesh Gonduhchawar proposed The technical idea of developing an open source software and hardware over the last few years have made it easy to develop better monitoring[3] and Zhao liqiang also proposed the wireless sensor network using which it become possible for the user to control and monitor the green house parameters in smart farming [4].

K.Lakshmisudha proposed the precision based agriculture system is focused on developing a system which would provide alert to the users using the messages and emails these features outlines the benefits of a wireless sensor based network system by using the GSM module.

As per BezaNegashGetu, It provides a deep study of the electronic system for automatic control of water pumps that are designed and simulated for monitoring agricultural fields and smart irrigation system based on the level of soil moisture sensing. The speed of the motor can be controlled using this

electronic system which turns off the motor during maximum wet and turns the motor on at the time when the temperature is high and moisture content in the soil is low respectively. The system would take a number of counts and on getting the accurate data it performs multifunction for which it is build. But the issue that was raised is that it does not support several water levels and uses old techniques [6].

Shakthipriya N, as mentioned it reviews the state of art wireless sensor technology in agriculture. According to the readings of soil moisture sensor, pumps would be on and water would be supplied in the fields at the time of water scarcity [8]. Once the field is provided with adequate water, the pumps are automatically switched off. Thus, water conservation is showed in the system and this would help us to even solve the major issue of water scarcity. Also the alert will be sent to user via SMS using GSM modem. The issue in the work is it provides only precision values that it is neither accurate nor cost efficient [7].

A proposed ideal proposes the use of wireless communication technology for developing an efficient technique for smart agriculture by providing a worthy and efficient sensing system and easy to implement irrigation system [9].

S.R. Nandurkar, V.R.Thool, R.C.Thool, proposes a wireless sensor network technique which is cheap and efficient to acquire the soil moisture and temperature from the farm and as per the need of farmer to take the decision whether the irrigation should be enabled or not [10].

[11] The use of sensors maintains the level of water inside the tank and by the use of mobile application the data will be stored in the cloud. Mobile application is been used to view level of water according to which motor will work on automatic and manual. If the water level is low automatically motor gets switched on and as soon as it gets filled the motor will be switched off.

Dr. V .Vidya Devi,G. Meena Kumari, Ethernet IEEE was used to control and monitor the atmospheric conditions. The process of handling partial root zone drying could be resolved to the very possible extent [12].

A. Algorithms Preferred

To achieve our task for smart farming and smart irrigation system algorithms have proposed by scholars in the past. Algorithms are considered to be an easy way to define a lengthy process in a communicative way [13]. The system generates the data for humidity, temperature, soil moisture for desired counts and thus performs the action according to the algorithm .The most preferred algorithm as per the ease of programmer is as follows:

Algorithm preferred:-

1. Algorithm for automatic functioning IF sensors report

   Temperature >x

   Humidity >y

   ALERTS are sent to the application user using SMS/EMAILS and pumps are automatically on

   IF Moisture in soil >A

   Pump off

   IF Moisture in soil<B

   Pump on

2. Algorithm for manual function IF sensors report

   Temperature >x;

   Humidity >y;

   ALERTS would be sent to the application using SMS/EMAILS and pumps are on through webpage.

   IF Moisture in soil >A

   Pump off through webpage.

   IF Moisture in soil<B

   Pump on through webpage.

B. Hardware Requirements

The following project is developed and executed on the basis of the following tools used. These tools are preferred because they help us to develop the project in a cost effective and valuable way.

1. Arduino Uno
2. Analog Soil Moisture Sensor
3. DHT22 Digital Temperature and Humidity Sensor
4. MQ-135 Air Quality Gas Sensor Module
5. MQ-7 Gas Tester Carbon Monoxide Detecting Sensor Module 4P 180mA 5V DC
6. MQ2 Gas Sensor, Methane, Butane, LPG, Smoke Sensor
7. Ultrasonic sound sensor
8. LCD 16×2 Alphanumeric Display(JHD162A)
9. Jumper Wires Male to Male, male to female, female to female
10. GSM Modem Module for Arduino
11. Batteries
12. Motor
13. 1 kilo-ohm Resistances

Figure 1: Tools Used.

1. Soil moisture sensors:-

It is a modern day device which is used to study the moisture content in the soil [14]. This type of technology is effective because it sights the water content in soil indirectly by using the parameters such as electrical resistance, interaction between the neutrons.

It gives two types of output:-

1) Digital output-it is the fixed output.

2) Analog output-it is the variable output due to threshold.

When the moisture content in the soil is low the current will not pass through the terminals of the sensors and thus it will behave as an open circuit. On the other side, when the moisture content is high it will act as a shot circuit and current will pass through its terminals. The advantages of using this kind of sensor are as followed:-

1. The efficiency of these kinds of sensors is very high as it is platinum coated.

2. The range of sensing of this kind of sensors is also very high.
3. It has anti rust technology which increases its useful life.
4. It is affordable for the farmers.

2. PIR Sensors:-

Heat from body can be sensed in the form of radiation that the body emits PIR sensors is a technology which detects these kind of radiations which are radiated from every object with temperature above absolute zero . Some other applications of PIR sensors are burglar alarms, motion sensors, etc. In our project these kind of sensors are used to detect humidity and animal presence in the farm which increases the security in the farm.

3. Temperature Sensors:-

The temperature sensors are very crucial as it detect the rise and fall in temperature due to which a mechanism is generated for the motor or pump to be on when temperature is high above normal and off when temperature is normal. Some preferred analog temperature sensors are

1. LM 135/LM 135 A
2. LM 235/LM 235 A
3. LM 335/LM 335 A

These sensors are used because of their ease in calibration. The most widely used and preferred sensor for smart farming is LM 35, Because it consumes minimum amount of energy, It is cheap and moreover it can operate at a maximum voltage of 5 volts. It can sense temperature from a range of -55 degree Celsius to 150 degree Celsius [15]. It has following three pins

1. Ground (Gnd).
2. Voltage supply (Vcc).
3. Analog sensor.

4. GSM Module:-

It is modem which works in establishing a communication between mobile phones or computing machines. It serves as a mobile phone because of its capability to have a unique mobile number. It is connected to the controllers using RS-232; by the means of "AT COMMANDS" [16]. We can enable it to perform operations like:

1. Send messages to user.
2. Send emails.
3. Receive command and forward it.

And many other applications can also be performed using the GSM module. It accepts the GSM network operations; it can also be constructed using old mobile phones and is operated in a range of 900/1800 Hz. It can also operate whether it is in signal range or not.

5. RS -232:-

It is a serial communication device which is beneficial for a project in establishing a strong relation between the components of our system Such as modem, ardinuo, sensors and the android app/software used. In technical words it is often termed as a standard interfacing device as its definition appeals "A computer is data transmission equipment".

Software used:-

1. Python.
2. THINK GAG.
3. Embedded C.

III. Overview and Statistical growth

The increasing demand of food with the rise in global population has put the farmers in the situation to adopt new technologies by using which they can grow their crops and monitor their fields in a more efficient way.

The following table shows the growth of IoT in agriculture field. The growth of IoT is expanding from last few decades. According to Figure 2, The IoT market is going to increase 14.7% by 2025. The following table shows the relationship between IoT devices (in millions) and years. We can conclude that in the period of five years the shipment of IoT devices has increased approximately by 250% and it is observed that it is tremendously increasing day by day. According to the table the current market of IoT in agriculture is nearly 16.73billion and is expected to reach 48 billion by 2025, making a CAGR of 14.7% within these years [8].

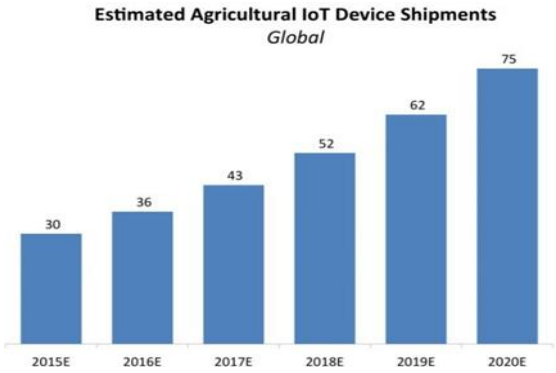

Figure 2: Growth of IoT in Agriculture.

IV. Proposed framework

IoT has a bright future and so in the field of agriculture. The future work proposes a project on vehicle based farming system. A vehicle can be designed which can be used to provide an overall view of the crop field by using a camera at its top. It will be a motor operated vehicle by IoT. We are all well aware of the fact that motor can be operated. Our future work focuses on connecting such motors to the wheels of the vehicle and putting an effort to try and control their RPM. We would prefer the use of an ardinuo board to establish a perfect control over the whole mechanism. This system can be useful

in monitoring large sectors of land and providing an immediate report to the farmer regarding the status of its farm and the efficiency of crop monitoring and irrigation system. It could even help in agriculture activities like cutting, spraying, weeding etc. It could also be helpful in protecting the farms from the animals. The proposed vehicle could operate in both automatic as well as manual modes. An effort has been put to develop a rough code for the following vehicle:-

```
/* Adafruit Arduino - Lesson 13. DC Motor */
int motorPin = 3;
void setup()
{
      pinMode (motorPin, OUTPUT);
      Serial.begin(9600);
      while (! Serial);
      Serial.println ("Speed 0 to 255");
}
void loop()
{
      if (Serial.available())
        {
              int speed = Serial.parseInt();
              if (speed >= 0 && speed <= 255)
               {
                  analogWrite (motorPin, speed);
               }
         }
}
```

v. Conclusion

A crop monitoring and irrigation system is been developed which able to monitor/ control pump operation in the farm by sensing the temperature, humidity, soil moisture etc and increase the efficiency of decision making and harvest analyzing characteristics[17]. This kind of system is also enabled to send the SMS and email to the user regarding the status of his farm. This system has a less complicated circuit and is affordable for farmer. Observing the present situation of agriculture the system can sense as a boon for the farmer. The system can be controlled using an android app and webpage which will provide alerts and it can work in both automatic and manual way which thus increases its efficiency. In future the use of vehicle based monitoring system would enhance its features and complexity would be reduced to a lower level.

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