Innovations

Smart Agriculture forming and Monitoring Using IOT based Sustainable Technology

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Abstract

*Climate changes and rainfall has been erratic over the past decade. Due to this in recent era, climate-smart methods called as smart agriculture is adopted by many Indian farmers. One of the important applications of IoT is Smart Agriculture. It reduces wastage of water, fertilizers and increases the crop yield. Smart agriculture is an automated and directed information technology implemented with the IoT (Internet of Things). IoT is developing rapidly and widely applied in all wireless environments. In this project, sensor technology and wireless networks integration of IoT technology has been studied and reviewed based on the actual situation of agricultural system. Temperature sensor, Moisture sensor and pH sensor which senses the temperature, moisture content and pH in the soil which are connected to Raspberry pi. A combined approach with internet and wireless communications, Remote Monitoring System (RMS) is proposed. Nowadays IoT is the growing technology in the present era. As considering all the aspects into picturization we proposed a new methodology in which a farmer can easily identify the status of his field and proceed for the crop to be irrigated. In this we calculate the Temperature, Humidity, Soil Moisture, and pH of the field. By visualizing all the parameters, we considered the respective individual can easily identify the nature of his field and the crop that can be cultivated in the field.***

Keywords: *IoT, Remote monitoring system, Raspberry Pi, Sensors, Smart Agriculture.*

1. Introduction

IOT describes the network of physical objects i.e., things that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. In

INDIA there have been advancements in technologies in various sectors, but in agriculture there is no advancement in the technology [1-2]. As INDIA has the largest agriculture land but the growing and yielding of the crops are not up to the mark. Agriculture is one of the largest sectors in India. The share of agriculture in GDP is increased to 19.9% in 2020-2021 from 17.8% in 2019-2020.Many people were facilitated by agriculture sector, but it still lacks in modernization and advancement [3-4]. Technology can be used for updating the agriculture and mainly the irrigation methods to get efficient yield and control. Nowadays IoT has brought tremendous changes in agriculture in many different ways just like using the sensors. When sensors like moisture sensors, temperature and humidity sensors are placed across the fields, farmers are able to receive more accurate data and can able to do schedule irrigation periods [5-7]. In our project we developed a smart irrigation system that continuously monitors and automatically irrigates the field whenever it is requires. It helps us to prevent the crop from excessive watering or lack of watering at the required times which will adversely affect the crop production. There are two sections namely transmitter and receiver in our project. Transmitter side consists of sensors which sense the field parameters and passes this information to the receiver [8-9]. At receiver side receives the data and a mini submersible pump is connected to Raspberry pi 4.Accordingly to the received data the Pump will turn on/off automatically by comparing with given Threshold values. And this information is passed to the cloud, so that we can be able to observe the data from anywhere through laptops or mobile phones [10-14]. Unlike the other systems we are adding few more parameters that are to be analysed for better yield and control. It is a trans-receiver module that we are using in this project to collect the data within the range of 1.5 kilo-meter [15-18]. So, this method gives much more accurate results for smart irrigation with low cost.

2. Literature Review

A Sustainable Agriculture System Using IOT explains about a Sustainable Agriculture System Using IOT. This work developed a system a system which will automatically monitor the agriculture fields [19-23]. As well as performing live video streaming for monitoring the agriculture field from the server itself, through raspberry pi camera. The agriculture fields are monitored for environmental temperature, humidity at soil moisture sensor. IOT and wireless sensor node helps to decrease the efforts, for observing the agricultural fields [24-27]. IOT also avoids the loss of agriculture parameters database and save in the storage device or cloud for long life. It also provides continuous monitoring in all places including the critical areas. Agriculture product rely on environment factory like relative humidity, PH of soil, temperature etc. The proposed system model is developed in order to get more yields by identifying the causes. A Model for Smart agriculture using IOT Smart Agriculture using IOT [28-34]. Climate changes and rainfall has been erratic over decade. Due to this, climate smart methods called smart agriculture is adopted by many farmers. In the existing system, village farmers may have planted the same crop for centuries, but over period, weather patterns and soil conditions and epidemics of pests and disease have been changed. By using the proposed system approach, which senses the local agricultural parameters, identify the location of sensor, transfer the data crop fields and crop monitoring [35-40]. The Received updated information allows the farmers to cope with and even benefit from these changes. The Complete real-time and historical environmental information is expected to help to achieve efficient management/monitoring and utilization of resources [41-45]. Smart Agriculture System using IOT Technology Smart Agriculture System using IOT

Technology. In the existing system agriculturists used to figure the ripeness of soil and presumptions to develop certain kind of products [46-51]. They didn't think about the level of water, dampness and climatic conditions. The profitability relies totally upon the last phase of the harvest in which they depend. In this proposed system, they improved the efficiency of the product which appraises the nature of the harvest [52-58]. To go up against the challenges in the field, IOT is used in providing accuracy and conservative cultivation. They also used wireless sensor networks in precision Agriculture by separating the solitary plants for checking in the tens or several square feet. Also used different kinds of sensors such as Temperature sensor, Humidity sensor, Soil moisture sensor, Water level sensor and ARM processor [59-64]. IOT Based Monitoring System in Smart Agriculture IOT Based Monitoring System in Smart Agriculture. The farmers are still using traditional methods for Agriculture, which results in low yielding of crops and fruits, so the crop yield can be improved by using automatic machineries [65-69]. But by using IOT, we can expect the increase in production with low cost by monitoring the efficiency of the soil, temperature and humidity monitoring. In existing System, they used only the traditional methods for the crop yield. But in the proposed system, the combination of traditional methods with IOT and wireless sensor networks can lead to agriculture modernization [70-72]. The developed System is more efficient and beneficial for farmers. The application of such system in the field can definitely help to advance the harvest of the crops and global Production.

Smart Agriculture Monitoring System using IOT Smart Agriculture Monitoring System using IOT. The implemented framework comprises of different sensors and de-vices and they are interconnected by means of remote correspondence modules [73-74]. The sensor data is been sent and received from client end utilizing Internet connectivity which was enabled in the Node MCU mo the same time. Duel- an open source IOT platform. This system is used to maintain the optimal conditions of the irrigation system effectively. The data can be viewed on the Thing Speak app or any web page. The farmer can go through each and every information regarding the levels, at what time it's been functioning, any fluctuations appearing or not, whether the operations are been performed in time [75-76]. The foremost function is to monitor the crop growth using digital means. This will provide the accurate values of various parameters upon which growth depends. Besides, this model will help the farmer to monitor more than one land at the same time. Monitoring through this system requires less man power, people with physical disabilities can be employed for monitoring fields. Smart Farming using IOT Smart Farming by the aid of automation and IOT technology [77-78]. We aim to implement a smart GPS based remote controlled vehicle that performs various tasks like monitoring fields to prevent thefts, scaring birds and animals, sensing soil moisture content, spraying fertilizers and pesticides, weeding, sensing soil moisture, etc. Smart irrigation, by usage of optimum amounts of water, depending on the requirement of each crop type and the soil will be executed [79-80]. Finally, we plan on enforcing smart warehouse management, with temperature and humidity sensing for the benefit of the products being stored, and detection of presence of any invader who tries to steal from the warehouse. Controlling and monitoring of all these operations will be through a remote smart device with Internet connectivity and the operations will be performed by interfacing sensors, ZigBee modules, with micro-controller.

3. System Development

A. Hardware Architecture

The Raspberry pi 4 board is connected with the various sensors to measure the field in different parameters. As the Raspberry-pi 4 board as internal Wi-Fi, we tend to connect the module to the Thing Speak software to store the data in the cloud. Through the cloud we can send the information of the field parameters to the Farmers directly to their Mobile phones. By using this type of module the Farmers get to know their fields in a great way in this pollution world where everything is polluted.

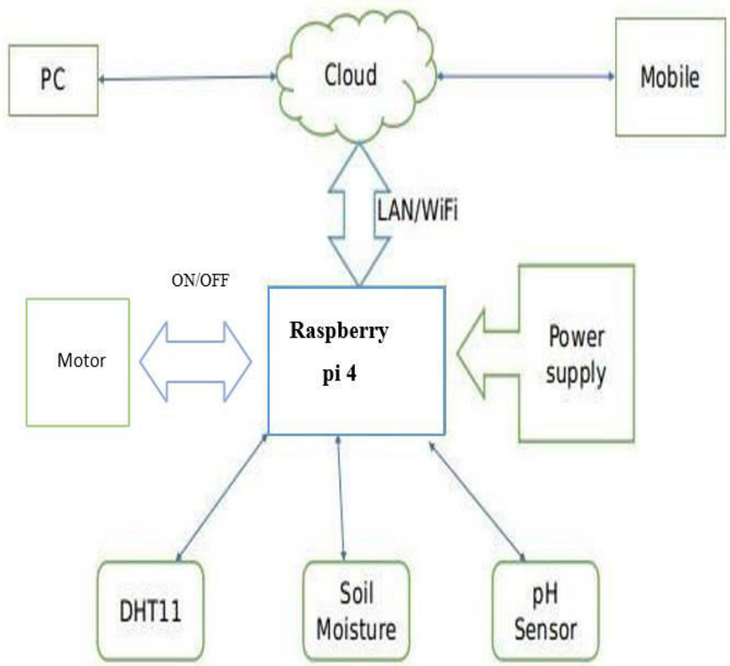

Fig.1: Block Diagram

B. Raspberry Pi 4

Raspberry Pi 4 is a stand-alone third generation computer with Broadcom BCM2837B0, 64bit quad-core ARM processor. It has memory of 1GB, dual band 2.4GHz and 5GHz IEEE 802.11.b/g/n/ac WLAN, Bluetooth 4.2, BLE and Ethernet over USB2.0. There are 40 GPIO pins for interfacing and 4 USB ports. Pi 4 has separate HDMI port for video output, MIPI camera serial interface port and display serial interface port, a dedicated micro SD card slot to load Operating System (OS) and data storage. The OS RASPBIAN is booted onto the SD card. Python programming language is used mainly. A large set of library files required for programming can be downloaded and installed timely according to the requirement. Raspberry Pi is a series of small single-board computers (SBCs) developed in the United Kingdom by the Raspberry Pi Foundation in association with Broadcom. The Raspberry Pi project originally leaned towards the promotion of teaching basic computer science in schools and in developing countries. The original model became more popular than anticipated, selling outside its target market for uses such as robotics. It is widely used in many areas, such as for weather monitoring, because of its low cost, modularity, and open design. It is typically used by computer and electronic hobbyists, due to its adoption of HDMI and USB devices [81-86].

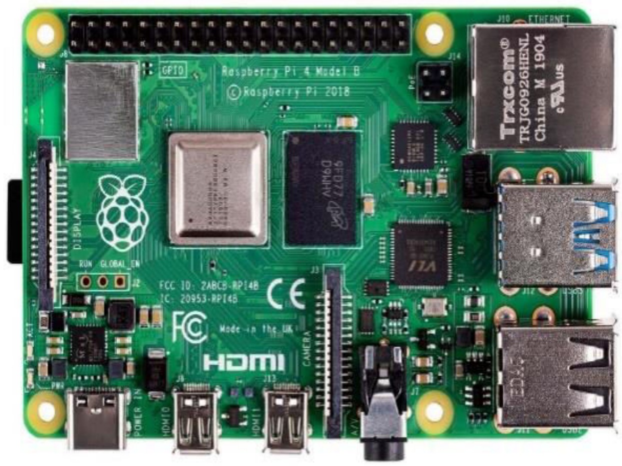

Fig.2: Raspberry pi 4

C. DHT 11

The DHT11 is a commonly used Temperature and humidity sensor that comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. DHT11 is a Temperature and humidity sensor. It uses thermostat and capacitive type humidity sensor.

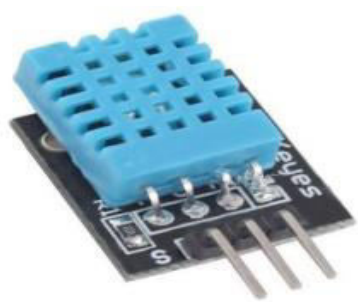

Fig. 3: DHT 11 sensor

D. pH Sensor

A pH sensor helps to measure the acidity or alkalinity of the water with a value between 0-14. When the pH value dips below seven, the water starts to become more acidic. Any number above seven equates to more alkaline. Each type of pH sensor works differently to measure the quality of the water.

The overall working rule of pH sensor and pH meter depends upon the exchange of ions from sample solution to the inner solution (pH 7 buffer) of glass electrode through the glass membrane. The porosity of the glass membrane decreases with the continuous use that decreases the performance of the probe.

Fig.4: pH sensor

E. Battery

An electric battery is a source of electric power consisting of one or more cells with external connections for powering electrical devices. When a battery is supplying power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, and the free-energy difference is delivered to the external circuit as electrical energy.

Fig.5: Battery

F. Soil Moisture

The soil moisture sensor consists of two probes which are used to measure the volumetric content of water. The two probes allow the current to pass through the soil and then it gets the resistance value to measure the moisture value. When there is more water, the soil will conduct more electricity which means that there will be less resistance. Therefore, the moisture level will be higher. Dry soil conducts electricity poorly, so when there will be less water, then the soil will conduct less electricity which means that there will be more resistance. Therefore, the moisture level will be lower. Soil moisture sensor consists of 4 pins.

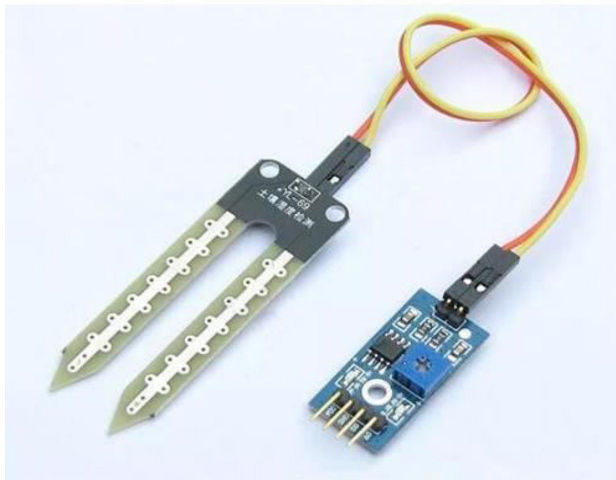

Fig. 6: Soil Moisture Sensor

G.SD Card

The SD card is a key part of the Raspberry Pi; it provides the initial storage for the Operating System and files. Storage can be extended through many types of USB connected peripherals. If there is no SD card inserted, it will not start. Raspberry Pi basically uses a micro SD card as a hard drive and to store any information. For this reason, we recommend using a Class 10 micro SD card in your Raspberry Pi. There is also a separate, even faster category called UHS-1 (for Ultra High Speed), often both are used.

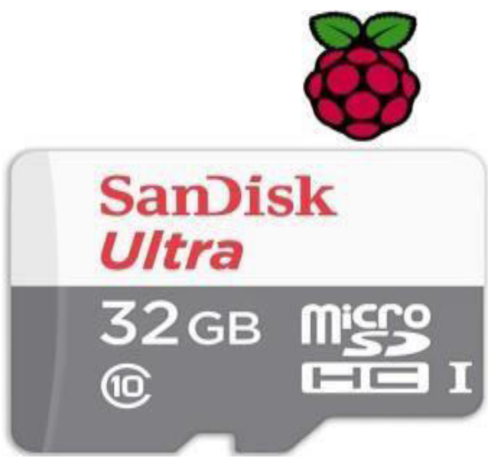

Fig.7: SD card

I. MCP3008

MCP3008 is a 10-bit Analogue to Digital converter having eight single ended input channels. It has a 4-wire serial SPI compatible interface that is used to get digital output for all channels. It has an onboard sample and holds circuitry.

J. Jumper Wires

A jump wire (also known as jumper, jumper wire, jumper cable, DuPont wire or cable) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

K. Power Bank

Portable Power Banks are comprised of a special battery in a special case with a special circuit to control power flow. They allow you to store electrical energy (deposit it in the bank) and then later use it to charge up a mobile device (withdraw it from the bank). The Power Banks are available of different power according the power of the chargeable devices. It is easy to carry Power bank for an individual.

L. Water Pump

A water pump is an electro mechanical machine used to increase the pressure of water to move it from one point to another. Modern water pumps are used throughout the world to supply water for municipal, industrial, agricultural, and residential uses. There are several types of water pumps including positive displacement pumps and centrifugal pumps, which provide the same service, however, operate differently.

M. Relay

A relay is an electrically operated switch. It consists of a group of input terminals for one or multiple control signals, and a group of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof. Features: RW Series Relay covers switching capacity by 10A in spite of miniature size to comply with the user's big choice.

N. Software Requirement

Python IDLE

IDLE (short for Integrated Development and Learning Environment) is an integrated development environment for Python, which has been bundled with the default implementation of the language since 1.5.2b1. It is packaged as an optional part of the Python packaging with many Linux distributions. It is completely written in Python and the Tkinter GUI toolkit (wrapper functions for Tcl/Tk). Python programming languages can be used to write the code.

Raspberry Pi Software

Raspbian is a free operating system released in July2012that runs on the Raspberry Pi single board computer. It is derived from Debian Linux, and uses the LXDE desktop environment by default. Raspberry Pi OS is highly optimized for the Raspberry Pi line of compact single-board computers with ARM CPUs. It runs on every Raspberry Pi except the Pico microcontroller. Raspberry Pi OS uses a modified LXDE as its desktop environment with the Open box stacking window manager, along with a unique theme. The default distribution is shipped with a copy of the algebra program Wolfram Mathematical, VLC, and a lightweight version of the Chromium web browser.

O. Work Flow

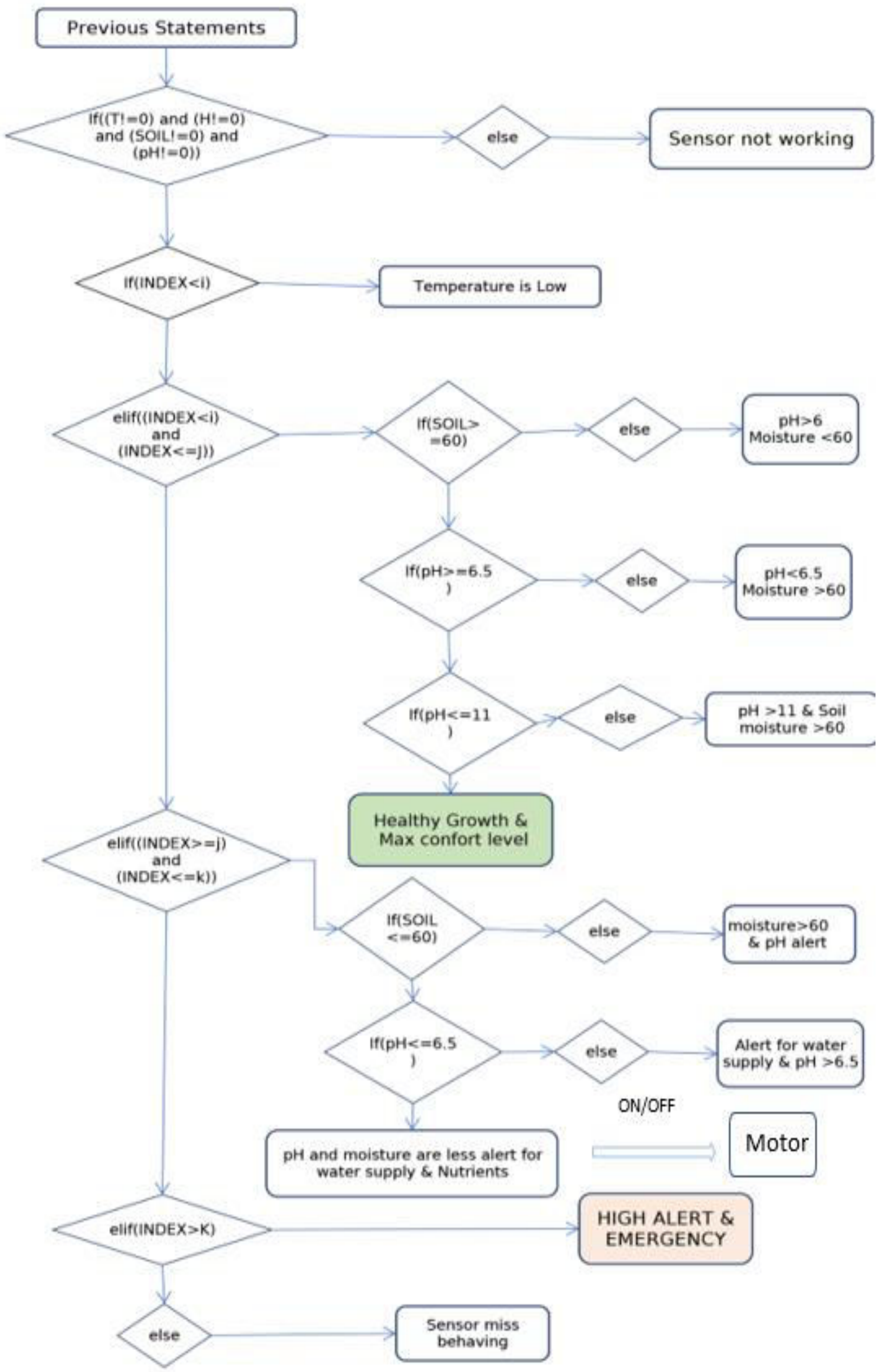

Fig 8: Flowchart

4. Proposed Methodology

A. Working Principle

Here when we give power supply to the Raspberry pi using power bank or direct connection using charger (adapter), we will see that all sensor get active by glowing led which is inbuilt in sensor and raspberry pi. Usually, we require keyboard and mouse for controlling and monitor for visualizing the screen which is present inside the Raspberry pi memory. But rather than using that we will be taking help of VNC. Here Raspberry pi will act as VNC server and we will be using mobile as VNC viewer for controlling. VNC act as bridge for connecting the raspberry pi and mobile. Make sure that you are using same source of WIFI i.e., from router or personal hotspot for raspberry pi and mobile. VNC viewer has inbuilt keyboard as well as mouse option for working as professional desktop setup. Make sure that all pins of sensor are correctly connected to right pin of power supply (5v and GND) and raspberry pi. Code is written and then run, following thing will happen, DHT11 sensor will send the Humidity and Temperature values to the Raspberry pi in similar way when pH sensor is connected to the UART pins of the Raspberry pi the data is generated by the sensor like temperature, pH, depth and length are send to raspberry pi through serial communication when we provide it with power supply. Finally Soil Moisture sensor will send analog signals and digital signal (1 and 0), to get the accurate values we will be using MCP3008 IC which will convert analog values to digital values, hence we will be getting values range from 0 to 100.

This all values are printed in the console window every time based on the time delay given. We have written our formula for status of soil in code such that it will take parameters of the sensor and calculate the result and then display the status of the soil. If we ON the WIFI of the raspberry pi then the values will be stored in cloud, here we have used “Thing speak” cloud to visualize the values in form of graph which are provided in the output section in this report. The status of motor is sent to the authenticated owner.

B. Proposed System

Fig 9: Finding Soil Moisture

From the literature survey which we made we came across the 'MISSENARD Index' formula which later changed to 'CMM' in CLAY-MIST: IoT-cloud enabled CMM index for smart agriculture monitoring system. From the CMM index formula we made some modification as we have used more sensors than there method. Here we can get the data of soil from various sensors such as Temperature, Humidity, pH and Soil Moisture. These all are individual data, we have proposed our formula named as INDEX which will be use constant, and all sensor values in it such that there will be one single value by which we can predict the nature of soil. The values observed by the sensors are uploaded to cloud, gets analyzed and runs in parallel with the program code inputs. Furthermore, this data consistently determines the motor activity and statistic i.e ON\OFF states of the motor. Below is the formula

INDEX = ((T*A+B)-0.5*((1-H/100)*(1-SOIL/100)*(1-pH/14))*(T*A-28))

Where,

A, B are constants;

T = Temperature;

SOIL = soil moisture;

H = Humidity;

pH = PH

5. Results and Discussion

A. Project kit

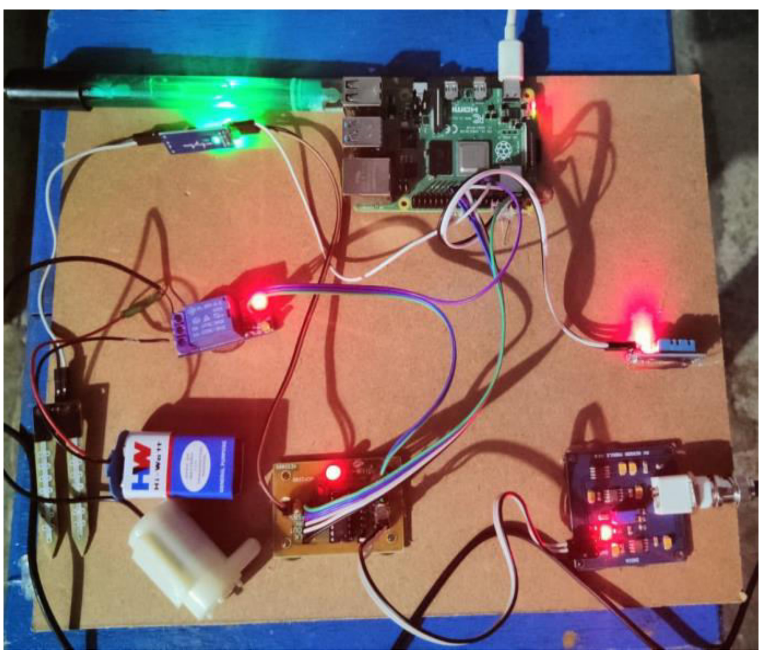

Fig 10: Project Kit

B.Thing Speak Results

All the sensed values are uploaded into Thing Speak cloud using internet. Below are the graphs taken from the Thing Speak cloud, where we can see the values of all sensor w.r.t time and date.

Field 1 Chart: Temperature
Field 2 chart: Humidity

Field 3 Chart: pH

Field 4 Chart: Soil Moisture

Field 5 Chart: Motor

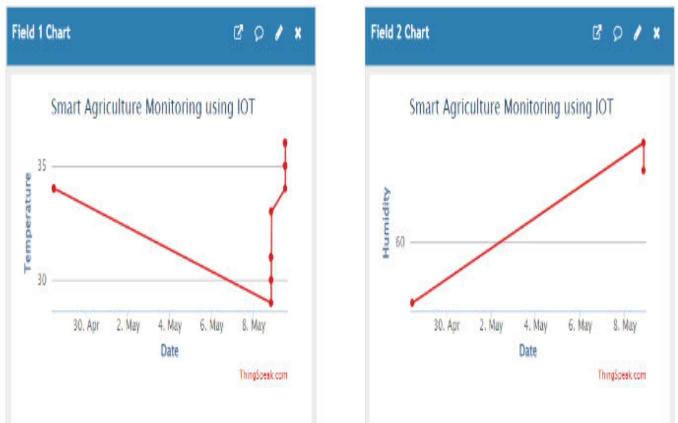

Fig. 11: Temperature and Humidity Graphs

Fig. 12: pH value and Soil Moisture Graphs

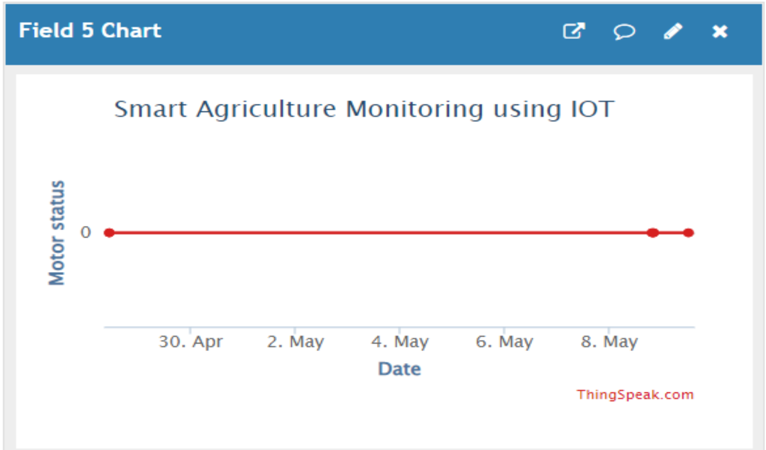

Fig. 13: Motor status Graph

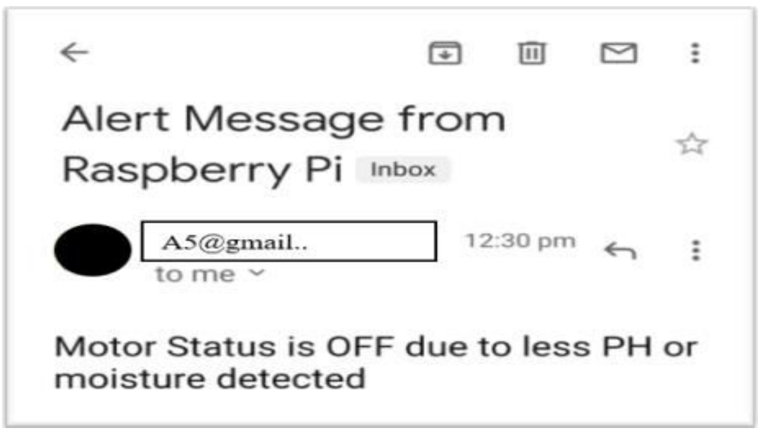

Fig.14: Alert message

6. Conclusion

In this work we have presented Measurement index for smart agriculture monitoring system to know the parameters of various fields in different locations to satisfy the particular to be grown for more yielding and making the farming lands more crop growing. As we said, prepared a module to find the various parameters of the land values. We also find a online tool to connect the module through WIFI and store the information regarding the fields and to send the information to the individual by the cloud to their mobile phones. We have created a theme ON/OFF the motor according to the measurement index values from the different sensors in our project and to give information about the status of the motor to authenticated owner through Email. Our project mainly focused on the pH value of the water to decrease the soil pollution

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7. Future Scope

Smart farming based on "IoT technologies enables growers and farmers to reduce waste and enhance productivity" ranging from the quantity of fertilizer utilized to the number of journeys the farm vehicles have made, and enabling efficient utilization of resources such as water, electricity, etc. IoT smart farming solutions is a system that is built for monitoring the crop field with the help of sensors (light, humidity, temperature, soil moisture, crop health, etc.) and automating the irrigation system. "The farmers can monitor the field conditions from anywhere". They can also select between manual and automated options for taking necessary actions based on this data. For example, if the soil moisture level decreases, the farmer can deploy sensors to start the irrigation. Smart farming is highly efficient when compared with the conventional approach. Data collected by smart agriculture sensors, in this approach of farm management, a key component are sensors, control systems, robotics, autonomous vehicles, automated hardware, variable rate technology, motion detectors, button camera, and wearable devices. This data can be used to track the state of the business in general as well as staff performance, equipment efficiency. The ability to foresee the output of production allows planning for better product distribution.

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