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Internet of Things (IoT) for Precision Agriculture Application

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***Abstract* — Internet is experiencing a very explosive growth nowadays with the amount of the devices connecting to it. Earlier we had only personal computers (PCs) and Mobile handset connected to internet but now with Internet of Things i.e. IoT concept of connecting things with internet, millions of device are connecting with it. This development of IoT leads to the idea of machine to machine communication which means that two machines can communicate to each other and also all the data which was previously with private server can now is available on internet so the user can access it remotely. Application of IoT is feasible in almost all industries particularly where speed of communication is not an issue. This paper proposes the application of cloud based IoT in the agriculture domain. Precision agriculture is basically a concept which insists to provide right amount of resources at and for exact duration of time. These resources can be any things such as water, light, pesticides etc. To implement precision agriculture the benefits of IOT has been utilized in the proposed paper. The fundamental idea is to sense all the required parameter from the agriculture field and take required decision to control the actuator. These agriculture parameters are Soil Moisture, Temperature & Relative Humidity around plant, Light intensity. Based on the reading sensed by the sensor suitable action is taken i.e. irrigation valve is actuated based on soil moisture readings, valve for fogger (for spraying water droplet) is actuated based on the Relative humidity(RH) readings etc. This paper proposed the development of the sensor node capable of measuring all these parameter and creating the actuation signal for all the actuator. On top of that sensor nodes are also capable of sending this data to cloud. An Android application is also developed in order to access all these agricultural parameter.**

Keywords— Smart Farming, Precision Agriculture, IOT, Wi-Fi, ESP8266, sensor, Node, Mobile Application

I. INTRODUCTION

Agriculture is one of the rare industries where the technology has not been accepted in the large scale, one of the reasons behind that is the economic condition of most of the farmers in India or any developing country. The scarcity of the agricultural products worldwide is going to increase day by day due to two major factors i.e. overpopulation and urbanization. With overpopulation overall demand of agricultural product will increase urbanization has lead to process where lots of agricultural land is being converted into Non-Agricultural field (NA) for the infrastructure development near the urban areas. Basically the rural area is decreasing quite significantly day by day and the amount of farming is also decreasing which may results in decrease in agriculture production. Now to overcome this situation world has only solution is to increase crop productivity by utilizing the resources very judiciously. The wastage of available resources has to be decreased, there comes the concept of precision agriculture. Precision agriculture is an approach in which the agricultural crops are fed with the optimum amount of resources required by the crop for exact duration of time. Traditional irrigation process has a typical time based watering (irrigation) practice in which farmer used to irrigate the crop after certain amount of time (typically few days). But problem with this approach is that sometimes that crop doesn't need water so early so ultimately that leads to wastage of water and sometimes crops needs water a bit early. So to overcome such issue this paper presents a soil moisture detection sensor to get soil moisture content so that crop can be irrigated accordingly. This also helps in preventing the over irrigation because apart from water wastage over irrigation can sometimes leads to diseases in crop. Like soil moisture, Temperature and Relative humidity along with light illumination around the plant is also key parameter to control.

Soil moisture is important for the physical structural strength of plant while temperature (heat), humidity (water molecule) and the light is required for photosynthesis process. Temperature control in green house environment is extremely important because crops grows optimal if we can provide them temperature in specific range for certain amount of time i.e. During Summer crops normally grows with highest efficiency at 75 to 85 degree F with presence of day light and 60 to 75 degree F at night. When environment is bit cloudy then it requires bit lower temperature. If we talk about winter then during that period of time outside air temperature is always on lower side so if temperature drops very low then it can damage plant leaves. During daylight of winter temperature should not exceeds 70 degree F. All the above comments of effect on the temperature are generic. Specifically most of the cool weather crops such as lettuce and broccoli find it easier to grow best at 50 degree during

night time and 60 to 65 degree F in day time. Summer crops like squash and tomato needs 55 degree F minimum at night to grow and on other side it requires 65 degree F during day time. Most importantly the temperature shouldn't go above 80 degree F for such crop for optimum production. In order to maintain the strength of woody tissue in plant stem, air circulation has to be controlled. This also helps in degreasing the opportunity for fungi in crop. So to get best possible output all these parameter has to be controlled. Relative Humidity around the crop is key parameter for not only the growth of food in the plant but also for strength of the plant structure. Generally Relative humidity around the plant should remain in range of 70 to 85 degree during high growth period. Ornamental crops grow healthier and attractive with supplemental light. The amount of luminous is very important for the photosynthesis process.

This paper proposed the development of sensor node which is capable of generating control signal for any actuator and simultaneously sending data to the cloud. All data from sensor node is sent to things speak cloud. A mobile application has been developed to visualize the data in a smart phone.

II. LITERATURE SURVEY

The paper [1] discusses possible solution in reduction of transport cost for agricultural products, also predicts the prices of crop based on past information and present market scenario. It also gives a solution of reducing middle mans who normally tends to get more profit share than producers and consumers. This solution helps to bridge a communication gap between farmers and agricultural product buyer.

In paper [2], author explains the need of wireless sensor network in the agricultural field so as to increase the productivity. Author also explains the need of precision agriculture in current scenario of agriculture particularly in India. This paper [2] shows the architecture for analyzing and monitoring of the environment parameters.

The paper [3] suggests the scope of IoT in the domain of agriculture. It also shows the various layers of market for agricultural product and how IoT can be applied at different layer. It also shows all the existing technology which can be handy while thinking of IoT for agriculture.

The proposed system in paper [4] is the analysis of the usage of system on chip (SoC) in WSN while controlling and monitoring greenhouse parameter. The author also discusses the evolution in wireless network and the development of typical sensor node that include I/O interface, memory, processor, transreceiver and battery along with sensors.

The agricultural monitoring system with remote controlled using GPS. The basic aim of using GPS is to monitor and automate irrigation using data sensed at sensor node and transferred the data using RS232 from sensor node to central control station having PIC 16F877A controller. The system is also having the capacity of human or animal intrusion detection.

This paper [6] is an article which suggests standardized internetworking interface and its procedures depending on one M2M worldwide standard. Authors present 1 M2M High level Functional internetworking architecture and test it with different vertical configuration. Author has also considered most possible potential threat of latency or connectivity losses in the network.

The proposed system in paper [7] has majorly the capacity of monitoring light intensity around the crop and storing data in a database so as to compare and analysis it further. It is very convenient in taking optimum decision within the given time using the database of the field parameter. The system in the paper has only targeted the light intensity as their only parameter from the agricultural field to control.

The authors in paper [8] try to solve the problem in the crops due to unequal rain distribution by controlling the environment parameter i.e. soil ph and moisture. An Arduino is used as a controlling unit. It controls the process along with communication process as well.

The technological constraint and challenges which have to cater while deployment of IoT based low scale pilot project in agriculture domain is outlined in paper [9]. This paper states a conceptual idea for all the stages of agricultural products namely food production, processing, distribution and the retail market.

The author has presented semantically improved digital farming with the help of use case Phenonet with IoT platform which is an open platform in paper [10]. They have also developed and demonstrated interoperability of this platform in addressing the technological challenges faced by application.

The system capable of identifying rodents in grains stores is designed in paper [11]. The system in this paper is also capable of acquiring data and analyzing data. The PIR sensor, ultrasonic ranging device, web camera and ultra sound repeller are used as the sources of data. Along with it, it also used Raspberry pie as data gateway in the system.

The paper [12] presents a system termed PATRIOT which depicts the gradual and feasible development and implementation of Internet of the thing in the domain of Agriculture. It emphasis on the concept accessing data in anytime and from anywhere using IoT.

III. PROPOSED WORK

The Fundamental concept of work is expressed in Fig. 1 which consists of various components namely humidity & temperature sensor, Soil Moisture sensor, Microcontroller unit (MCU) along with WiFi module, wifi router, thingspeak cloud and finally the mobile app. Soil moisture measurement is done by using YL – 69 electrode. There are two terminal in electrode between which the resistance is measured. With change in the soil moisture the

resistance between this two point changes. So this change in moisture is the measure of amount of moisture in the soil. YL – 38 is a chip which is used in the proposed work to convert change in resistance into analog voltage. It is fed with 3.3 v supply so it gives output from 0 to 3.3 v. Output of this chip is fed to MCU unit as shown in figure. It has also got a Digital output pin using which actuator signal can be generated locally. Set point is adjusted using onchip potentiometer. DHT 11 is used to sense relative humidity and temperature of surrounding atmosphere.

DHT 11 is a single device with having both humidity sensor and temperature. It sense humidity using capacitive sensing technology and senses temperature using thermistor embedded inside the small cabinet. It gives output in digital pulse form so it is connected to the digital input of MCU. As this sensor gives data in pulse form, data gets updated every 2 sec, but the targeted process in the proposed paper is very slow so it is not an issue for us.

NodeMCU is a microcontroller unit which is used as an MCU in the proposed system. It is a development prototyping kit based on ESP8266. Apart from GPIOs, it also comes with PWM capability, an ADC for the analog input all in the single board. It is actually an open source platform for development of IoT application. It also has firmware which help in running the WiFi SOC based on ESP8266. NodeMCU basically collects the data from all above mentioned sensor at its GPIO pins. Data from DHT11 is given at GPIO 0 of NodeMCU while analog data from soil moisture is given at analog input of NodeMCU which got 10 bit inbuilt ADC. It converts 0 to 3.3v analog signal to 0 to 1023 count. Soil moisture data is mapped into the percent value so that it can be interpreted well. Arduino IDE software is used to do programming of the MCU. It is again a platform which is utilize to program such prototype board. For testing purpose wifi hotspot tethering of the cell phone is used as a wifi router. SSID and passwords are used while coding the board so that board can connect to the internet using hotspot tethering of cell phone.

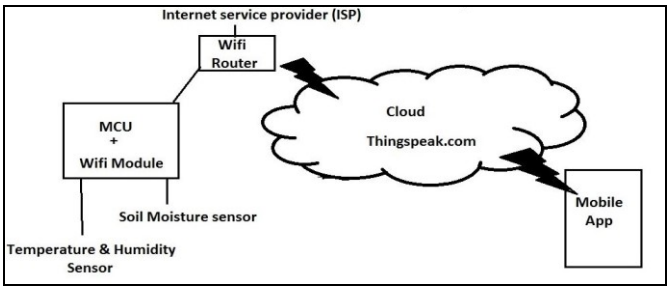

Fig. 1 Block diagram of proposed system

Thingspeak is used as a cloud for the proposed work in the paper. It is actually an IoT platform for analytics service which helps you store, visualize and analyze as well. It allows real time visualization of our data to thingspeak. Channel is created in thingspeak in which we can visualize our data. Inside the channel, 3 fields are created to visualize the data namely Temperature, Relative humidity and the soil moisture. An API key is generated with the channel which is also used while coding the board. Three analog value has been sent to that field where we have graphical presentation of the information. The very basic mobile application is developed for the prototype. App inventor tool is used to develop the mobile app. It is a cloud based tool which allows us to build app in the web browser itself.

IV. Results and Observations

In the proposed work the output of the proposed work is actually visualized in the thingspeak platform. The graphical representation of the data sense at the agricultural field is given in the Charts. The temperature of the surrounding environment obtained at thingspeak is shown in Fig. 2, similarly Relative humidity and the soil moisture sensor data are as shown in Fig.3 and Fig. 4.

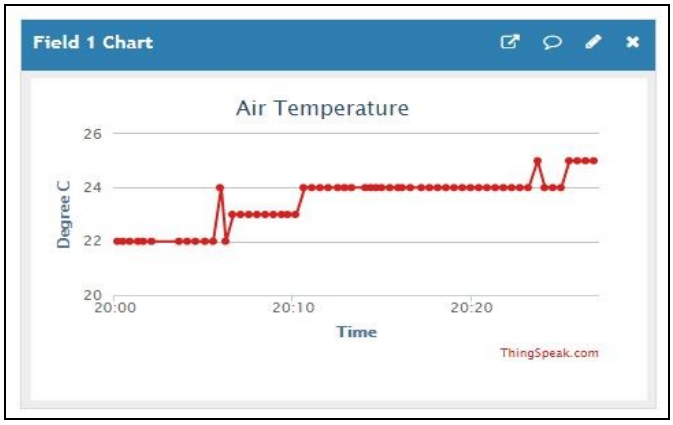

Fig.2 Surrounding Air Temperature

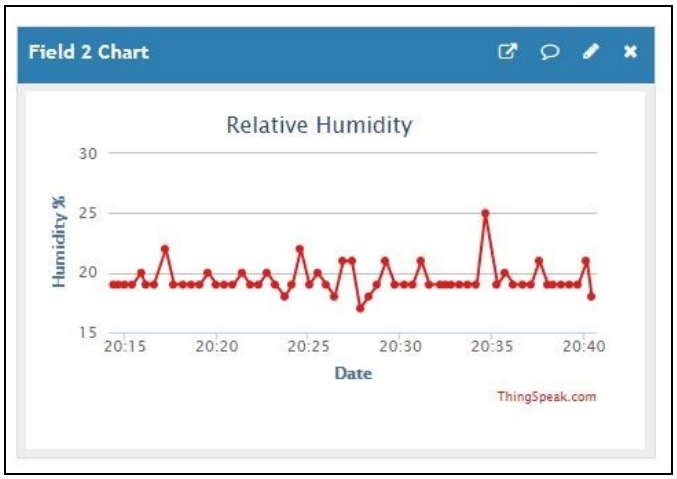

Fig. 3 Surrounding Air Relative Humidity

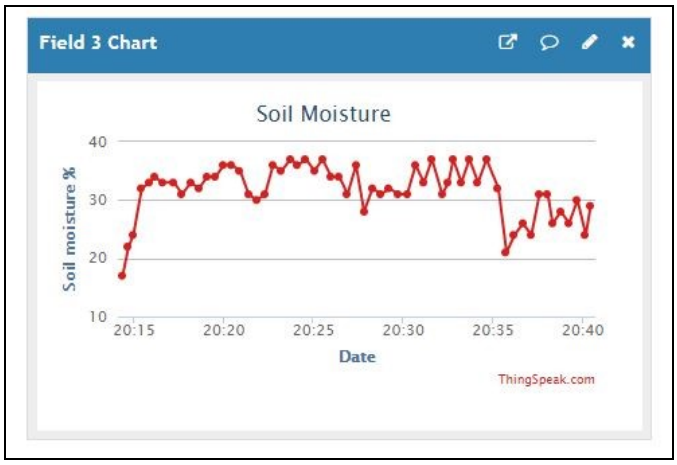

Fig. 4 Soil Moisture reading

As discussed earlier the mobile application has been created to visualize the data in the cell phone. The data from thingspeak cloud has been exported using the api key and URL for feed status is used for each field of particular channel. Field 1, Field 2 and field 3 shows the graphical representation of surrounding air temperature, Humidity and soil moisture sensor readings. All the data are exported to mobile application as shown in Fig. 5.

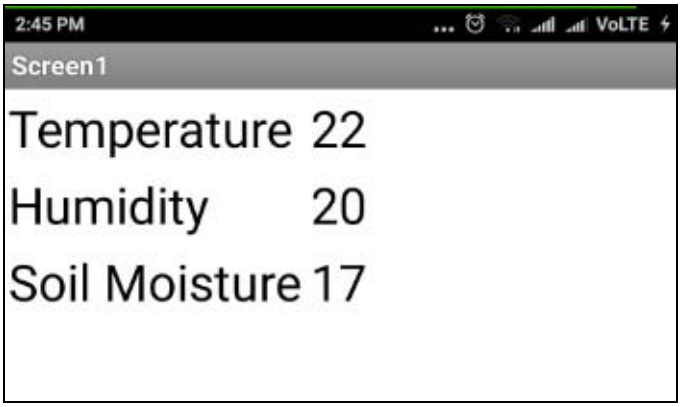

Fig. 5 Screenshot of Mobile Application

V. Conclusion and Future Scope

An electronics system has been proposed that includes a sensor node along with the IOT application in the domain of agriculture. The proposed system is capable of sensing data and controlling the parameter locally, simultaneously it sends data to the thingspeak cloud which further is accesed by the user in the mobile phone. In future this work can be carried out by improving the usage of mobile app like adding alarms if particular parameter is not controlled properly. In the proposed system set point for relative humidity, soil moisture and surrounding temperature is mention during coding of the MCU now to make this prototype more practical these control of setting the set point can be given to the mobile app itself.

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