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IoT based Precision Agriculture

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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

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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 duringnight time and 60 to 65 degree F in day time. Summer cropslike squash and tomato needs 55 degree F minimum at nightto grow and on other side it requires 65 degree F during daytime. Most importantly the temperature shouldn't go above80 degree F for such crop for optimum production. In orderto maintain the strength of woody tissue in plant stem, aircirculation has to be controlled. This also helps in degreasingthe opportunity for fungi in crop. So to get best possibleoutput all these parameter has to be controlled. RelativeHumidity around the crop is key parameter for not only thegrowth of food in the plant but also for strength of the plantstructure. Generally Relative humidity around the plantshould remain in range of 70 to 85 degree during highgrowth period. Ornamental crops grow healthier andattractive with supplemental light. The amount of luminousis very important for the photosynthesis process.

This paper proposed the development of sensornode which is capable of generating control signal for anyactuator and simultaneously sending data to the cloud. Alldata from sensor node is sent to things speak cloud. A mobileapplication has been developed to visualize the data in a smart phone.

II. LITERATURE SURVEY

The paper [1] discusses possible solution inreduction of transport cost for agricultural products, alsopredicts the prices of crop based on past information andpresent market scenario. It also gives a solution of reducingmiddle mans who normally tends to get more profit sharethan producers and consumers. This

solution helps to bridgea communication gap between farmers and agriculturalproduct buyer.In paper [2], author explains the need of wirelesssensor network in the agricultural field so as to increase theproductivity. Author also explains the need of precision agriculture in current scenario of agriculture particularly inIndia. This paper [2] shows the architecture for analyzingand monitoring of the environment parameters.

The paper [3] suggests the scope of IoT in the domain of agriculture. It also shows the various layers ofmarket for agricultural product and how IoT can be appliedat different layer. It also shows all the existing technologywhich 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 controllingand monitoring greenhouse parameter. The author alsodiscusses the evolution in wireless network and thedevelopment of typical sensor node that include I/Ointerface, memory, processor, transreceiver and battery alongwith sensors. The agricultural monitoring system with remotecontrolled using GPS. The basic aim of using GPS is tomonitor and automate irrigation using data sensed at sensornode and transferred the data using RS232 from sensor nodeto central control station having PIC 16F877A controller.The system is also having the capacity of human or animalintrusion detection.This paper [6] is an article which suggests standardized internetworking interface and its proceduresdepending on one M2M worldwide standard. Authorspresent 1 M2M High level Functional internetworkingarchitecture and test it with different vertical configuration.Author has also considered most possible potential threat oflatency or connectivity losses in the network.

The proposed system in paper [7] has majorly thecapacity of monitoring light intensity around the crop andstoring data in a database so as to compare and analysis itfurther. It is very convenient in taking optimum decisionwithin the given time using the database of the fieldparameter. The system in the paper has only targeted thelight intensity as their only parameter from the agriculturalfield to control.The authors in paper [8] try to solve the problem inthe crops due to unequal rain distribution by controlling theenvironment parameter i.e. soil ph and moisture. AnArduino is used as a controlling unit. It controls the process along with communication process as well.

The technological constraint and challenges whichhave to cater while deployment of IoT based low scale pilotproject in agriculture domain is outlined in paper [9]. Thispaper 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 improveddigital farming with the help of use case Phenonet with IoTplatform which is an open platform in paper [10]. They havealso developed and demonstrated interoperability of thisplatform in addressing the technological challenges faced by application.

The system capable of identifying rodents in grainsstores is designed in paper [11]. The system in this paper isalso capable of acquiring data and analyzing data. The PIRsensor, ultrasonic ranging device, web camera and ultrasound repeller are used as the sources of data. Along with it,it also used Raspberry pie as data gateway in the system. The aper [12] presents a system termed PATRIOTwhich depicts the gradual and feasible development and implementation of Internet of the thing in the domain ofAgriculture. It emphasis on the concept accessing data inanytime and from anywhere using IoT.

III. PROPOSED WORK

The Fundamental concept of work is expressed in Fig. 1 which consists of various components namelyhumidity &temperature sensor, Soil Moisture sensor,Microcontroller unit (MCU) along with WiFi module, wifirouter, thingspeak cloud and finally the mobile app. Soilmoisture measurement is done by using YL – 69 electrode.There are two terminal in

electrode between which theresistance is measured. With change in the soil moisture theresistance between this two point changes. So this change inmoisture 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 vsupply 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 Digitaloutput pin using which actuator signal can be generated locally. Set point is adjusted using onchip potentiometer.

DHT11 is used to sense relative humidity and temperature ofsurrounding atmosphere.DHT 11 is a single device with having both humiditysensor and temperature. It sense humidity using capacitivesensing technology and senses temperature using thermistorembedded inside the small cabinet. It gives output in digitalpulse form so it is connected to the digital input of MCU. Asthis sensor gives data in pulse form, data gets updated every 2sec, but the targeted process in the proposed paper is veryslow so it is not an issue for us.

NodeMCU is a microcontroller unit which is used asan MCU in the proposed system. It is a developmentprototyping kit based on ESP8266. Apart from GPIOs, it alsocomes with PWM capability, an ADC for the analog input allin the single board. It is actually an open source platform fordevelopment of IoT application. It also has firmware whichhelp in running the WiFi SOC based on ESP8266. NodeMCUbasically collects the data from all above mentioned sensor atits GPIO pins. Data from DHT11 is given at GPIO 0 ofNodeMCU while analog data from soil moisture is given atanalog input of NodeMCU which got 10 bit inbuilt ADC. Itconverts 0 to 3.3v analog signal to 0 to 1023 count. Soilmoisture data is mapped into the percent value so that it can beinterpreted well. Arduino IDE software is used to doprogramming of the MCU. It is again a platform which isutilize to program such prototype board. For testing purposewifi hotspot tethering of the cell phone is used as a wifi router.SSID and passwords are used while coding the board so thatboard can connect to the internet using hotspot tethering ofcell phone.

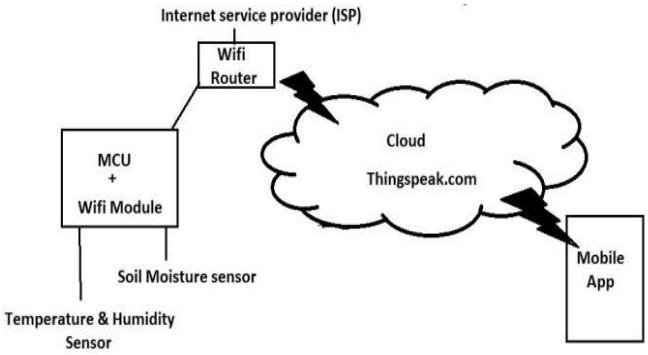

Fig. 1 Block diagram of proposed system

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

IV. RESULTS AND OBSERVATIONS

In the proposed work the output of the proposed workis actually visualized in the thingspeak platform. The graphicalrepresentation of the data sense at the agricultural field isgiven in the Charts. The temperature of the surroundingenvironment obtained at thingspeak is shown in Fig. 2,similarly Relative humidity and the soil moisture sensor dataare as shown in Fig.3 and Fig. 4.

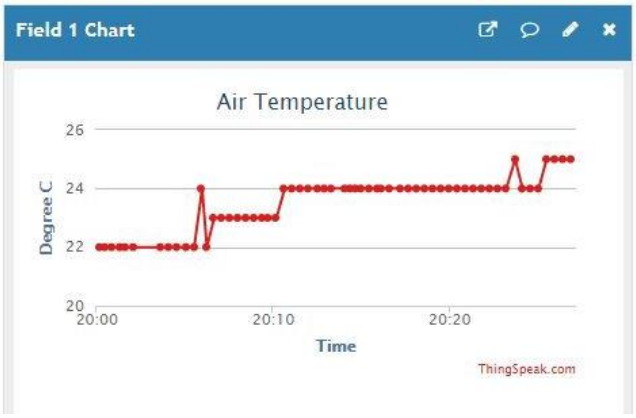

Fig.2 Surrounding Air Temperature

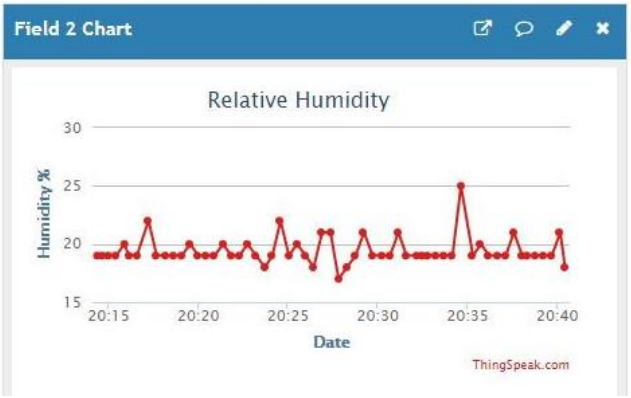

Fig. 3 Surrounding Air Relative Humidity

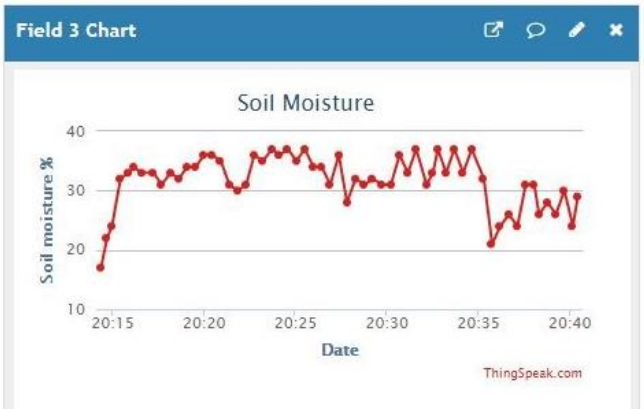

Fig. 4 Soil Moisture reading

As discussed earlier the mobile application has beencreated to visualize the data in the cell phone. The data fromthingspeak cloud has been exported using the api key andURL for feed status is used for each field of particularchannel. Field 1, Field 2 and field 3 shows the graphicalrepresentation of surrounding air temperature, Humidity andsoil moisture sensor readings. All the data are exported tomobile application as shown in Fig. 5.

Fig. 5 Screenshot of Mobile Application

V. CONCLUSION AND FUTURE SCOPE

An electronics system has been proposed thatincludes a sensor node along with the IOT application in thedomain of agriculture. The proposed system is capable ofsensing data and controlling the parameter locally,simultaneously it sends data to the thingspeak cloud whichfurther is accessed by the user in the mobile phone. In futurethis work can be carried out by improving the usage of mobileapp like adding alarms if particular parameter is not controlledproperly. In the proposed system set point for relativehumidity, soil moisture and surrounding temperature ismention during coding of the MCU now to make thisprototype more practical these control of setting the set pointcan be given to the mobile app itself.

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