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Smart monitoring and controlling for precision agriculture using IoT

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***Abstract*—Monitoring and controlling the agriculture field parameters plays an important role in crop production and management. In many areas water is wasted while watering plants. At present there is scarcity water and we should know how to use the available water in an efficient way. Plants are immobile and some of the environmental conditions such as soil water content, air temperature and soil temperature affect the soil quality and thus the crop yield. High level sensing systems are needed to optimize the water usage and reduce spreading of diseases. Storage of information and its processing and management makes precision agriculture more efficient.**

IoT based sensing systems have improved capabilities to accurately monitor the environmental conditions. Automatic irrigation is the best way to optimize the usage of water in crops. In addition, gateway is also used control the sensor values and transmits these values to a user. The gateway is programmed based on the threshold of the sensor, by which when the sensed value raises above the threshold a corresponding action take place. This system is cost effective and will provide productive management in farming.

Keywords—soil moisture, precision agriculture, Internet of Things(IoT), raspberry pi 3.

I. INTRODUCTION

Agriculture is the main source of economy in our country. Water is the most essential resource needed for agriculture. Farmers mainly depend on rain water for irrigation process and other needs in the farmland. Now a days the climatic changes and improper usage of water resources have resulted in water scarcity throughout the country. Lack of rains, unplanned use of water, and carelessness leads to scarcity of water. Here the system introduces techniques to optimize the usage of water for agricultural uses. The modern irrigation techniques such as drip irrigation by calculating the required amount of water for various crops, finding the water retaining capacity of soil, soil moisture measurement is used here.

A. Overview

In manual irrigation methods large amount of water is wasted in unwanted areas, this is overcome in modern irrigation. Water is the essential resource that is needed by all living beings. So it is necessary to check the usage of water and save the water for the future generation. Rain is an important source of water which contributes to deposit a large fraction of fresh water on the earth. In the field of agriculture, use of proper methods of irrigation is important and it is well known that drip irrigation is very economical and efficient. In future global crop demand is expected to double, this requires crop productivity increase 2.4% annually, but according to current situation there is only an increase of 1.3% annually. Some of the main reasons for this low production are unplanned water supply and diseases caused due to unexpected environmental conditions. Plants are stable they are affected by the water content in the soil and surrounding environmental conditions.

Recently many WSN (Wireless Sensor Network) systems are developed all over the world but ancient systems do not have a standard way of data discovery, accessing and sharing. Precision agriculture (PA) is one way to increase the crop productivity and also a cost effective method. In this system main aim is to increase the crop productivity through remote monitoring and proper planning of field conditions. Monitoring and controlling the environmental conditions such as soil moisture, temperature, humidity, wind speed, wind direction, leaf wetness values are very useful for decision making to increase the demand of crop. The data from the field is mainly used for saving water and monitoring the field without human aid. Soil moisture sensor and temperature sensor will continuously sense the field information regarding soil humidity and temperature. So, the farmer can easily monitor the agriculture land from remote places. PA (Precision Agriculture) is a set of techniques which

provides a suitable solution for increasing crop production and its main aim is to optimize the field-level management. Use of proper communication technologies is one concern in acquiring information about the crops in the field.

One main reason for loss in crop production is unexpected climatic conditions; nowadays seasons vary unexpectedly, this affects majority of fields and production. One method to avoid this problem and protect crops is by predicting the future environmental conditions which cause the spread of diseases. This predicting method is available for urban areas but our aim is to design a low cost device that can be used in rural area also. In recent years sensor involvement in agricultural field for water monitoring and management is raised. The real time data from the field is useful for farmers because farmers can form the crop planning strategies at any time. This system achieves interoperability which is a new method for integrating different systems to obtain better results.

Water scarcity is one big problem for agriculture sector. In the conventional drip irrigation system, based on the irrigation timetable the farmer knows the different crop condition in different climatic conditions. The automatic irrigation is done in this project. With use the low cost sensors and the easy design to make the project at a low cost product, which can be bought by a poor farmer. This method is well suited for areas where water is scares and places where water is to be used at very low level. Monitoring the environmental conditions such as moisture, temperature, wetness level based on this data controlling is done. Normally in the farmland with a water pump, if the land needs water farmer manually turn on/off the motor pump. In our method, we reduce the man intervention and automatic irrigation is done. The name precision implies that it accurately watches the growing of crop and it monitors the amount of water and fertilizer delivery. Here we used trending technology internet of things (IoT) it offers advanced connectivity device systems& services that goes beyond machine to machine communication and covers variety of protocols.

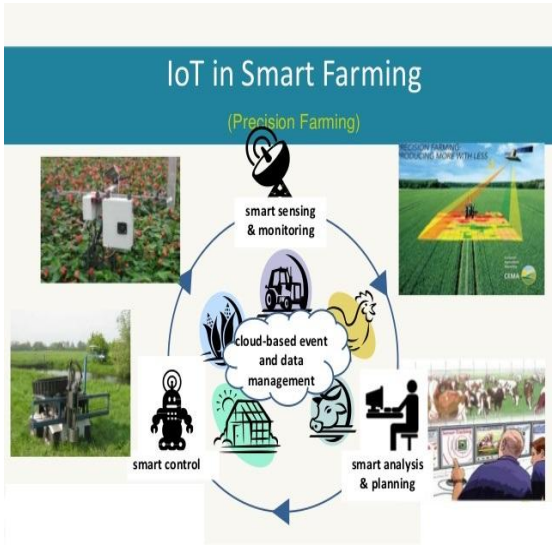

Fig.1. *Farming based on IoT*

The term Internet of Things was first discovered by Kevin Ashton in 1999. Recently our world is running one click, the IoT satisfies this dream is comes true. IoT is a network that is able to link physical and virtual objects between 2 devices. The impact of the "Internet of Things revolution" from makes the new opportunities and business models to concerns about security, privacy. For consumers new IoT products such as Internet enable appliances, home automation components monitoring components and energy management devices it makes the smart world.

II. COMPONENTS USED

HARDWARE:

- Soil moisture sensor
- Temperature sensor
- Raspberry pi 3(model B)
- Relay
- DC motor
- Fertilizer tank

SOFTWARE:

- Python

A. Soil Moisture Sensor

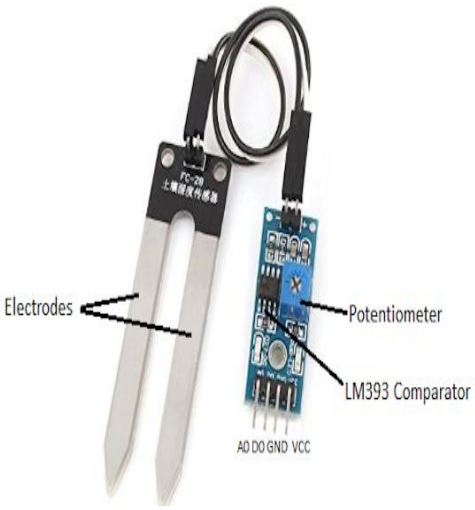

Fig.2.1. *Diagram of soil moisture sensor*

Pin Details:

A0- Analog output

D0- Digital output

GND-ground

VCC- Supply

The sensor gives analog output of zero volt when there is 100% moisture and 5V for 0% moisture and analog output more accurate.

B. Temperature Sensor

This sensor belongs to LM 35 series, which is precision integrated temperature sensor, whose output voltage is linearly proportional to the centigrade temperature. Generally LM 35 series gives temperature in the range of -55 to +150°C but our sensor gives output from 2 to 150°C.

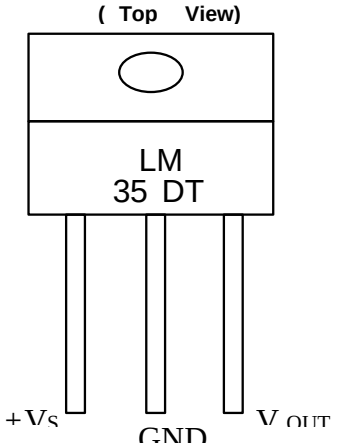

Fig.2.2. *Pin diagram of temperature sensor*

C. Raspberry Pi 3 Model B

- Broadcom BCM2837 64bit ARMv7 Quad Core Processor powered Single Board Computer running at 1.2GHz
- 1GB RAM
- BCM43143 Wi-Fi on board
- Bluetooth Low Energy (BLE) on board
- 40pin extended GPIO
- 4 x USB 2 ports 4 pole Stereo output and Composite video port
- Full size HDMI
- CSI camera port for connecting the Raspberry Pi camera
- DSI display port for connecting the Raspberry Pi touch screen display
- Micro SD port for loading your operating system and storing data
- Upgraded switched Micro USB power source (now supports up to 2.4Amps)
- Expected to have the same form factor has the Pi 2 Model B, however the LEDs will change position

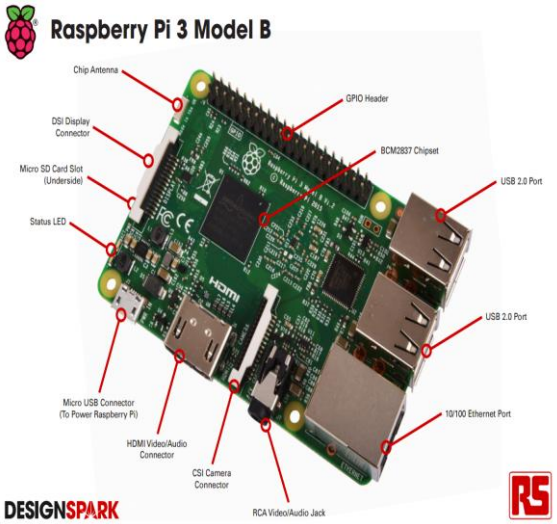

Fig.2.3. *Raspberry pi kit*

D. DC Motor

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a

set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC.In a single L293D chip there are two h-Bridge circuit inside the IC which can rotate two dc motor independently. H-bridge is a circuit which allows the voltage to be flown in either direction. H-bridge IC are ideal for driving a DC motor. Due its size it is very much used in robotic application for controlling DC motors.

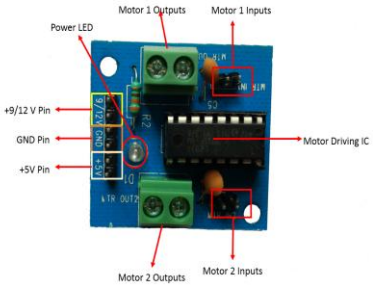

Fig. 2.3. *Motor driver*

III. BLOCK DIAGRAM

In each blocks work their specifications finally all data send to the mobile via internet. Here raspberry pi act as a gateway based on the sensing values required actions are taken. Sensors are connected to the gateway so sensors gives a field data continuously this will take a decisions precisely.

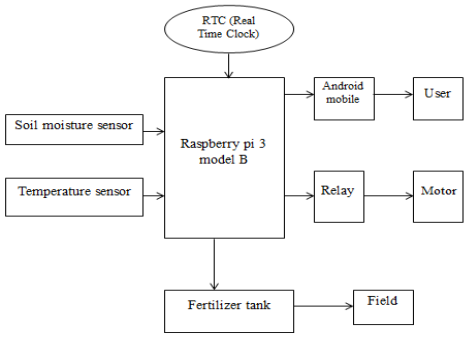

Fig.3.1. *Block diagram of the monitoring system*

A. Block Diagram Explanation

The working of the system is as follows: Raspberry pi 3 model B is interfaced with soil moisture sensor, Temperature sensor and motor. Connect the gateway in power supply green light will be glows on the kit now kit is working condition. Raspberry pi 3 connected to the soil moisture sensor; based on the moisture level automatically motor will be on/ off. The programming is done by python software, based on threshold values corresponding actions are taken.

When the soil is moisturized and soil moisture sensor senses moisture presence it keeps the pump off and when it senses absence of moisture it switches on the pump and supply water to field. Then we need to continuously monitors the sensors and based on that we can take some actions.

It supplies water until it again senses the presence of moisture, once it senses moisture it switches of the pump. The real time data from the sensors are very useful for future farming process and automatic irrigation is done this is much useful method for famers in remote areas. The fertilizer tank provides the fertilizer on demand. Motor working status is continuously sent to the android mobile for the user via internet. Using solar panel for power supply purpose reduce the battery need.

B. Flowchart

Algorithm

It states the steps that the proposed system undergoes.

Step 1: Start the process.

Step 2: Initialize the sensors

Step 3: Check the moisture level (less than or more than).

Step 4: If the level will be more than a threshold value, no need to irrigation

Step 5: If Moisture level is less than a fixed criteria, start irrigation

Step 6: Pump will be automatically on.

Step 7: After the process completed, it moves to original state.

Step 8: Stop the process.

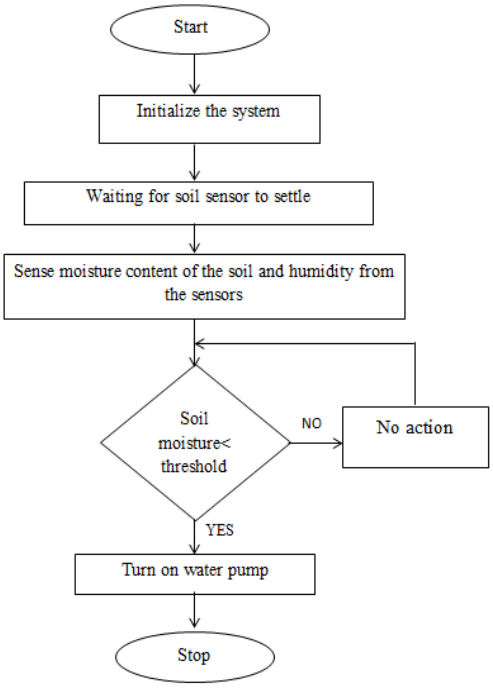

Fig.3.2. Flow chart

C. Results

In figure 3.3 is experimental setup of the monitoring system it senses the real time data and these data are transferred to the gateway unit, this gateway unit handles the information about the sensors. A software application was developed by predetermining the threshold values of moisture content in soil and temperature level was programmed into the raspberry pi. This system optimizes the usage of water quantity. The sensing data is send to the gateway these values are stored in cloud storage and enable the Wi-Fi in to the kit so the values are send to the user mobile phone through internet.

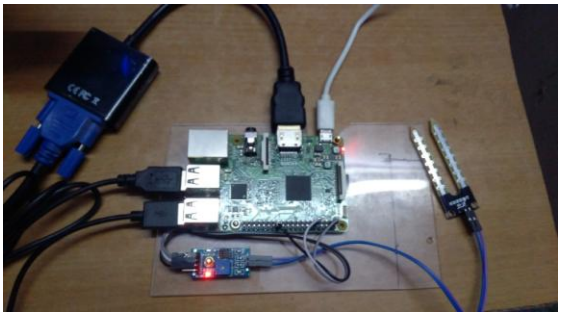

Fig.3.3. *Experimental setup*

In fig.3.4 display window in raspberry kit it gives a details about the motor condition.

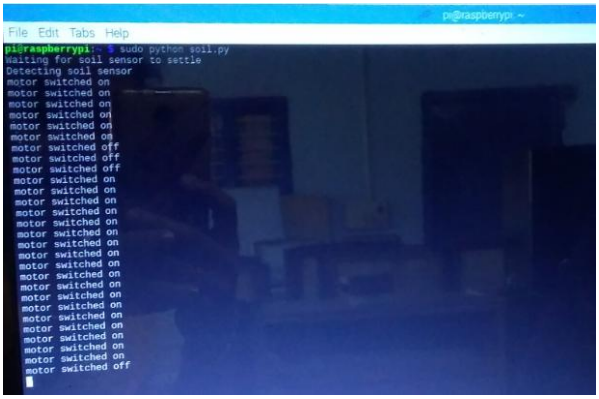

Fig.3.4. *Output*

Ranges of soil moisture and temperature:

RH- 20%- 98%
Temperature- 10^{o}C-45^{o}C

IV. CONCLUSION

The automatic irrigation monitoring and controlling system for agricultural field is implemented and is found to be very feasible and cost effective. The system is very economical in terms of hardware components. The system helps in saving water and electricity and can be implemented in large agricultural areas. Based on IoT technology user can view the status of the motor action. This system reduces the labour problem and eliminates manpower. System can be switched into manual mode whenever required. It is very useful in all climatic conditions and all types of farming. Decision making is easy for monitoring the environmental parameters while using sensors. Precision agriculture is a very effective way of integrating the different sensors. Monitoring the field parameters helps to optimize the use of water. Agricultural monitoring is one of the WSN applications with important benefits to the farmers. The environmental conditions such as soil humidity and temperature should be monitored continuously and controlled in order to provide optimal crop conditions. By gathering the data from sensor nodes we are able to take the better decisions for further processes. For precision agriculture the real time data enable product growth and take appropriate management measures such as remote control for drip irrigation.

This system is designed in order to improve the quality of agricultural production and would decrease the management and farming costs.

The hardware components used in this system is cheap, easy to use and efficient, but all of these components are chosen carefully in order to give optimal solutions. In this monitoring system, it is better to choose higher efficiency communication protocols and power devices. This paper increases the crop productivity and quality. In future by using IR sensors any objects passing into fields can be detected and alerted. Solar panels can be used because agricultural field is an open area where high intensity of sun light is available, thus reducing the power supply need. Addition of leaf wetness sensor for determining disease level and avoiding it in an early stage can increase the crop production.

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