Soil Moisture Monitoring using Capacitive Sensor for Controlled Irrigation

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Abstract

Aim of this work is to observe the interaction between soil moisture and germination of crops. Requirement of water by crops basically depends upon meteorological conditions and different soil factors. Water content or moisture content is the quantity of water contained in a material such as soil, rock or wood. In this system soil moisture is measured by capacitive measurement, using capacitive sensor of sunrom technologies. Results indicate that germination mainly depends upon soil moisture and is a function of soil moisture.

Keywords : *Soil Moisture, Dielectric Constant, Capacitive Technique*

I. INTRODUCTION

Agriculture is the backbone of all the countries throughout the world. In the remote areas and inadequate rainfall areas it is necessary to supply stored water to the fields. The process of artificially supplying water to the cultivated land is called as irrigation. In traditional methods like watering from a tank, hand pumps and canal water there are drawbacks like under irrigation, over-irrigation that causes damage to crops and reduces the yield. Due to less manpower it is essential to operate field irrigation automatically.

Objective of this study is to increase the crop yield under different climatic conditions. An automatic irrigation system is developed using capacitive moisture sensor and ZigBee technology.

Soil moisture can be measured using different methods. Varieties of commercial instruments are available for measurement of soil moisture. The drought and hot weather conditions increases the water requirement. For getting maximum yield, adequate soil moisture throughout the crop growing season is important. Water supply should be enough to keep the soil moisture in such a way that it should not be very less or it should not be over irrigated. Frequent cultivation damages the texture of soil.

Different methods of soil moisture measurement:

1] Gravimetric Technique
2] Radioactive Technique
3] Capacitive Technique
4] Conductivity Technique
5] Soil Suction Technique

In this paper Capacitive Technique for soil moisture measurement is used.

II. RESEARCH METHOD

A. *Sensor Used*

Capacitive sensor of Sunrom technology for measurement of soil moisture is used.

The sensor has a low power requirement and very high resolution. This gives ability to make many measurements over a long period of time with minimal battery usage. In addition, the sensor incorporate a high frequency oscillation, which allows the sensor to accurately measure soil moisture in any soil with minimal salinity and textural effects

The sensor measures dielectric constant of soil in order to find its moisture content. It obtains soil moisture by measuring the dielectric constant of the media through the utilization of frequency domain technology. As soil moisture changes, capacitance changes. Dielectric constant of water is much higher than that of air or soil minerals, dielectric constant of soil is a sensitive measure of water content in soil.

B. *Measurement of Moisture Using Capacitive Sensor*

Block Diagram

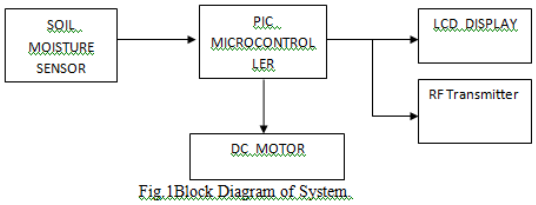

Fig 1Block Diagram of System

On the transmitter side sensor senses soil moisture using capacitive technique. As soil moisture changes, dielectric constant changes and this changes capacitance. As capacitance changes, frequency changes. Frequency to voltage converter is used that gives output in digital form. Output is given to a PIC microcontroller which gives moisture readings in

centibars. It is displayed using LCD display. A feedback is given to the system on receiver side which controls water requirement to field using wireless technique. Whenever moisture increases above a certain level watering to the field is stopped automatically using ZigBee wireless technology. As water content of soil changes, capacitance of soil also changes. This change in capacitance is sensed by capacitive sensor. It gives the digital output which is directly proportional to the capacitance of soil.

The RF Module ZigBee:

ZigBee, the RF module is heart of the Wireless Sensor Node. ZigBee is a wireless transceiver supporting the IEEE 802.15.4 protocol. Data may be sent to individual nodes (point-to-point), or to all nodes in range (point-to-multipoint) using a broadcast address.

Here ZigBee is used to control on and off action of DC Motor remotely. When moisture level increases above the upper limit, command is given to DC Motor through ZigBee that will stop watering to the field. On the other side when moisture level goes below lower limit command is given to DC Motor to start watering through a relay that operates wirelessly.

Figure 2. RF Module The ZigBee.

The complete experimental set up:

Fig.3.Experimental Setup Transmitter Side

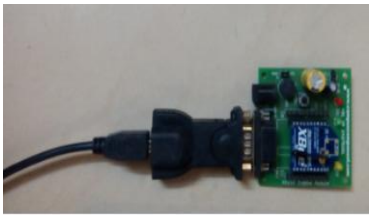

Fig.4.Experimental Setup Receiver Side

Experiment is carried out using three pots. Conditions of the three pots are selected accordingly.

1] Pot 1 is kept inside house, so that it should not get sunlight at all.
2] Pot 2 and pot 3 are kept outside house so that they should get maximum amount of sunlight.
3] Quantity of water is varied as follows:
A] Pot 1 without sunlight and Pot 2 with sunlight are given same amount of water.
B] Pot 2 and Pot 3 which are kept in sufficient amount of sunlight are given different quantities of water.
Germination of crop in all the three pots is observed accordingly.

Starting Day 1

Seeds are sown in all the three pots at the same time.

Fig .5.Observation of Pots, Starting Day 1.

Readings using sensorfor threepots:

Fig.6SensingMoisture

Fig.7.Testing soilmoisture using Sensor

After Germination height of crops in the pots is:

Fig.8.Pots after Germination

It is observed that seeds in pots that are kept outside house are germinated first as they are getting sufficient amount of water and sunlight.

III. RESULTS AND ANALYSIS

Following table gives results in terms of soil moisture and height of the crop for a duration of 13 days.

Table. 1. Result of Moisture Content and Height of Crop.

No of Days	Moisture Reading (cbar)			Crop height (cm)		
	POT1	POT2	POT3	POT1	POT2	POT3
DAY1	95	92	88	---	---	---
DAY2	115	110	95	---	---	---
DAY3	120	120	115	---	---	---
DAY4	135	130	130	---	---	---
DAY5	144	140	135	---	---	---
DAY6	130	120	120	---	---	---
DAY7	135	135	135	---	---	---
DAY8	125	125	130	---	----	1
DAY9	135	110	94	1	2.5	3
DAY 10	135	115	120	3	4	5
DAY 11	100	115	115	8	8	8
DAY 12	140	130	130	8	9	9
DAY 13	130	130	125	9	10	11

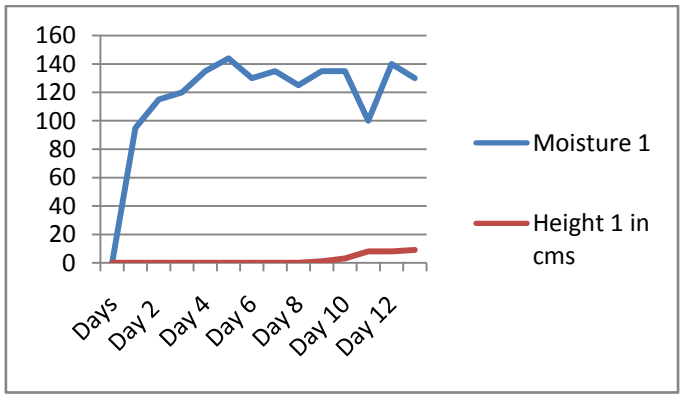

Fig.9. Graph of Moisture vs. Height of Pot1.

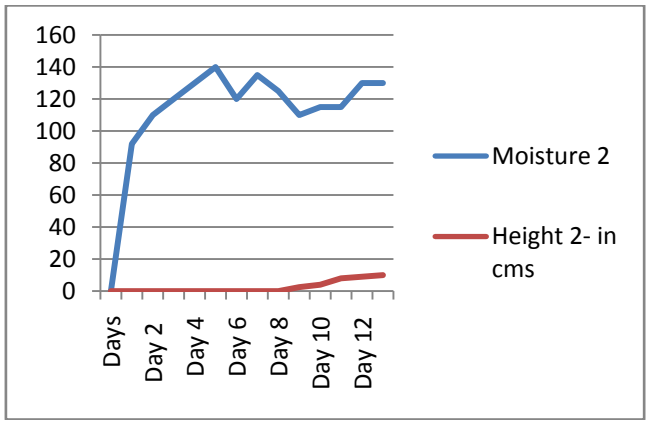

Fig.12. Graph of Moisture vs Height of Pot 2

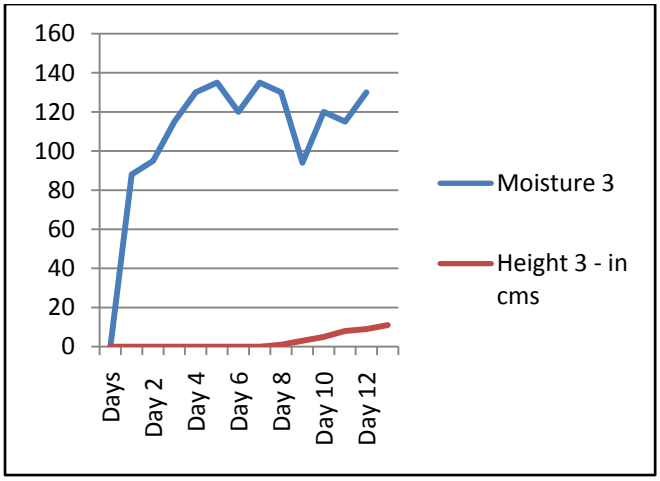

Fig.11 Graph of Moisture vs. Height of Pot 3

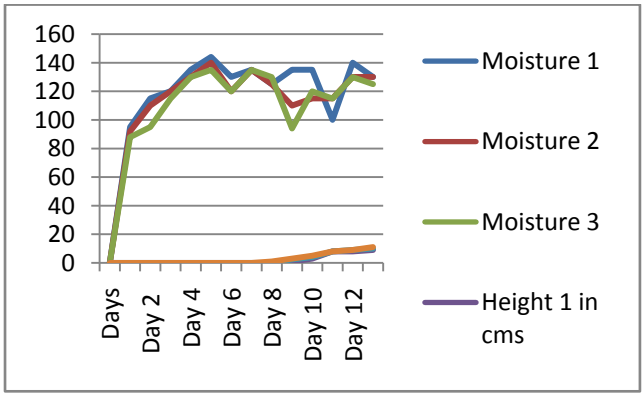

Fig.12. Comparative Graph of Pot 1, Pot 2 and Pot 3

IV. CONCLUSION

Intelligent capacitive sensor finds wide application in different areas where water usage is important. Mainly it is used at precision agricultureand in Green Houses and Polyhouses. From experimentation that is carried out it is seen that soil moisture and sunlight are both factors that affect the growth of a plant. Pot No. 3 that is getting sufficient amount of sunlight and water in germinated properly .Controlling soil moisture is very important in the crop yields. Moisture sensor used is of low cost and high resolution sensor. As it requires very low battery usage, system is not costly. It can be used in any type of soil.

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