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Monitoring moisture of soil using low cost homemade Soil Moisture Sensor and Arduino UNO

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***Abstract*— Persistent increase in population of world is demanding more and more supply of food. Hence there is a significant need of advancement in cultivation to meet up the future food needs. It is important to know moisture levels in soil to maximize the output. But most of farmers cannot afford high cost devices to measure soil moisture. Our research work in this paper focuses on home-made low cost moisture sensor with accuracy. In this paper we present a method to manufacture soil moisture sensor to estimate moisture content in soil hence by providing information about required water supply for good cultivation. This sensor is tested with several samples of soil and able to meet considerable accuracy. Measuring soil moisture is an effective way to determine condition of soil and get information about the quantity of water that need to be supplied for cultivation. Two separate methods are illustrated in this paper to determine soil moisture over an area and along the depth.**

Keywords—soil moisture; soil moisture sensor; low cost moisture sensor; Arduino UNO; embedded systems

I. Introduction

Water content or moisture content is the quantity of water contained in a material, such as soil (called soil moisture), rock, ceramics, fruit, or wood. Water content is used in a wide range of scientific and technical areas, and is expressed as a ratio, which can range from 0 (completely dry) to the value of the materials porosity at saturation. It can be given on a volumetric or mass basis. Soil moisture is a key variable in controlling the exchange of water and heat energy between the land surface and the atmosphere through evaporation and plant transpiration. Soil moisture sensors measure the water content in soil. The standard method of measuring soil moisture content is the thermogravimetric method, which requires oven drying of a known volume of soil at 105 ≥C and determining the weight loss. This method is time consuming and destructive to the sampled soil, meaning that it cannot be used for repetitive measurements at the same location [1].

Rapid measurement techniques using electronic sensors such as time domain reflectometers, capacitance, impedance and dielectric sensors offer an alternative to destructive and time consuming gravimetric sampling [2]. Several other methods were proposed to determine soil moisture [3], [4]. In [5], soil moisture is monitored by measuring electromagnetic radiations emitted by soil at different temperatures. The sensitivity of micro waves to soil moisture is key in this method. Apart from measuring soil moisture, monitoring soil moisture distribution is also important in agriculture [6].

Our method focuses on low cost and simple method unlike most of the above methods with a goal of extensive usage. One of the most commonly used technologies in soil moisture sensors is based on electrical resistance of the soil. In this method two copper rods are inserted into soil separated by a certain distance [7]. This arrangement acts as a sensor to measure the moisture in the soil. The conductivity of soil changes by changing the amount of water in it. Measuring soil moisture is important in agriculture to help farmers manage their irrigation systems more efficiently. Not only are farmers able to generally use less water to grow a crop, they are able to increase yields and the quality of the crop by better management of soil moisture during critical plant growth stages.

II. Moisture Sensor

A homemade low cost sensor is used in this experiment. The design of this sensor requires a piece of thermocol sheet, two long copper wires. The copper wires are inserted in thermocol at constant distance which acts as sensor.

The ends that are to be inserted in to soil are stripped off. The wires are supported by straight sticks to avoid bending while inserting into soil. Multiple numbers of sensors are used to increase range and accuracy of apparatus.

Fig. 1. Low cost moisture sensor

III. PROCEDURE

This is a simple Arduino project for a soil moisture sensor that will light up a LED at a certain moisture level. It uses Arduino Uno microcontroller board [12]. Two wires placed in the soil pot form a variable resistor, whose resistance varies depending on soil moisture. This variable resistor is connected in a voltage divider configuration, and Arduino collects a voltage proportional to resistance between the 2 wires. Insert the 2

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probes (wires, pcb) in the dry soil and measure the resistance value and then pour water and measure it again. Use a mid-value for the resistor (eg: 50k for 100k in dry soil and 10k in wet). The other method to find the resistors value is to try different values or use a potentiometer. Insert the probes into the soil that has the desired moisture when to light up the LED and signal that the plant needs water. Adjust the potentiometer and see the point at which it starts to light. Measure the potentiometer current value and replace it with a fixed resistor.

IV. METHOD-1

In this method, the same sample of soil is examined by changing the amount of water and values at different amount of water have been tabulated.

- Based on the values three zones of conductivity is defined.
- First zone is dry zone where soil requires more water and it is indicated red LED on the PCB.
- Second zone is where soil does not require water and it is indicated green LED on the PCB.
- Third zone is wet zone where soil has more water than the requirement.

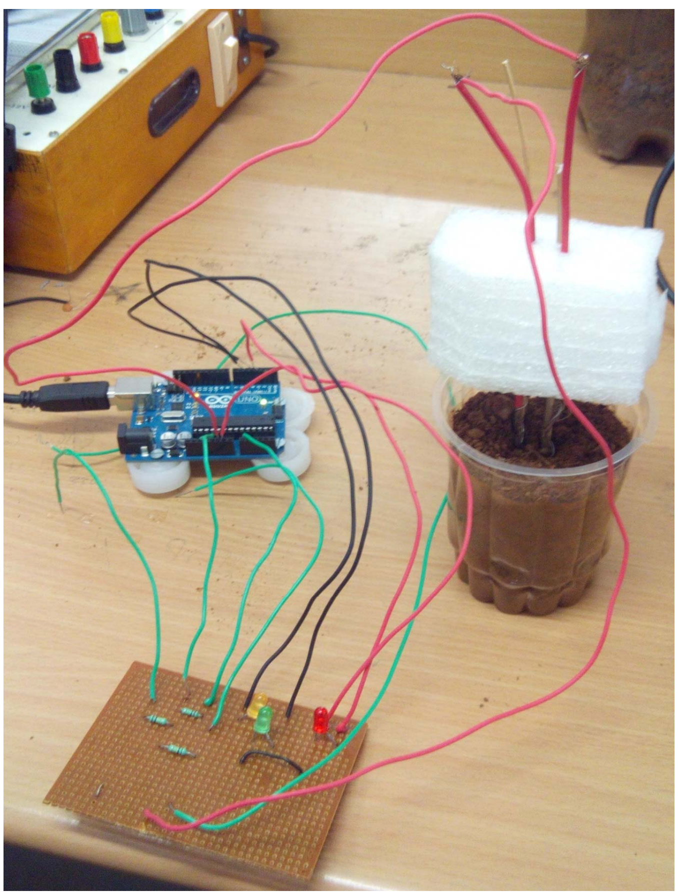

Fig. 2. Setup for measuring soil moisture of a sample

Using this Method we can know the zone under which a sample is coming and its requirement for good plantation. The circuit consists of one sensor, Resistor, 3 LEDs for three zones and Arduino Uno Board Matlab interface for Arduino has been used to measure sensor output values.

V. METHOD-2

This method is performed by taking soil in a bottle of certain height .Then it is separated into three levels based on the depth and three sensors are inserted into the soil at three levels each one at a different depth. By pouring water the values of the sensors are taken .By this method moisture at different depths of the soil can be known.

- A two litre bottle is used for our method. A marking is done on the bottle dividing into three equal levels.
- Three sensors are inserted into three levels as shown in the figure.
- The output of each sensor is given to different analog ports A0, A1, A2 respectively
- A PCB consisting of Resistors and LEDs is designed for easy experimental set up.
- The LEDs can be used as warning to avoid large amount of water as well as less amount of water.

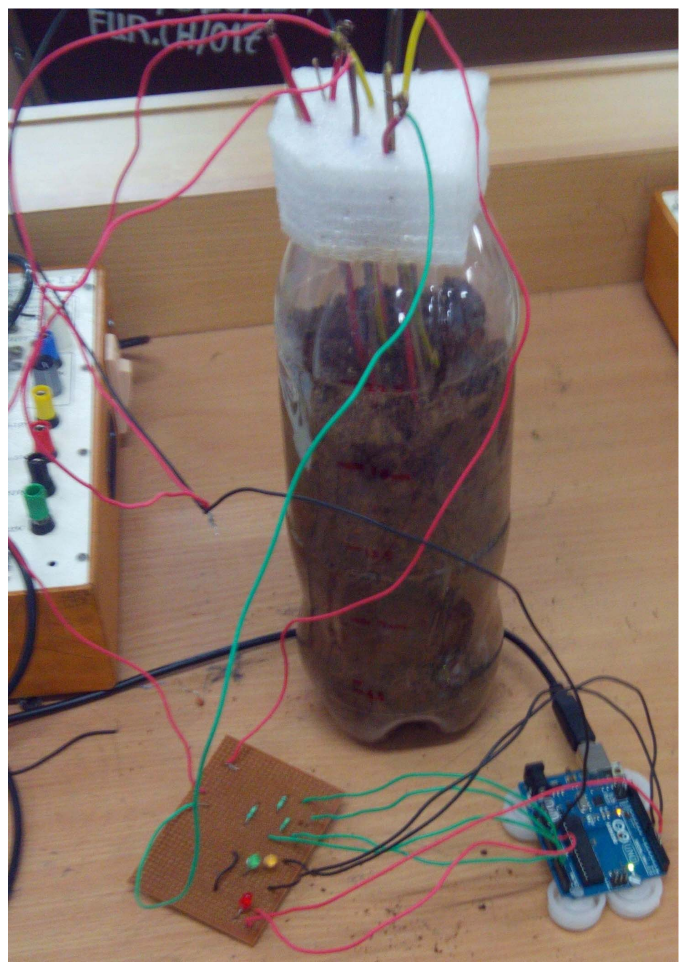

Fig. 3. Setup for measuring soil moisture of a sample at different depths

VI. Results

A. Method-1

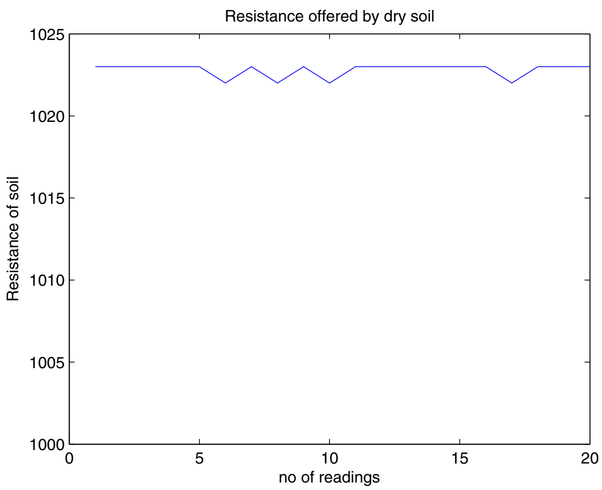

Fig. 4.

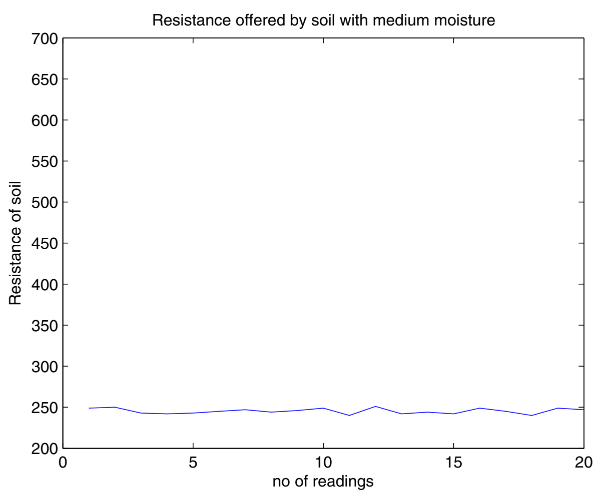

Fig. 5.

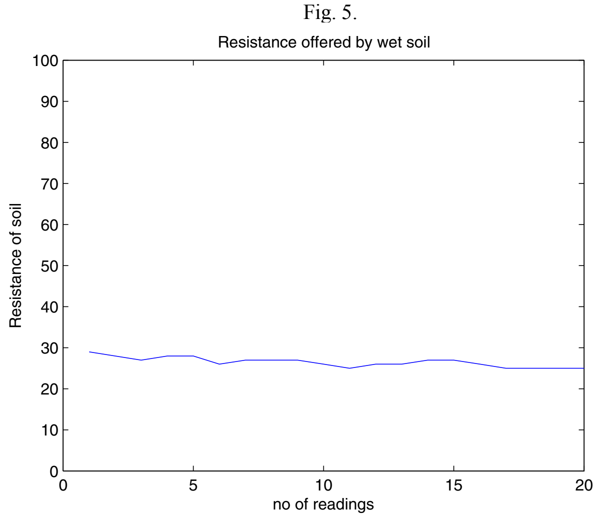

Fig. 6.

Reading are taken for repeated number of times to check the repeatability of sensor and results are found to be not too deviating from the average value as shown in figures. Accuracy of setup can be increased by implanting more sensors in soil at different locations. Also the variation in soil moisture can be estimated over an area.

B. Method-2

In this method, water is poured into soil from the top and soil moisture is measured at different levels along the depth. The extent to which watering effects soil moisture of inner layers with respective to outer layers can be estimated using this method.

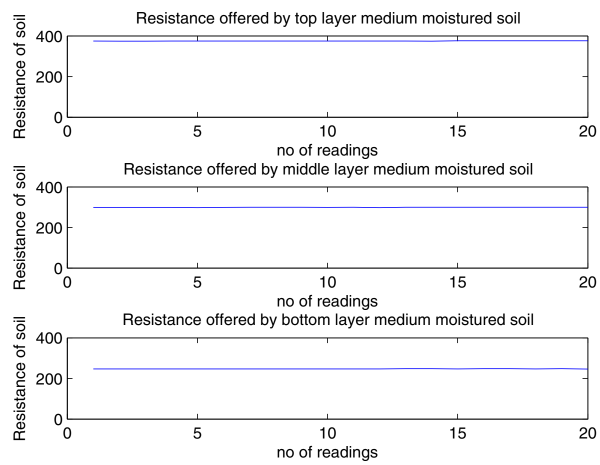

Fig. 7.

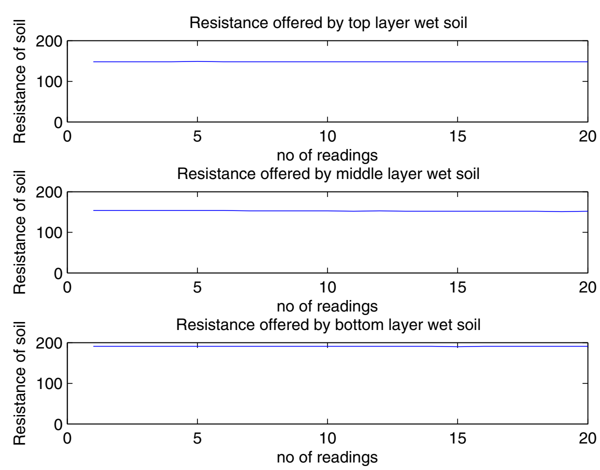

Fig. 8

VII. Applications

Urban and suburban areas, landscapes and residential lawns are using soil moisture sensors to interface with an irrigation controller. The system can be used as alert when moisture level falls outside a suitable zone for irrigation. Connecting a soil moisture sensor to a simple irrigation clock will convert it into a smart irrigation controller that prevents an irrigation cycle when the soil is wet[11]. Soil moisture sensors have significant role in implanting smart irrigation systems and telemetry systems [7], [8]. Soil moisture sensors also can useful in making suitable sport turfs especially for golf. Archeologists believe that better understanding of soil hydrology using Soil moisture sensors may aid in revealing ancient mystery irrigation practices in seemly waterless desert environments. Monitoring soil moisture will not only benefit environmental researchers but also farmers, golf course superintendents, archeologists, and regulators. Soil moisture sensors play an important role in helping to protect water resources and understand our ever changing climate [9].

VIII. Conclusions

Resistance values of dry soil are more compared to resistance of wet soil because the conductivity of soil increases due to increase in moment of ions in wet soil. The first method is effective in determining and monitoring soil moisture at multiple places simultaneously. The second method is useful in monitoring varying soil moisture distribution along the depth using soil moisture values at different depths of uniform soil. As many as 6 sensors can be used simultaneously to reach maximum accuracy using Arduino UNO which contains 6 analog input ports. The low cost of equipment and the simple procedure of our method are significant when compared other methods. One of the peculiar feature of our proposed method is measuring soil moisture along the depth can help in determining the appropriate time of water supply to reach crop roots which can improve cost efficiency and water resource management.

References

[1] J. P. Walker, G. R. Willgoose, and J. D. Kalma, "In situ measurement of soil moisture: a comparison of techniques," in Journal of Hydrology 293 '04, Callaghan, NSW 2308, Australia, 2004, pp. 85–99.

[2] M. O. et al., "Soil moisture measurement in heterogeneous terrain," pp.2604–2610.

[3] B. et al., "An optical reflectance technique for soil moisture measurement part i: Theory, description, and application," Normal, Alabamal, 1996, pp. 1315–1319.

[4] V. S. P. et al., "Soil moisture measurement system for dphp sensors and in situ applications," Mumbai, India, 2013, pp. 12–15.

[5] O. P. N. C. et al., "Measurement of soil moisture using microwave radiometer," in Proc. IEEE International Conference on Microwave '08, India, 2008, pp. 621–624.

[6] N. B. A. Karim and I. B. Ismail, "Soil moisture detection using electrical capacitance tomography (ect) sensor," Perak Darul Ridzuan, Malaysia, 2011.

[7] C. kumar sahu and P. Behera, "A low cost smart irrigation control system," Sambalpur, INDIA, 2015, pp. 1146–1152.

[8] W. L. et al., "An agricultural telemetry system implemented using an Arduino-android interface," Quezon City, Philippines, Nov. 12–16, 2014.

[9] Keith Bellingham, Soil Moisture Applications and Practices using the Hydra Probe II Soil Moisture Sensor [Online]. Available: http://www.stevenswater.com

[10] G.J. Gaskin and J.D. Miller, 'Measurement of soil water content using a simplified impedance measuring technique', Journal of Agricultural Engineering Research 63, 153-160, 1996.

[11] Aman Tyagi et al., "A low cost portable temperature-moisture sensing unit with artificial neural network based signal conditioning for smart irrigation applications", Journal on smart sensing and intelligent systems vol. 4, no. 1, march 2011.

[12] The Arduino UNO ATmega328P technical specifications. Available: https://www.arduino.cc/en/Main/ArduinoBoardUno

[13] R. S. Alessi and Lyle Prunty, "Soil-water Determination Using Fiber Optics" in Soil Science Society of America Journal, 1985, Vol. 50, No. 4, pp. 860-863.

[14] B. K. Bellingham, "Method for irrigation scheduling based on soil moisture data acquisition" in Irrigation District Conf., 2009, pp. 383-400.

[15] D. A. Robinson et al., "Soil Moisture Measurement for Ecological and Hydrological Watershed-Scale Observatories: A Review" in Vadose Zone journal, Madison, 2008, Vol. 7, No. 1, pp. 358–389.