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A NEW TECHNIQUES FOR SOIL MOISTURE SENSOR

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ABSTRACT

Irrigation management strategies based on soil moisture monitoring give a significant benefit for the application of the proper amount of water in the fields. The design and development of a soil moisture sensor as well as a response monitoring device are presented in this paper. Soil moisture sensor detects the moisture present in the soil by figuring the variable water content (VWC) with the help of probes. The probes in this sensor are constructed of nickel, which is a corrosion-resistant and durable material ideal for agricultural applications. The soil moisture is measured by the response monitoring system, compared to the threshold values provided by the user, and an alert is generated if the soil moisture falls below the predefined value or rises above the predefined value. It aids in the solution of problems relating to the growing of crops that require irrigation at irregular intervals. It's also useful for keeping track of soil moisture in golf courses. There is a potential of more research and improvement in this field in future and it can be further improved by using Bluetooth to provide direct wireless distribution of output data to the farmer. The moisture retention capacity of the soil can be calculated using data from a computer database.

KEYWORDS: *Moisture, Probes, Sensor, Soil, VWC, Water.*

1. INTRODUCTION

India is a rapidly developing country with a huge population. The essential needs of food and water are increasing day by day as the population grows. As a result, it is necessary to conserve these resources and make efficient use of them(1). We must find efficient ways to use water and save it for future generations because it is one of the most vital aspects of our everyday lives. Irrigation management strategies for fields are one method. Knowing how much moisture is in the soil can help with irrigation water management strategies(2).Since water is held in the pores between soil particles, the greatest volume of water that a particular soil can hold depends on the total volume of pores also known as porosity. Gravitational Water: The water that drains after moving through the earth due to gravity. Gravitational water travels through the soil's bigger pores and drains swiftly.

1. Capillary Water: The water that is held against gravity inside soil pores. The ratio of adhesion and cohesion powers determines the capillary powers that keep water inside the pores. The tendency of water molecules to attach to other surfaces is known as adhesion, while the tendency of water molecules to stick to one another is known as cohesion. When adhesion is larger than cohesion, capillary forces are stronger. Smaller holes have better adhesion(3).

2. Hygroscopic Water: Surface forces hold a small coating of water in vapour form closely to soil particles, this makes a thin layer of water known as hygroscopic water. Plants do not have access to hygroscopic water.

A nickel probes-based soil moisture sensor and a response monitoring system were devised and built to determine soil moisture. Knowing the moisture content allows the agriculturist to estimate when and how much to water the soil in order to avoid excess watering and crop wilting. These measures will boost crop yields, enhance crop quality, conserve water, save energy, and reduce fertiliser usage(4).

1.1. Moisture Detection of Soil:

A moisture detector is used to determine the amount of moisture in the soil, as the name suggests. The amount of moisture in the soil is determined by a number of elements, including the type of soil (sandy, loam, clay, sandy loam), salts in the soil (iron, manganese, calcium, phosphorus, nitrogen, sulphur, and so on), and temperature. Irrigation is carried out based on the moisture sensor's reading. Based on the methods used to determine soil moisture, soil moisture sensors can be categorised into the following types(5,6).

1.1.1. Soil Variable Water Content (VWC) Centered Soil Moisture Detector:

These sensors are used to figure out how much water is in the soil. Mass or volume can be used to determine VWC. The output is expressed as a percentage of the total content. VWC is a percentage of the total amount of water in the soil at any particular time(7). A known volume of soil is dried in the lab, and the percent soil moisture content is computed as follow.

% VWC = (weight of wet soil–weight of dry soil) / (weight of dry soil) × 100

Soil moisture sensors can be made to fit a variety of soil types. It is possible to create a database. It can be used to figure out what acids, alkalis, and salts are in the soil. Correlating the output voltage with the salinity of the soil can also be used to compute it. The use of Bluetooth allows for direct wireless delivery of output data to the farmer. The moisture retention capacity of the soil can be determined using values from a stored database on a computer(8).

2. LITTERATURE REVIEW

Ramkumaret al. discussed the automation of plant monitoring systemsand intelligent gardening approaches with the help of the internet of things (IoT) Raspberry PI. The primary goal of automation is to make people's lives easier by decreasing manual labour and improving the overall performance of any system without requiring user engagement. Soil and air temperature, humidity, sunshine, soil moisture, and pH are all critical factors in the quality and productivity of plant development. By regularly monitoring and documenting these garden factors, information regarding plant health and growth may be presented to the user. It enables better knowledge of how each parameter influences plant growth. But this system is limited to small garden implementation on large scale i.e., in the agricultural field will be complex and expensive. Also for the farmers who are less familiar with the technology will find it difficult to use as it requires awareness of the technology(9).

K. Soulis et al. discussed how recent advances in electromagnetic sensor technologies have made automated irrigation scheduling a reality. Many of the available sensor placement guidelines, on the other hand, were derived from site and crop-specific experiments. The accuracy of sensors could also have an impact on irrigation efficiency. This research looks into how the positioning and accuracy of soil moisture sensors can affect the performance of soil moisture-based surface drip irrigation scheduling systems under various conditions. In order to simulate soil moisture-based irrigation scheduling systems, several numerical experiments were carried out using a mathematical model with a system-dependent boundary condition. The findings of this study showed that the positioning and accuracy of soil moisture sensors can have a significant impact on irrigation efficiency in soil moisture-based drip irrigation scheduling systems. These findings emphasize the importance of conducting a thorough investigation that takes into account the characteristics of specific crops, irrigation and scheduling systems, as well as soil moisture sensors, in order to provide a solid foundation for improved irrigation scheduling. The importance of soil-specific calibration of sensors used in such systems is also emphasized. Finally, a significant finding of this research is that computer models can be effective tools for delving into the details of sensor positioning and accuracy, as well as other automated scheduling system characteristics(10).

Research Questions:

1. How to implement smart irrigation system using soil moisture sensor?
2. What are the components used in soil moisture sensor?

3. METHODOLOGY

3.1. Design:

The schematic flow chart is shown in Figure 1. The flow diagram demonstrates the working of the sensor and how it collects moisture present in the soil. After that, these data are compared to the threshold value set by the farmer. Different indicators are utilised to alert the Farmer that the level of moisture is less than the predetermined value and that additional moisture is required. A buzzer and light emitting diode (LED) indicators are connected to the master controller There is also a liquid crystal display(LCD) that displays the percent Variable Water Content (VWC) on a continual basis.

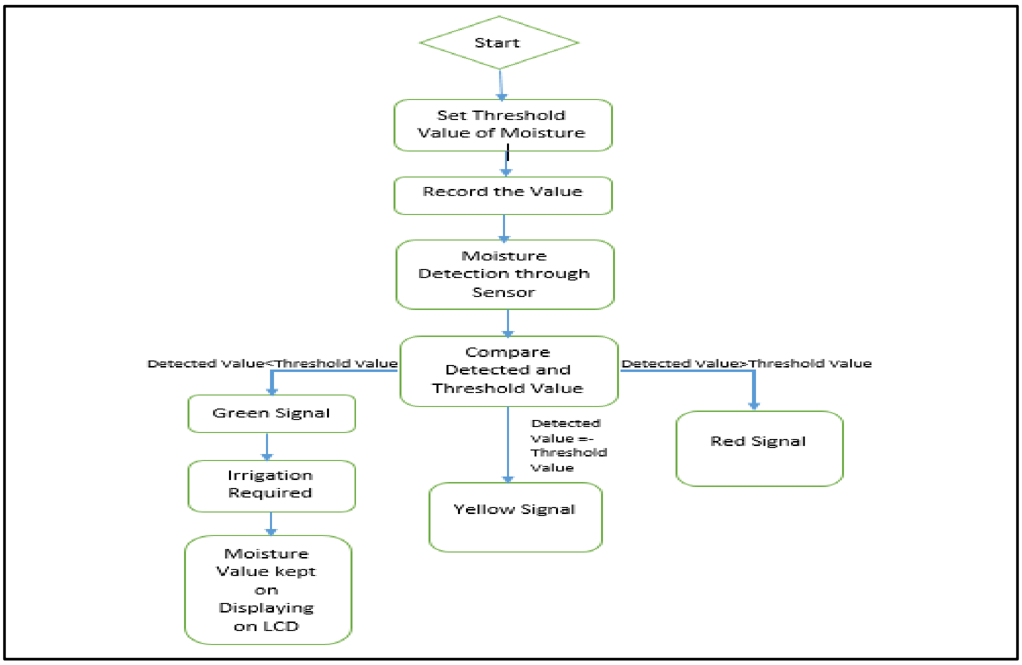

Figure 1: Illustrates the schematic flow chart of working of soil moisture sensor.

3.2. Instrument Used:

A microcontroller, power source, LCD, buzzer, LED indicators, keypad, and moisture sensing probes make up the entire system. The peripheral interface controller (PIC18F452)is a microcontroller utilised in this system, which is fuelled by a 5V power source, is at the heart of the system. A crystal oscillator with a 4MHz clock frequency, a reset switch, an LED indicator, and two 22pF noise-filtering capacitors make up the power circuit. Because of the high-performance, improved flash microcontroller with an inbuilt 10-bit Analog to Digital Convertor, the Peripheral Interface Control microcontroller is preferred above other controllers. The controller is attached to the moisture detector. The keypad is utilised to enter the appropriate threshold moisture value examined by the agriculturist. It consists of three buttons: an increase button, a decrease button, and a third button for storing the threshold value. Moisture sensor estimates moisture from the soil once the agriculturist sets the threshold value. This observed value detected by the sensor is matched to the value that was entered as the threshold value. If the moisture level is below the recommended level, irrigation is required. A buzzer is also connected to the microcontroller, and it will turn on and off depending on the moisture levels. The moisture content is expressed as VWC.

3.3. Data Collection:

Table 1 shows the different parameter of the designed sensor and the ratings or values of the parameter used in the detector. The main parameter are dimension of the probes i.e., 9.5×0.7×0.5 cm, power source provided to the system of 5V, area of influence 25cm, conversion time of ADC of 72 microsecond, resolution 4.8 milli Volt

TABLE 1: PROVIDES THE LIST OF DIFFERENT PARAMETERS OF THE PROPOSED SOIL MOISTURE SENSOR AND RESPONSE MONITORING SYSTEM

Parameters	Values
Dimensions	9.5×0.7×0.5 cm
Power source	5V
Voltage Signal	0-4.2 V
Area of influence	25 cm
Conversion Time of ADC	72 microsecond
Resolution	4.8 mV

3.4 Sensing Probe:

The sensor is made up of pure nickel having 2-probes. Nickel is utilised because it has good conductivity characteristics as well as the ability to be buried in the soil for an extended period of time. In the soil, it will not corrode. Nickel probes have a length of 9.5 cm and a width of 0.7 cm. The distance between the 2 probes is 0.5cm, and the sensor probe's tips are shaped like a triangle to make them easy to bury in the soil

4. RESULTS AND DISCUSSION

In this paper a soil moisture sensor and a response monitoring device is designed to detect the moisture of the soil and to save the crops from over irrigation and dryness with the help of sensing probes made up of nickel and the control system to monitor the present level with the predetermined level. It is been seen that most of the crops gets damaged due to the traditional irrigation because it mostly results in over irrigation or dryness of crops. In this growing demand of food we need an efficient way of irrigation which helps in saving of water as well as proper irrigation of crop according to the moisture level of soil sensed by the proposed system.

The designed soil moisture sensor helps the agriculturist to give a threshold value of the soil moisture to the system according to his study of the soil. And the moisture detected by the nickel probes is monitored by the control system with the help of microcontroller. If the moisture level of the soil is above the predetermined level an alert is sent to the user similarly during moisture less than threshold again a notification is sent to the user. The soil moisture sensor was tested on a small scale and the data obtained by the sensor displayed on the screen was observed. The value of the moisture obtained by the proposed sensor is shown in Table 2.

TABLE 2: ILLUSTRATES THE VALUE THE MOISTURE OBTAINED BY THE PROPOSED SOIL MOISTURE SENSOR

Threshold Value	Detected Value (%Moisture)	Voltage
33	58	2.884 V
33	62	2.737 V
33	42	3.445 V
15	46	3.303 V
33	82	2.010 V

After assembling the soil moisture sensor according to the parameter given in Table 1 a test was performed for gathering the data of output voltage designed sensor in morning environmental condition and evening environmental condition. A graph is plotted from the collected data shown in Figure 2 for morning data and Figure 3 for evening data. We can see that there is a sudden decrease in the output voltage in morning which downfall of the moisture level hence an alert is sent to the user for irrigation. And the comparison between the output voltage of designed system and printed circuit board (PCB) based nickel plated sensor is shown in Figure 3.

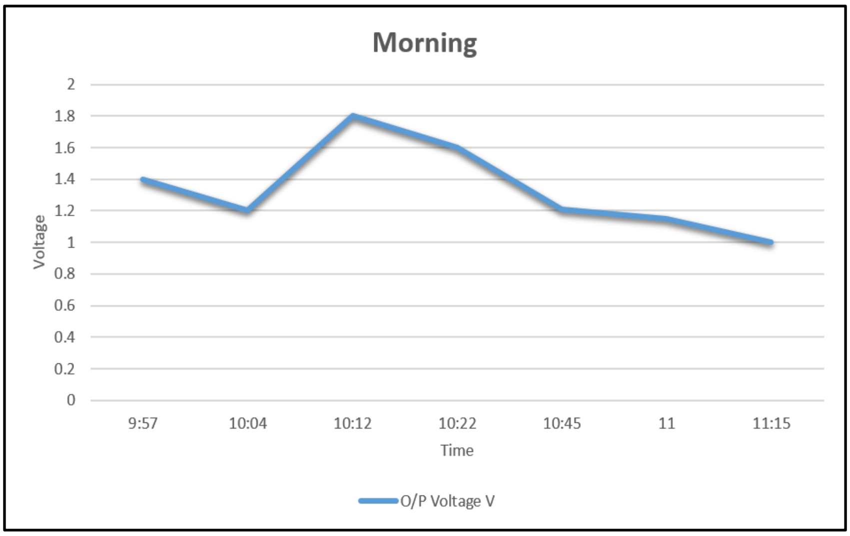

Figure2: Illustrates the graphical representation of the output voltage obtained in the morning time.

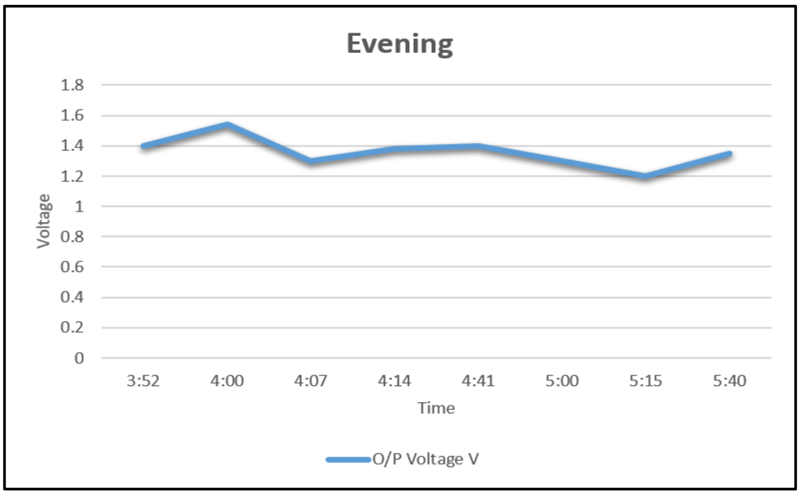

Figure3: Illustrates the graphical representation of the output voltage obtained in the Evening time.

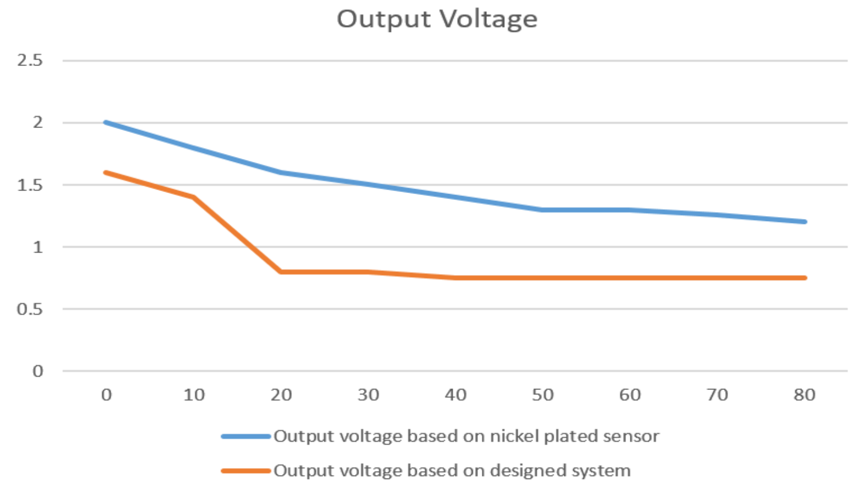

Figure 4: Shows the comparison between the output voltages of nickel plated sensor and designed system.

5. CONCLUSION AND IMPLICATIONS

The soil moisture sensor and tracking system has been intended to be simple to use and comprehend. It can be operated by farmers of all ages. It is possible to reprogram to add new functions. The moisture content of the crop is measured up to the root zone. As a result, it can be used to determine the moisture content of any crop. The sensor probes are positioned vertically in the soil to check the depth of irrigated water, or they can also be positioned horizontally in the soil at various heights depending on the crop. It is simple to use and can be used by farmers with little or no knowledge of the sensor. The moisture is measured twice a day, in the morning and evening, and it is discovered that moisture is linear up to 20% VWC, after which the output voltage becomes nearly constant. Soil moisture sensors can be made to fit a variety of soil types. It is possible to create a database. It can be used to figure out what acids, alkalis, and salts are in the soil. Correlating the output voltage with the salinity of the soil can also be used to compute it. In future it can be advanced with the use of Bluetooth that would allow for direct wireless delivery of output data to the farmer. The moisture retention capacity of the soil can be determined using values from a stored database on a computer.

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