Development of Moisture Sensor Interface using Arduino

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Abstract: **This paper is to develop an interface sensor's signal to the board and shows the data read from the sensor using LCD and connected to PC using a serial monitor. The data of soil's resistivity from the sensor is transmitted to Arduino. Arduino then will convert it to volumetric water content(VWC) value and displayed it on LCD or serial data on PC . The implementation of the study used a microcontroller that was called Arduino Uno and integrated with SD card shield module as the data collector. From the testing it shows that the sensor capable to read 1% to 79% of moisture sensor based on the calibration made.**
Keywords**: soil moisture, resistivity, sensor, Arduino Uno**

I. INTRODUCTION

This experiment aimed to create an application in agriculture field to monitoring the soil moisture for the crops. A moisture sensor works by estimating the amount of water in soil based on the dielectric constant, or the soil's ability to transmit electricity. The dielectric constant increases as the soil's water content increases, producing an estimate of how much water the soil holds.

The electromagnetic technique (resistive sensor) used in this project as the method to determine the soil moisture and it depend upon the effect of moisture on the electrical properties of soil. Soil resistivity depends on moisture content, hence it can help as the basis for a sensor[1]. The two probes is used to pass current through the soil, and then it will read that resistance to get the moisture level. More water makes the soil conduct electricity more easily (less resistance), while dry soil conducts electricity more poorly (more resistance)[2]. The difficulty with resistive sensors is that the absolute value of soil resistivity depends on ion concentration as well as on moisture concentration [3] .

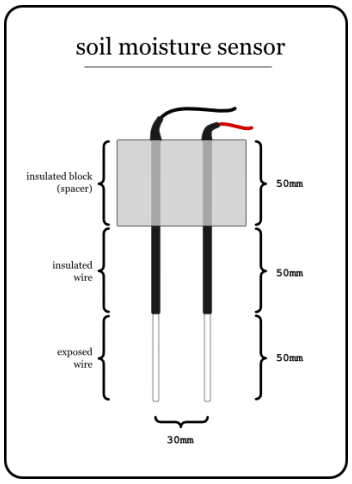

Figure 1. Basic diagram of soil moisture sensor.

II. METHODOLOGY

It divided into a four main parts to achieve the objective of the experiment which is sample(soil) preparation, collecting data, hardware connection and software development.

A. Samples Preparation

For medium preparing, five beakers are used as a sample container to hold of 10%,20%,40%,60%, and 70% moisture of the soil. The volume of the soil is set to 200ml and the water is poured or added based on the percentages that have been labeled. The medium sample used is coconut fibre because the level of hydrophilic is higher and it also easy to get.

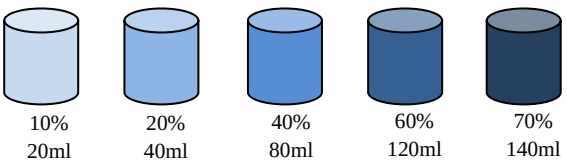

Figure 2. The percentages of moisture level samples.

These samples are wrapped properly and left out for 24 hours so that the water can be fully absorb by the medium and decreasing the vaporization process to avoid false reading.

Figure 3. The medium sample being wrapped using the aluminium foil.

B. Collecting Data

The sensor probe is penetrated into these samples about 3cm depth at the five different spot in beaker to ensure the sensor reading is accurate. The voltage reading and sensor reading are recorded then from these parameters the graph is plotted to generate the straight line equation. The equation is required in software development in other to consider the moisture sensor is reliable or not after output display is connected this device.

C. Hardware Connection

The main part for hardware of this project are Arduino Uno microcontroller, LCD keypad shield, SD card shield and moisture sensor probe. The 3 pin of probe sensor is connected to 5v power supply, ground and analog input as data for the microcontroller. From the testing of the probe it show the voltage reading increase due to the increasing of moisture level. By the Arduino microcontroller usage the connection of LCD and SD card shield is easily to attach on it. The shields have been ready with a connector pins leg so that the user can attach or mount it on a variety of Arduino boards. The LCD shield is used to display the string value of percentage moisture level. Besides, it also view the user condition of the soil based on the moisture level. For the data logger or collector, the SD card is used as storage to save the data from the sensor reading. The data will be saved into the text document(.txt) and it easily to access for the process of analyzing the data. Figure 4 shows the connection of the hardware to the laptop or computer.

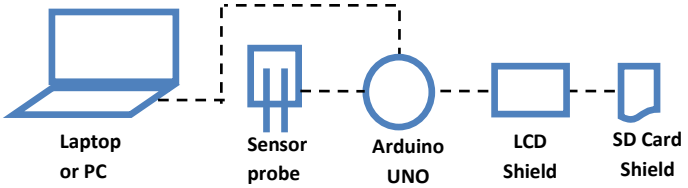

Figure 4. Block diagram of connection between the hardware to the laptop or PC

D. Software Development

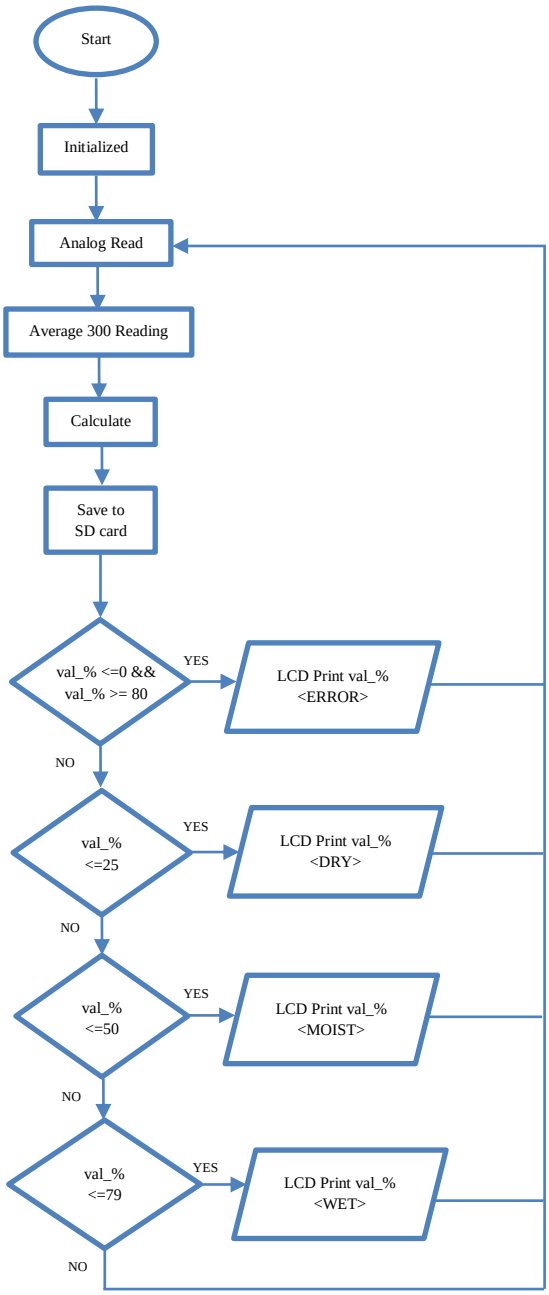

Figure 5. Flow chart of the moisture sensor software.

For the software flow chart in Figure 5, it starts with initialization setup by declaration of usage the LCD, SD card library and analog pin input. Then, when the probe sensor was penetrating into the sample it produce analog reading that was read between 0 to 1024 decimal. From the analog reading, the average of the value will be taken with 300 times before proceed to the calculation process. The average value reading is required to get an accurate value. In the calculation process, the value of percentage will generated by the conversion of analog value to voltage reading and substitution of linear equation in the program. Next, it will proceed the saving the

data into the SD card. The data will automatically logging and save when the probe sensor start read the data once it penetrated into the samples . Then the optional decision will required displaying the value and indicator of moisture level on the LCD shield, then the program continue looping to analog read process.

III. Result And Discussion

During testing, the sensor has been penetrate into the sample and the reading of voltage is recorded. The penetration depth of the sensor in the soil is constant to avoid reading error in different samples. Table 1 shows the measurement of the voltage and sensor reading. The increasing of voltage is slightly low but it sufficient to view differentiation between those samples. The voltage reading is changing due to the changing of sensor read data. The higher of the moisture cause the resistive(in the soil) decrease and the voltage is increase, meanwhile dry soil conducts electricity more poorly (more resistance)[4].

Figure 6. Measurement of voltage from different level of moisture.

TABLE 1

Measurement of Voltage Based on the Moisture Samples

% of Moisture(%)	Voltage(V)	Sensor Read
10	3.32	699.76
20	3.50	715.37
40	3.70	747.49
60	3.77	778.61
70	3.80	794.33

Voltage reference, V_{REF} for Arduino UNO microcontroller is 5V or 1024 decimal. It mean from 0 to 5v is represent in decimal is 0 to 1024. So, 1 decimal is equal 4.89 mV. To convert the value of sensor read into voltage is by using Eq.(1).

$$Voltage, V = Sensor\ read\ \times 4.89\ mV \quad (1)$$

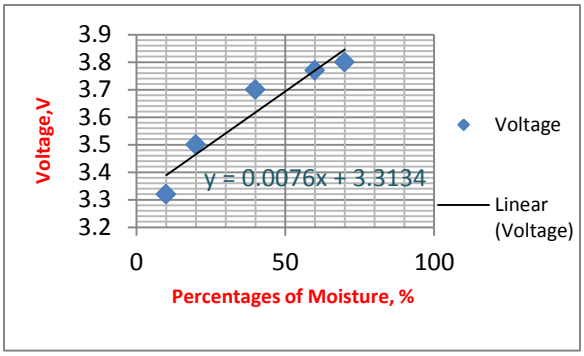

Figure 7. Graph for % of Moisture versus Voltage.

From the table, the graph on Figure 7 is plotted to analyze the data and obtain the straight line equation in Eq.2 as a reference equation that used in software. From Eq.3 the slope and y- interception value is acquired.

$$y = mx + c \quad (2)$$

$$y = 0.0076x + 3.314 \quad (3)$$

Then , it transformed to Eq.(4)

$$x = (y - 3.314)/0.0076 \quad (4)$$

The Eq.(4) is equivalent to percentage volume of water in the soil where x is value of moisture level and y is value of voltage read. In the software, the Eq.(4) will be insert in line of calculation process. At the sample exceeded 79%, the sensor not capable to read the data because of some limitation due to the sensor sensitivity. The limitation of sensor is tested by using the sample with 80% level of moisture.

TABLE 2

Measurement of Voltage Based on the Moisture Samples

% of Moisture(%)	Voltage(V)	Sensor Read
10	3.32	699.76
20	3.50	715.37
40	3.70	747.49
60	3.77	778.61
70	3.80	794.33
80	3.73	756.68

From the Table 2, it shows on the sample 80% the sensor produce the reading with 756.68 value. It shows the reading is lower than sample 70%. The voltage is also decrease because is accordance with the value of sensor read. From the testing, it can conclude this sensor not capable to read or estimate the level of resistive on sample 80% and above due to limitation of sensibility of the sensor.

Figure 8. Display the moisture value on LCD shield.

To proving the moisture level of samples is same value with value labeled on the beaker, it required to test the samples by displaying the result on the LCD shield. From the result, it shows the percentage value display on the LCD is ±5% different with value labeled on the beaker samples. Aside from the value of percentage the moisture, it also display the condition or indicator of samples. For this experiment, it was set in the Table 3.

TABLE 3

INDICATOR OF THE SAMPLE BASED ON THE DIFFERENT RANGE OF MOISTURE LEVEL

Range of Percentage of Moisture(%)	Indicator
0	Error
1 to 25	Dry
25 to 50	Moist
51 to 79	Wet
80 and above	Error

From the experiment, Figure 9, Figure 10, Figure 11 and Figure 12 shows the displaying value percentage of moisture and the condition of the samples on the LCD shield.

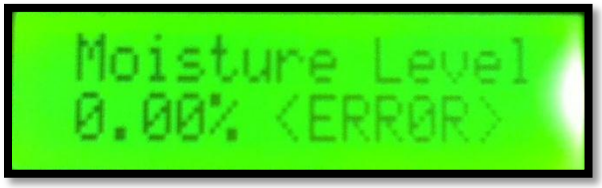

Figure 9. LCD display when the probe is not penetrate into the sample.

Figure 10. LCD display on the beaker sample labeled 10%.

Figure 11. LCD display on the beaker sample labeled 40%.

Figure 12. LCD display on the beaker sample labeled 60%.

For the monitoring data read, Arduino software provided with the Serial Monitor on Figure 3. By using this application, the output value or data read can be view or monitor on computer or laptop without referring LCD or other means of display. The COM port serial will be set based on the USB on the laptop or computer. For this project, the data required to be monitor are the value of sensor reading and percentage of moisture.

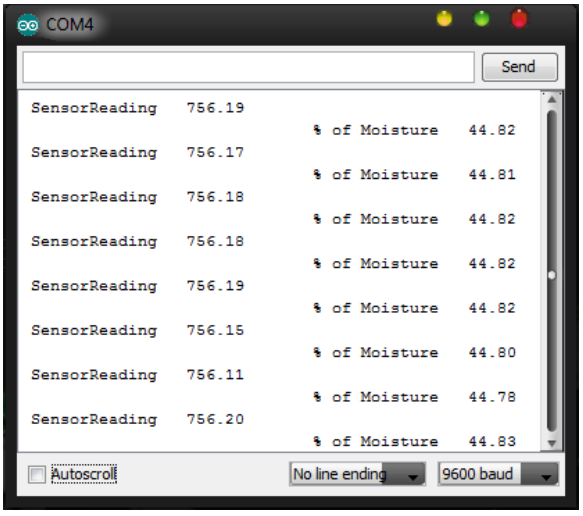

Figure 13: Serial port and serial data monitor.

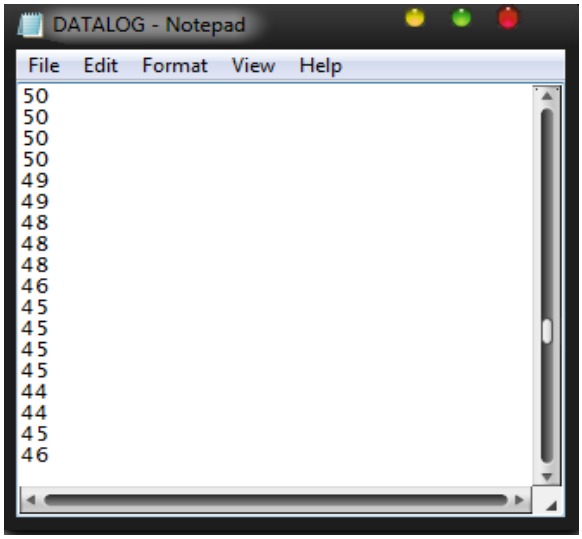

Figure 14: Data of % of moisture level save into SD card

Figure 14 shows the data of % of moisture level save into SD card. The data is saved into text document(DATALOG.txt). The data is logging and saving when the probe sensor is penetrated into the samples and continued process until the power supply is turn off or the SD card is removed from the SD card shield.

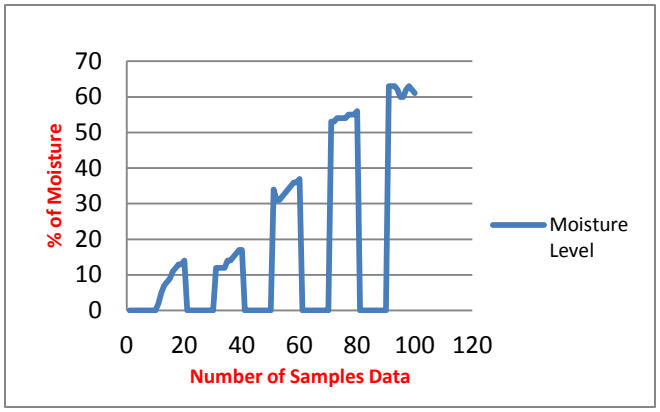

Figure 15: The pattern of graph after been tested with different samples.

From the data in DATALOG.txt document it can be copied into the Microsoft Excel or others means of software to create the graph. From the graph, the percentage of moisture can be analyzed by viewing the pattern of the graph. Figure 15 shows the an example pattern of graph with 100 number of sample data is taken.

IV. Conclusion

This experiment shows this moisture sensor capable to contribute the approximate moisture level of soil. Although the sample is using volumetric method, it will not 100% uniformly of moisture for the sample same as the actual soil. It will be some variation caused by the external factor such as type of medium, rectification and evaporation but not more than 5 %. This moisture sensor can't be proved as the best device to provide the moisture level of soil because certainly not compared with a device in market as the benchmark. For the improvement in the future this moisture sensor device will be added with a temperature sensor. When the sun heats on the soil and the soil warms up, the resistance changes. So, with additional circuit temperature sensor, it can use that data warp the soil moisture to remove the false reading.

Acknowledgments

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