

Development Soil Moisture Profile with Data Logger

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-----ABSTRACT-----

A soil moisture monitoring system is a collection of devices that can detect soil moisture, read or store data, and transmit data to a computer, which can then organize, visualize, and interpret the data. The optimal water level in the soil is fundamental to plant growth. The soil moisture monitoring device is designed to evaluate and control the amount of water needed to maximize crop quality while conserving water resources during irrigation. The device is made up of a steel metal probe profile sensor, an arduino mega, a microSD card shield, a real-time clock, and a graphic display. Moisture resolution is 0.02%. The calibration can be done at any location depending on the type of soil and the first principle used.

KEYWORDS;- *Soil moisture, irrigation, crop quality, plant growth*

Date of Submission: 25-04-2023

Date of Acceptance: 05-05-2023

I. INTRODUCTION

Nigeria is a developing country with the highest population growth rate in Africa. Food and water are becoming increasingly scarce as the world's population grows. As a result, there is a need to conserve these resources and make efficient use of them. Because water is one of the most important elements in our daily lives, we must find efficient ways to use it while also saving it for future generations. One method is to use effective irrigation management practices for fields. The understanding of soil moisture could greatly benefit irrigation water management practices. To determine soil moisture, we designed and built a nickel probe-based soil moisture sensor as well as a response monitoring system. Knowing the moisture value allows us to estimate when and how much to water the fields in order to avoid crop wilting caused by overwatering. These practices will increase crop yield, improve crop quality, conserve water, save energy, and reduce fertilizer supplies [1, 2].

Typically, this decision is made based on previous experiences, such as weather forecast data (crop evapo-transpiration data) or soil-related measurements. Past experiences are probabilistic and are frequently not adjusted for seasonal variations in weather. It can be difficult to schedule irrigation based on crop evapotranspiration. This crop evaporation can make weather-based crop scheduling uncertain. Because of these methods' shortcomings, soil-based irrigation scheduling is the preferred method. Irrigation management based on soil moisture measurement reduces the amount of water applied to a crop and eliminates excess water while maintaining ideal soil moisture for crop production [3]. Soil moisture content is typically monitored in soil-based measurements. And there are various methods that can be used to accomplish this. Meters and sensors, as well as the Feel and Appearance method (using a shovel or soil auger), are among these methods. The Feel and Appearance method is subjective and necessitates experienced monitoring, whereas the latter employs sophisticated devices such as sensors that measure some physical property related to soil moisture. Additionally, some portable sensing tools are pushed directly into the soil or into an access tube planted in the soil for measurement. Other systems measure it using buried sensors that are wired to a fixed meter. Because this is an automated process, it produces accurate and efficient results.

II. MATERIAL AND METHOD

Figure 1 depicts the block diagram of the soil moisture profile measurement. Figure 1 shows a moisture probe with four different levels pegged into the soil at 5 cm intervals, a real-time clock, a microSD card, and a graphic display.

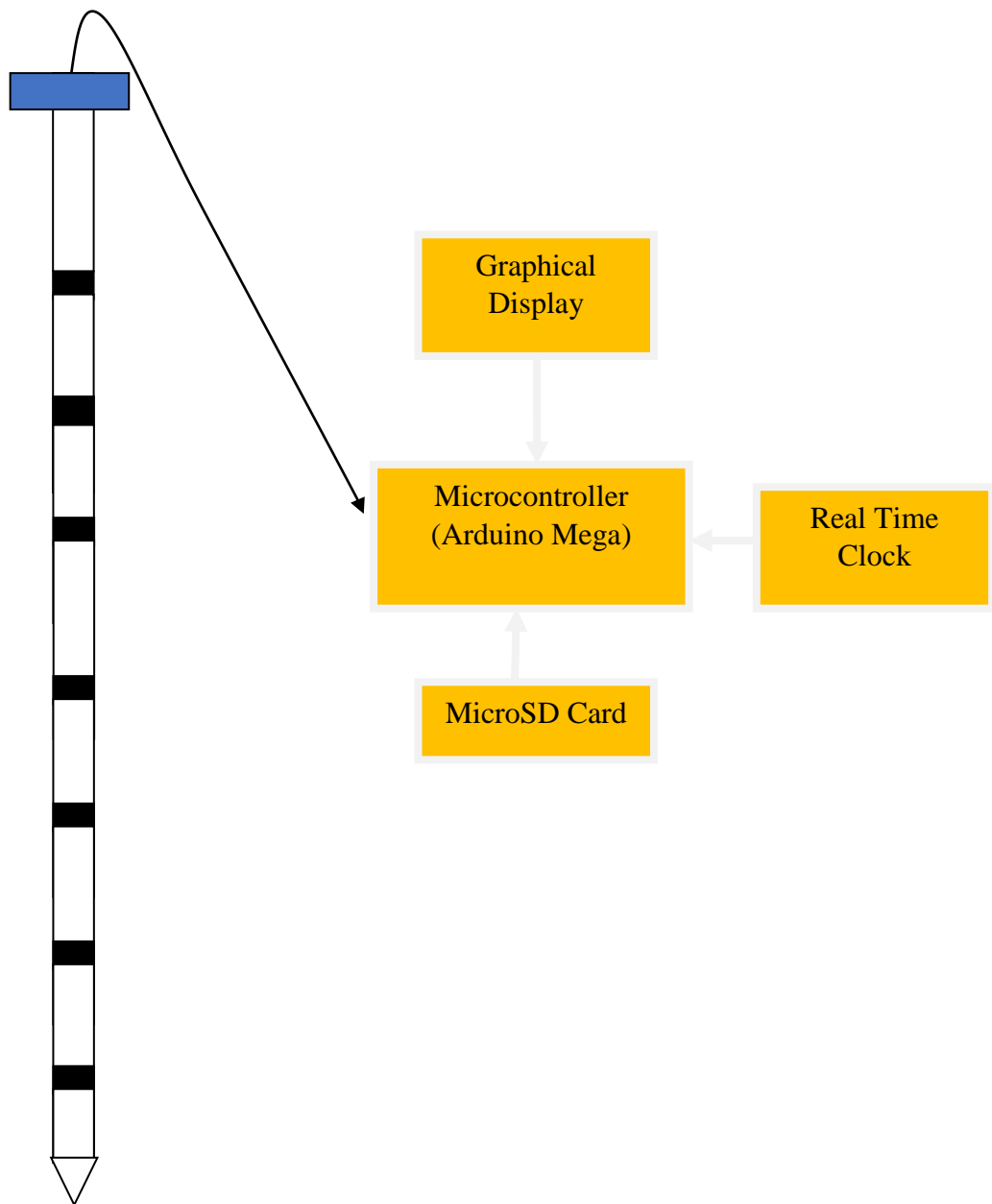


Figure 1. Block Diagram of Soil Moisture Profile Device

Construction of Soil Moisture Profile Probe

Steel metal pipe of 10 mm external and 6 mm internal diameter of 25 cm length was cut into 3 cm length. Figure 1 shows a 28 swg copper lead used for each joint. To separate 3 cm length steel metal pipe, a short plastic joint hole was used. At one end of the probe, a cylindrical hollow steel metal was used.



Plate 1. Picture of the Soil Moisture Probe Profile at 5 cm Interval

MicroSD Card Shield

SD card reader module is interfaced with the microcontroller with SPI (Serial Peripheral interface) standard. The module is designed for dual voltage power supply. The interface module can be used with two logic level either CMOS 3.3V or TTL 5V, as shown on Figure 2 of the schematic diagram of MicroSD card. [4]

Real Time Clock

The DS3232 is a low-cost temperature-compensated crystal oscillator (TCXO) with a very accurate, temperature-compensated, integrated real-time clock (RTC) and 236 bytes of battery-backed SRAM. Additionally, the DS3232 incorporates a battery input and maintains accurate timekeeping when main power to the device is interrupted. The integration of the crystal resonator enhances the long-term accuracy of the device as well as reduces the piece-part count in a manufacturing line.

The RTC maintains seconds, minutes, hours, day, date, month, and year information. The date at the end of the month is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The clock operates in either the 24-hour or 12-hour format with an AM/PM indicator. Two programmable time-of day alarms and a programmable square-wave output are provided. Address and data are transferred serially through an I2C bidirectional bus. The schematic diagram of RTC is shown in Figure 3.

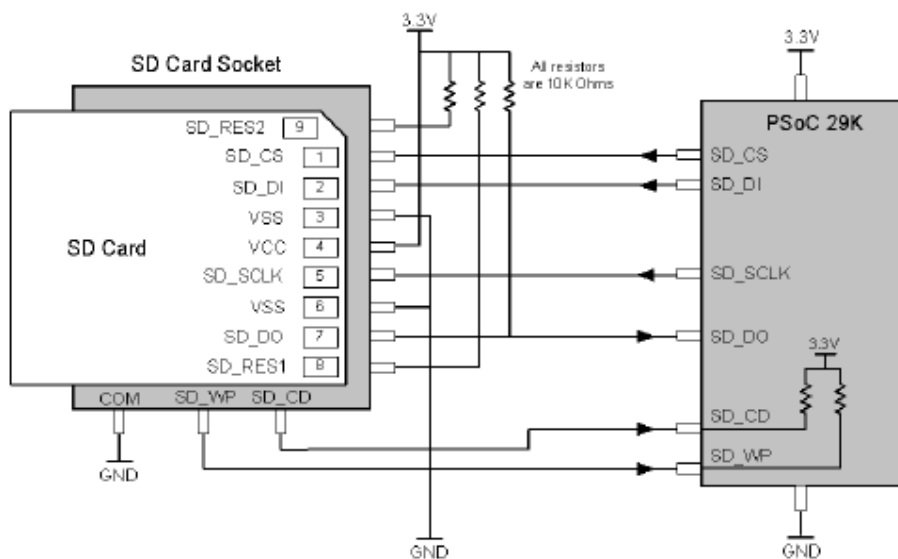


Figure 3. Schematic Diagram of MicroSD Card Module

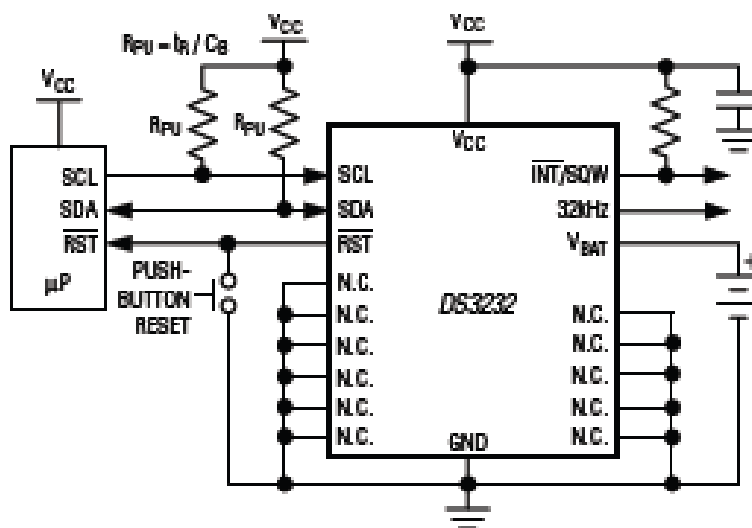


Figure 4. Schematic Diagram of RTC

Microcontroller Unit with Logging and Display Unit

A microcontroller is small size computer on a single IC containing a processor core, memory, and programmable input-output peripheral. Microcontrollers are made for embedded applications, in contrast with microprocessors, which are used for personal computers and other general-purpose applications. Atmega2560 is a low-power, high-performance, CMOS 8-bit microcontroller based on the AVR-enhanced RISC architecture. Atmega2560 provides 256 Kbytes with 8 Kbyte RAM of in-system self-programmable memory with read-while-write capability and 2 Kbyte EPROM. The microcontroller coordinates the instrument's activities, from accepting data from the moisture amplifier to processing data for storing and displaying information. The ST7920 display platform enables the use of the ST7920 with Arduino. The 3-wire SPI bus connects the components for information displays. It's a monochrome LCD graphic display. The E, R/W, and RS pins can be connected to any Arduino data port. During SPI communication, it is critical to connecting the PSB on the LCD to GND.[4, 5, 6]



Plate 2. Soil Moisture Probe Profile Device

III. TESTING AND CALIBRATION OF SOIL MOISTURE DEVICE WITH DATA LOGGER

Testing

The device was tested by simulated in the Laboratory at Department of Physics, F. U. T. Akure by gather soil in side plastic container as shown in Plate 3. Water is pour inside the gather soil at vary volume, the response of the soil moisture probe profile device moisture value in voltage increase as volume of the liquid increases

Calibration

Normally, before used the moisture measuring device it must be calibrated against soil type. In this device calibration was done with each type of soil using first principle. On this device, six type of soil was simulated in the Laboratory for calibration to determent each soil calibration constant. In carry out the calibration the following procedure.

In this most soil moisture device developed has voltage output and water content display with calibration setting. After, the equation has be liberalized and the constants of can be input into the soil moisture device. The facility was providing since soil nature differ from location to location and it necessary to calibration against the location. These are typically derived from a generic soil calibration, which is likely to be different to the soil in the study area.

Its importance to that to those soil moisture sensors is likely to have different sensitivities, even within sensors of the same type. There is need calibration in most situations.

- 1) The soil samples are collect from an area and depth to represent that particular location or site. It's important to collect the type of soil that will be measuring in the study.
- 2) Sieve out or manually remove any rocks, plant material or non-organic material from the samples.
- 3) Dry the soil samples – The most efficient way to do this is in an oven. From the literature the temperature recommended is between 105°C to 125°C. Soil samples can also be air dried on paper in a warm, dry room; however, this is likely to take days or even weeks.

4) Place the dried soil into plastic containers that are large enough for the sensing area of your soil moisture sensor to be completely buried without touching the sides of the container. We recommend at least 3-4 cm of soil between the sensor and the closest edge of the container. One container for each calibration point wish is use.

5) Create a range of moisture in each sample by adding water, where the first container is kept dry and the final container is fully saturated. You can use the soil moisture sensor to check that each container is increasingly moist. Be sure to measure from the driest to the wettest, or make sure the sensor is fully dried between each container. It is important that the soil in each container is well mixed so that the moisture level is consistent.

6) Measure and record the sensor output in each container, then take a sample from each container. Weigh these samples on an analytic balance and record the wet weight.

7) Place each sample into an oven to dry. Once dried fully, record the dry weight of each sample. Gravimetric Soil Water content can be calculated as follows:

$$\text{Water Content} = (\text{wet weight} - \text{dry weight}) / (\text{dry weight} * 100)$$

IV. CONCLUSION

The moisture measuring device was developed the display information is shown on Plate 2. The two USB is used to connect the sensor to logger unit. Moisture resolution is 0.02%. The calibration can be done at any location depending on the type of soil and the first principle used.

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Ewetumo T, et. al. "Development Soil Moisture Profile with Data Logger." *The International Journal of Engineering and Science (IJES)*, 12(5), (2023): pp. 01-05.