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Soil Water Level Testing For Agriculture

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❖ **<u>Abstract</u>: -**

As the population of the world increases rapidly, we have to arrange food for our existence and as well as to reduce environmental impact and increase the usage of limited natural resources, the use of precision agriculture is becoming more and more important nowadays. One of the main disadvantages for the use of precision agriculture is the cost of technological engrossment in the sector. For farmers, it is necessary to provide a low-cost and vigorous system that gives sufficient reliability.

Through this paper we will discuss a low-cost water level detecting sensor that can help the farmers to enhance the watering process in their cultivation work. Each node consists of four water level sensors that are able to measure the moisture at different depths. The sensor is based on mutual induction between coils that allow keeping track of the percentage of water content in the soil. We also have built a specific communication entente to improve the performance of the total system.

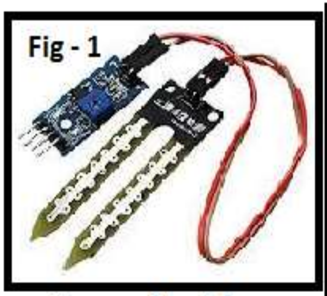
❖ **<u>Abbreviations</u>:-**

I) IDE- Integrated Development Environment. II) E.g. - Exempli Gratia or Example.
III) I.e. - That is. IV) USA- United States of America. V) PWM - Pulse Width Generator.
VI) POT- Potentiometer. VII) I/O-Input/output. VIII) LCD-Liquid Crystal Display.

❖ **<u>List of Components Required</u>: -**

i. Sensor Module, ii. 16*2 LCD Display, iii. 10 Kohm Potentiometer, iv. Arduino UNO
v. Breadboard, vi. Connecting Wires, vii. Power Supply.

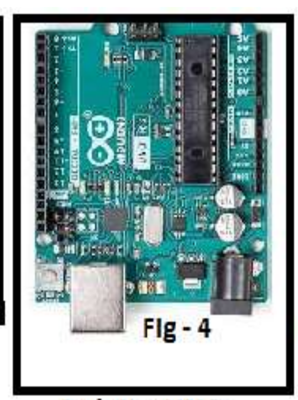
❖ **<u>Figures of The Above Mentioned Componens</u>**



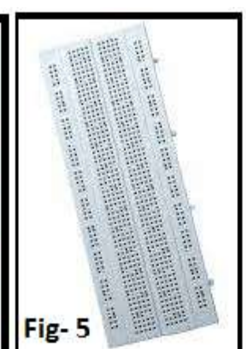
Sensor Module

LCD Display

Potentiometer



Arduino UNO

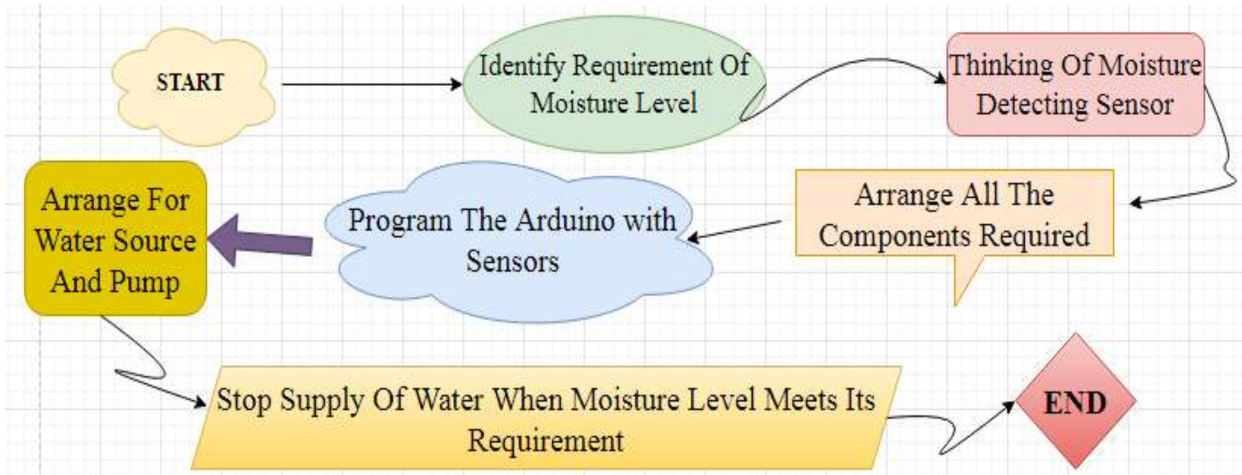


Breadboard

❖ **<u>Methodology Adopted</u>: -**

At first we have to identify what moisture level is required in soil for the agricultural work. It can vary depending upon which plant we want to grow. We have to arrange all the electronics components to make that testing equipment. Program the humidity sensor as per requirement. Then arrange for a water source so that when water is required we can bring from that with the help of a motor pump. Finally we also have to program it carefully so that when the moisture level needs its requirement stop pumping the water.

➢ **<u>Algorithm For The Soil water Level Testing For Agriculture</u>: -**



➢ **<u>Introduction</u>**: -

i. <u>Problem Statement</u>: **-** Well planned cultivation is one of the vital factors to increase the development of imperishable agriculture, especially in dry and semi-dry regions where there are the greatest constraints. Irrigation methods can be divided into three general categories; these are (1) gravity irrigation, (2) sprayer irrigation, and (3) trickle irrigation. However, in order to determine the particular irrigation needs of a specific plant, sensing devices must be used to obtain data such as soil moisture.

ii. <u>Motivation</u>: **-** Ideal agriculture is a concept that came out in the USA in the 1980s. It is an administration plan that allows making decisions to improve farming productivity and to achieve feasible ventures. It is based on the management of crops by measuring, and acting against the changeability of the aspects that affect them.

iii. <u>Goal of the thesis work</u>: - For the correct progress, it is essential to ensure that the roots have the right levels of water. High water levels can ease the proliferation of fungi in the roots thus affecting production. However, an extremely low soil water level can cause the soil to crack. Causing broken roots and the tree to die. This fact negatively affects the growth of plants and as well as their production. For farmers they want to use technology on a huge scale, it is important to provide low-cost systems to make easier deployments.

iv. <u>Outline of the thesis</u>: **-** In this paper, we present a group-based moisture sensor network to effectively irrigate agricultural lands. The circuit is composed of both actuators and sensor nodes that will collect data from the soil and will activate different watering systems as a function of the plants needs. The paper presents the design of the operation algorithm and the message for calculated use of water.

➢ **<u>Components Required</u>**

1) **Arduino UNO**:- It is an open-source microcontroller based on the Microchip ATmega328P microcontroller. The board is equipped with sets of digital and analog Input/output pins that may be interfaced to various expansion boards.The board has 14 digital Input/Output pins (six capable of Pulse-width modulation output), 6 analog Input/Output pins, and is programmable with the Arduino IDE.
2) **Soil Moisture Sensor Module**:- The Soil Moisture Sensor Module determines the amount of soil moisture by measuring the resistance between two metallic probes that is inserted into the soil to be examined. This can be used in an automatic plant watering system for some time when a plant needs watering.
3) **16*2 LCD Display**: **-** A 16x2 LCD (liquid crystal display) is a very basic module and is commonly used in various circuits. A 16x2 LCD means it can display 16 characters per line. In this LCD each character is displayed

in a 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix displays is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data.

4) **10 Kohm Potentiometer**: - A potentiometer is a three-terminal resistor with a rotating contact that forms an adjustable voltage divider. If only two terminals are used, it acts as a variable resistor or rheostat.
5) **Breadboard**: - A breadboard is a solder less device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their terminals into the holes and then making connections through wires.
6) **Connecting wires**
7) **Power supply**

★ **Background**: -

1) Interfacing Soil Moisture Sensor with Arduino: -

We have seen how a soil moisture sensor works; let us take you through the steps of Interfacing Soil Moisture with Arduino. The advantage of this soil moisture module is that you can get the analog output from it. By using this analog signal and giving it to the Analog IN of Arduino, you can precisely calculate the percentage of moisture in the soil.

- Make the connections as per the circuit diagram and upload the code to Arduino.
- Place the soil moisture probe in a “dry” pot and check for readings. In our case, it was around 25%.
- You can adjust the sensitivity of the sensor by the help of a potentiometer on the board of the sensor.

2) Programming Code of Arduino

```
#include<LiquidCrystal.h>
Const int rs = 9, en = 4, d4 = 6, d5 = 7, d6 = 4, d7 = 5;
Liquid Crystal lcd (rs, en, d4, d5, d6, d7);
int j=0;
int prev=0;
int pres=0;
void setup(){
  lcd. begin(16, 2);
  lcd. Set Cursor(0,0);
  lcd. print(" Soil Moisture  ");
  Serial. begin(9600);}
void loop()
{ j=analog Read(A0);
  j=map(j,0,982,148,0);
  pres=j;
  if(j>100)
  j=100;
  else if(j<0)
  j=0;
  lcd. set Cursor(6,1);
  lcd. print(j);
  lcd. print("%  ");
  prev =j;
  delay(400);
  }
```

❖ **Experiment: -**

i. Working: - The working of the Soil Moisture Sensor is very simple. It works on the principle of voltage comparison. The following circuit will be helpful in understanding the working of a typical soil moisture sensor. As you can see, one input of the comparator is connected to a 10KΩ Potentiometer while the other input is connected to a voltage divider network formed by a 10KΩ Resistor and the Soil Moisture Probe. Based on the amount of moisture in the soil, the conductivity in the probe varies. If the moisture content is less, the conductivity through the probe is also less and hence the input to the comparator will be high. This means that the output of the comparator is HIGH and as a result, the LED will be OFF. Similarly, when there is sufficient water, the conductivity of the probe increases and the output of the comparator become LOW. The LED starts glowing.

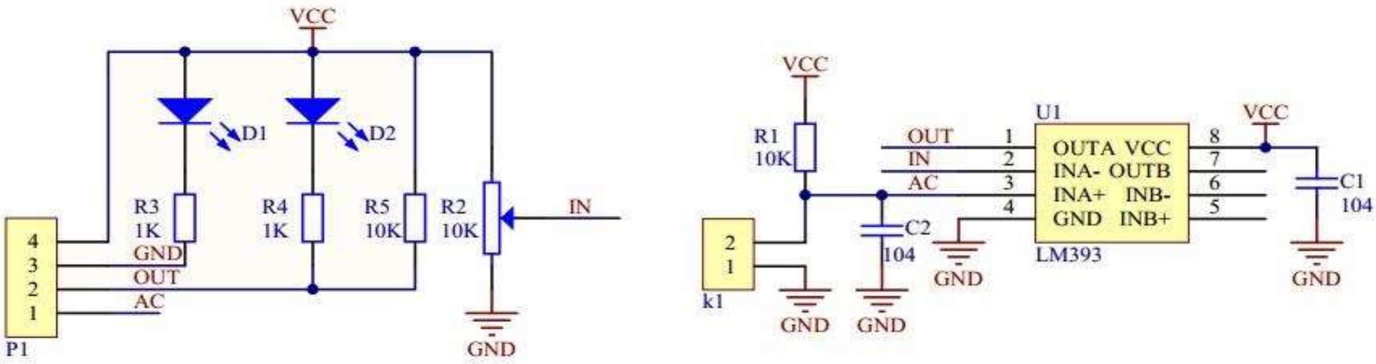


FIGURE: - 6 Working Principle

ii. Circuit Design: - The design of the circuit is very simple. Connect the probe to the breadboard and provides power supply to the board. Take the analog out pin from the breadboard and connect it to Analog IN pin A0 of the Arduino. To view the results, we used a 16×2 LCD Display, where we connected its data pins D4 – D7 to Arduino Pins 5 – 2. All the additional connections are mentioned in the circuit diagram.

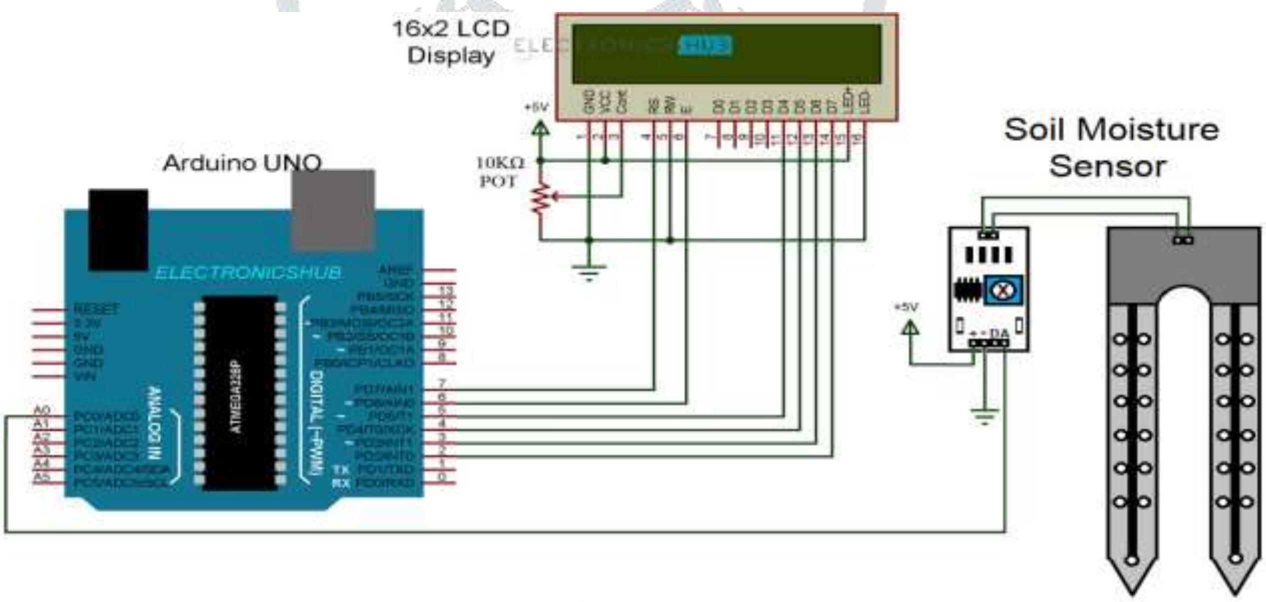


FIGURE: - 7 Circuit Diagram

➢ **Application: -**

If we talk about its application besides being used in agricultural land, it can be also used in-

1) Home Garden Watering,

2) Lawn Watering,

3) Interior Plants Caring and Maintenance,

4) Low Light Plant Setup and Maintenance.

- **Conclusion: -**

Measuring the amount of water needed to water a plant is useful to carry out sufficient use of a scarce resource such as water. The introduction of technology in the farming sector is also important to improve the sustainability and determination of the sector. For this reason, this paper has presented the layout of a low-cost sensor based on coils for measuring soil water content. These coils have been tested to analyze their behavior based on the water level of the soil. After the observed results, it has been concluded that the sensor that has had the best performance is prototype 1 working at 95 kHz. This sensor is able to measure the percentage of moisture content in the soil at the desired depth. The sensor and power supply circuit is connected to an ESP32 module for reading and storing water measurements. The whole system has been tested with real samples for the extraction of its mathematical behavior model. The results show that our sensor shows that by using these models we can get accuracies close to 91%. According to the results, and after modeling mathematically the results of the network coverage, we can conclude that for the case of mango groves, the best results are obtained when the emitter is placed at 0.5 and 1 m and the receiver is placed near the ground.

- **Future Scope**

In future scope, we would like to perform more practical experiments with different types of coils and different kinds of soils to design a more versatile sensor which is able to work with several types of soils without changing the sensor. It will also study the possibility of including a system to automatically adapt the working frequency to the type of soil. Because in our practical experiments we have included only the measurements of signal amplitude, it could be interesting to measure the quadrature component and phase of the obtained signal and try to analyze these parameters with changes of pH level of water. We also want to add other sensors in a multi-parametric node to place in the crop field to enhance the efficiency of water management in imperishable agriculture. In this sense, we want to check if soil temperature has any effect over the soil moisture measurements and, if required, over obtaining the soil moisture values compensated with temperature. Finally, as the last step, we will study the most appropriate enclosures to protect our entire system.

❖ **Table – 1**. Crop Wise Water Requirement Level (in mm).

CROP	WATER REQUIREMENT (mm)	CROP	WATER REQUIREMENT (mm)
RICE	1200	TOMATO	600-800
WHEAT	450-650	POTATO	500-700
MAIZE	500-800	PEA	350-500
SUGARCANE	1500-2500	ONIONS	350-550
COTTON	700-1300	CHILLIES	400-600
SOYBEAN	450-700	CABBAGE	350-500
BANANA	1200-2200	CITRUS	900-1200
BEANS	300-500	GRAPES	700-1200
TURMERIC	1200-1400	MANGO	1000-1200

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