Chapter 1

Introduction

1.1 Basic Introduction

Soil testing is an important tool for evaluating or avoiding problems of nutrients balance. Growers can roughly estimate how much fertilizers should be applied to their crop according to general fertilizer recommendations. But a more accurate, cost-effective fertilizer application requires soil testing. Soil test allows you to know the starting point, and this is a very valuable piece of information. Soil Identification is the most important factor for agriculture purpose, soil irrigation, water handling capacity etc. We need to know our soil, if we want to get the BEST from them. This project will help to detect which crop can grow in given sample of soil and develop a device which can measure all the possible properties, nutrients, moisture content of any soil given to it.

Unfortunately it has been overlooked in the past and taken for granted with disastrous results, such as the North American dust bowl of the 1930s. Today, the role of soil health on our climate as a whole is taken more seriously, with researchers at organizations such as the USDA-ARS (US Department of Agriculture – Agricultural Research Service) looking into how exactly soil interacts with the rest of our environment. Because of on-going research and general interest in soil health and sustainability growing ever year, monitoring soil in a more substantial an quantifiable way is becoming more important. In the past, monitoring the soil meant going out and physically handling the soil, taking samples, and comparing what was found to existing knowledge banks of sol information.

While nothing will replace actually going out and handling the soil for basic information, today’s technology makes it possible to remote monitor soil and track parameters that simply can’t be easily or quickly measured by hand. Soil probes are now extremely accurate and offer an unparalleled look at what is going on below the surface. Giving instantaneous information on soil moisture content, salinity, temperature and more, soil sensor are an important tool for anyone involved with soil, from a small-town farmer trying to increase his crop yield to
researchers looking at how soil retains and off gases CO₂. More important, just as computer have increased in power and dropped in price it became affordable for everyone.

1.2 Project overview

For various soils there are different types of properties like Nutrients, pH value, Organic matter etc. These properties can be detected by various numbers of testing, but these testing take lots of time. Our Device will detect all the parameters of a given soil sample once at a time. The soil test values are indicators of the relative available nutrient levels in the soil.

The soil test values for phosphorus, potassium, calcium and magnesium are not equal to the total amounts of these nutrients available in the soil for plant uptake, but they are correlated with plant growth and yield responses, and with fertilizer needs.

1.2.1 Nitrogen “N” in “N-P-K”

Nitrogen is probably the element you hear about the most when associated with gardening and farming. This is probably because applications of readily available forms of N create a quick growth response and short-term “greening-up”. Nitrogen is the essential constituent of proteins, which plants need to fabricate the chlorophyll responsible for plants’ green foliage. Nitrogen is also abundant in the atmosphere, constituting 80% of the air we breathe. While nitrogen gas in the air is inert, fertilizer forms of nitrogen can be highly volatile.

1.2.2 Phosphorus “P” in “N-P-K”

Phosphorous is the key element plants need for flowering, fruiting and rooting. You see this compound primarily in the form of bones (bone meal) or ancient bone piles (rock phosphate). It is normally found in nature combined with calcium in the form of calcium phosphate. In this form, the Pretends to remain “locked up” with calcium (not available to plants) so it must be “unlocked” in the soil through natural microbial and chemical processes. So, it is crucial to have phosphorous inadequate quantity and a
healthy, balanced, bio-active soil to make it available to the plants. Because of the stability of the calcium-phosphorous bond, burning does not occur even with high phosphorous applications.

### 1.2.3 Potassium “K” in “N-P-K”

Potassium, or Potash, exists in most types of organic matter and is critical for plant vigor as it regulates metabolism. Too much potassium can lead to a high pH. Wood ash is often suggested as a source of, but we do not recommend its use as it is very difficult to know just how much K is in the ash, and it also may not be considered a legal organic source of potassium.

### 1.3 Literature Survey

A Visit to “District Soil Survey and Soil Testing Officers, Soil Survey is often performed by commercial labs that offer a variety of tests, And Soil Testing Laboratory, Thane “. Soil testing targeting groups of compounds and minerals.

The advantages associated with local lab is that they are familiar with the chemistry of the soil in the area where the sample was taken. This enables technicians to recommend the tests that are most likely to reveal useful information. We learned from this laboratory the testing for soil pH and EC.

For the realization of the topic research, relevant information in the international scientific area was collected through studies of diverse literature from text books/literature, international scientific journals, environmental progress report from different agencies, Internet websites, reports by governmental agencies, substantial knowledge was gathered and a review of what other scientist have written on issues concurring with the research topic is made.
Integral analysis approach for different types of Soil

1.3.1 Physical value depend on soil

The pH optimum depends upon soil organic matter and clay content for clay and loam soils:
- under 5.2 is too acidic.
- 6.5 to 7 is ideal.
- over 7 is too alkaline pH value

The EC is a measure of the soil salinity:
- 1-2 affects a few plants
- 2-4 affects some plants
- >4 affects many plants

Table no 1.1: Micro-Nutrient Content Breakdown

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Nitrogen (N)</th>
<th>Phosphorus (P)</th>
<th>Potassium (K)</th>
<th>Combination (NPK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Critical</td>
</tr>
<tr>
<td>2</td>
<td>Low</td>
<td>Low</td>
<td>Medium / High</td>
<td>Bad</td>
</tr>
<tr>
<td>3</td>
<td>Low</td>
<td>Medium / High</td>
<td>Low</td>
<td>Bad</td>
</tr>
<tr>
<td>4</td>
<td>Low</td>
<td>Medium / High</td>
<td>Medium / High</td>
<td>Good</td>
</tr>
<tr>
<td>5</td>
<td>Medium / High</td>
<td>Low</td>
<td>Low</td>
<td>Bad</td>
</tr>
<tr>
<td>6</td>
<td>Medium / High</td>
<td>Low</td>
<td>Medium / High</td>
<td>Good</td>
</tr>
<tr>
<td>7</td>
<td>Medium / High</td>
<td>Medium / High</td>
<td>Low</td>
<td>Good</td>
</tr>
<tr>
<td>8</td>
<td>Medium / High</td>
<td>Medium / High</td>
<td>Medium / High</td>
<td>Good</td>
</tr>
</tbody>
</table>
1.3.2 Overall Datasheet of Soil

Table no 1.2: Moisture constants for few typical Indian soils

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Air dry moisture</th>
<th>Hygroscopic coefficient</th>
<th>Wilting coefficient</th>
<th>Moisture equivalent</th>
<th>Maximum water hold capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy black</td>
<td>3.8</td>
<td>20.7</td>
<td>29.9</td>
<td>53.2</td>
<td>79.7</td>
</tr>
<tr>
<td>Medium black</td>
<td>2.1</td>
<td>13.3</td>
<td>20.6</td>
<td>45.6</td>
<td>66.6</td>
</tr>
<tr>
<td>Alluvial</td>
<td>1.6</td>
<td>7.6</td>
<td>13.5</td>
<td>40.5</td>
<td>48.7</td>
</tr>
<tr>
<td>Sandy</td>
<td>0.5</td>
<td>1</td>
<td>5.3</td>
<td>21.8</td>
<td>25.2</td>
</tr>
<tr>
<td>Late rite</td>
<td>0.8</td>
<td>2.8</td>
<td>5.5</td>
<td>32.9</td>
<td>39.6</td>
</tr>
</tbody>
</table>

Table no 1.3: Interpretation of data

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorous</td>
<td>0-7</td>
<td>8-15</td>
<td>Over 15</td>
<td></td>
</tr>
<tr>
<td>Potassium</td>
<td>0-60</td>
<td>60-120</td>
<td>121-180</td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>0-4</td>
<td>4-10</td>
<td>Over 10</td>
<td>Iron</td>
</tr>
<tr>
<td>Manganese</td>
<td>0-0.5</td>
<td>0.6-1</td>
<td>Over 1</td>
<td>Manganese</td>
</tr>
<tr>
<td>Zinc</td>
<td>0-1</td>
<td>1-1.5</td>
<td>Over 1.5</td>
<td>Zinc</td>
</tr>
<tr>
<td>Copper</td>
<td>0-0.2</td>
<td>0.3-0.5</td>
<td>Over 0.5</td>
<td>Copper</td>
</tr>
<tr>
<td>Boron</td>
<td>0-0.2</td>
<td>0.2-0.5</td>
<td>Over 1</td>
<td>Boron</td>
</tr>
</tbody>
</table>

Table no 1.4: Ideal percentage of cat ions

<table>
<thead>
<tr>
<th></th>
<th>Potassium</th>
<th>Sodium</th>
<th>Calcium</th>
<th>Magnesium</th>
<th>Hydrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>abt 5%</td>
<td>millieq K</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 3%</td>
<td>Sodium</td>
<td>millieq Na</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abt 70%</td>
<td>Calcium</td>
<td></td>
<td>millieq Ca</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-20%</td>
<td>Magnesium</td>
<td></td>
<td></td>
<td>millieq Mg</td>
<td></td>
</tr>
<tr>
<td>5-10%</td>
<td>Hydrogen</td>
<td></td>
<td></td>
<td></td>
<td>millieq H</td>
</tr>
</tbody>
</table>
Integral analysis approach for different types of Soil

Table no 1.5: Red soil

<table>
<thead>
<tr>
<th>Red Soil</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical composition</td>
<td>non-soluble material</td>
<td>iron</td>
<td>aluminum</td>
<td>organic matter</td>
</tr>
<tr>
<td></td>
<td>90.47%</td>
<td>3.61%</td>
<td>2.92%</td>
<td>1.01%</td>
</tr>
<tr>
<td>Environmental condition</td>
<td>Warm, temperate, moist climate, under deciduous or mixed forest</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical property</td>
<td>Color</td>
<td>Structure</td>
<td>Texture</td>
<td></td>
</tr>
<tr>
<td>Crops</td>
<td>Groundnut, millets, ragi, rice, potato, sugarcane, wheat, tobacco, apple etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table no 1.6: Alluvial soil

<table>
<thead>
<tr>
<th>Alluvial soil</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical composition</td>
<td>Ample potash</td>
<td>Lime</td>
<td>Phosphoric acid</td>
<td></td>
</tr>
<tr>
<td>Physical property</td>
<td>Consist of:</td>
<td>Clay</td>
<td>Slit</td>
<td>Sand</td>
</tr>
<tr>
<td>Chemical property</td>
<td>Alkaline in nature. Lacking in nitrogenous &amp; organic substances.</td>
<td>EC &lt; 1.0 dsm⁻¹</td>
<td>Moisture content 10.5-22.0%</td>
<td></td>
</tr>
</tbody>
</table>
### Black cotton soil

| Chemical property | Rich in CaCO₃  
Iron oxide  
Organic matter like humus  
PH value is 8.9  
SiO₂/Al₂O₃ is 3.5%  
Soluble matter 68.71%  
Ferric oxide 11.24%  
Alumina 9.3%  
Water and Organic matter 5.83%  
Lime 1.81%  
Magnesium 1.79% |
|------------------|--------------------------------------------------|
| Physical property | High clay content being 40-50%  
High moist content |
| Minerals         | Iolite  
Kaolinite |
| Environmental condition | This soil passed high strength in summer and decrease rapidly in winter. |
| Crops            | Cotton, Wheat, Jawar, millets, castor, tobacco, sugarcane, vegetables etc.. |

### Late rite soil

| Chemical composition | Rich in iron and aluminum.  
Poor in lime, potash and magnesium. |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Red</td>
</tr>
</tbody>
</table>
| Physical property    | Acidic in nature.  
Coarse in texture. |
Integral analysis approach for different types of Soil

<table>
<thead>
<tr>
<th>Crops</th>
<th>Tea, coffee, cashew, rubber and coconut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minerals</td>
<td>It consist of:</td>
</tr>
<tr>
<td></td>
<td>Quartz</td>
</tr>
<tr>
<td></td>
<td>Zircon</td>
</tr>
<tr>
<td></td>
<td>Oxides of Titanium</td>
</tr>
<tr>
<td></td>
<td>Iron</td>
</tr>
<tr>
<td></td>
<td>Tin</td>
</tr>
<tr>
<td></td>
<td>Aluminum</td>
</tr>
<tr>
<td></td>
<td>Manganese</td>
</tr>
</tbody>
</table>
Chapter 2

Background

2.1 Basic

Soil monitoring assesses, prevents or lessens the effects of substances that may potentially harm soil or, water, air and organisms in contact with the soil. In Alberta, soil monitoring for industrial and municipal facilities is regulated under the Environmental Protection and Enhancement Act. Soil monitoring detects and evaluates possible substance release from industrial and municipal facilities to soils and related environments as well as monitoring of historical spills and leaks at plant sites.

Facilities such as sour gas plants, particularly those that recover sulphur, can require soil monitoring. Soil sampling or monitoring may also be required to establish baseline conditions for significant expansions or new plants. However, some facilities (or parts of them) may be exempted from soil monitoring requirements, due to minimal risks in the type of operation, or because engineered controls are in place to protect the soil.

2.1.1 Soil management program

Where soil monitoring reveals contamination in excess of specified limits, a management program is required consisting of a soil monitoring proposal, its implementation and periodic progress reports. The program aims to do the following (as needed):

- control the contamination source
- further assess and determine the size of the contaminated area meets remediation objectives authorized by Alberta Environment and Parks (AEP)
- choose appropriate treatment, containment, or disposal technologies
- implement, monitor and report on the chosen technology
- sample to verify contaminant removal to target levels
2.1.2 Types of monitored substances

Examples of contaminants that require monitoring include:

- toxic materials such as petroleum, heavy metals and polychlorinated biphenyls
- high levels of low toxicity petroleum products, elemental sulphur, and sodium salts
- materials that are mobile in the soil and may damage groundwater quality such as some salts, organic solvents, acids, alkaline substances and amines (strong basic substances such as ammonia).

2.1.3 Soil Pore Pressure Measurement

The BAT system can perform ground water pressure measurements. An electronic pressure transducer allows the BAT module to accurately measure both negative and positive ground water pressures at the position of the filter tip. Pressure measurements in the range from -10m to 150m can be determined to a resolution of 10mm of water column.

2.1.4 Soil Permeability Measurement

The BAT system allows for routine testing of in-situ permeability. Testing involves measuring the rate of flow into or out of a sample container. Flow rates are computed by monitoring the pressure change in the container and using Boyle's law to convert the pressure change to a volumetric change. Analysis of the time-pressure record yields the coefficient of permeability.

Top soil is a very important environmental compartment for many reasons, like it being the medium where plants grow, carbon accumulates, and so forth. But it also represents the "sink" where a wide range of waste materials, in very heterogeneous chemical forms, are disposed of and accumulate. This fact may allow contaminants to move downward the soil profile and reach subsurface and groundwater reservoirs. Agricultural activities can lead to land contamination due to the improper use of pesticides, agrochemicals, fertilizers, conditioners, and several other materials. The problem of contaminated land is exacerbated by industrial activities, including waste disposal and accidental spills that can also contribute to extensive contamination in the
near surface environment. Dangerous contaminants can impact the characteristics and productivity of the surface soil as well as the subsurface and valuable natural resources conditions. Soil pollution threatens human health, quality of foods, and groundwater but affects also the quality of the air.

Surface and subsurface soil monitoring and characterization can be challenging since chemical analyses at sampling points are local providing an inadequate model of the subsurface. Thus, novel, cost-effective, and multidisciplinary methods are needed to accurately describe surface/subsurface soil contamination whilst monitoring the evolution of the contamination over time producing time lapse models. Continuous advances on characterization methods (such as automated acquisition systems of subsurface parameters), changes in regulatory standards, and the development of remediation systems further complicate this task. With this special issue, we aim at bringing together scientists from different disciplines, with research focused on surface soil and subsurface contamination. Furthermore we want to highlight recent research advances on characterization and monitoring methods and identify the pathways for their implementation to industry, agriculture, and society to encourage their adoption.

A soil moisture monitoring system is a combination of devices that can perform one or more of the following functions: sense soil moisture, read/store data, and transmit data to a computer, which helps organize, visualize and interpret the soil moisture data. A soil moisture monitoring system can, therefore, be divided into the following five components: (1) the soil moisture sensing probe, (2) the power supply, (3) the data collection device, (4) the data transmitter, and (5) the base station.
2.2 Block diagram

Fig 2.1: Basic Block Diagram
2.3 Components

2.3.1 Arduino

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online[6]. We can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so we use the Arduino programming language (based on wiring), and the Arduino Software (IDE), based on Processing.

![Arduino Diagram](image)

Fig 2.2: Arduino
The Arduino hardware and software was designed for artists, designers, hobbyists, hackers, newbies, and anyone interested in creating interactive objects or environments. Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smart-phone or you’re TV! This flexibility combined with the fact that the Arduino software is free, the hardware boards are pretty cheap, and both the software and hardware are easy to learn has led to a large community of users who have contributed code and released instructions for a huge variety of Arduino-based projects.

There are many varieties of Arduino boards (explained on the next page) that can be used for different purposes. Some boards look a bit different from the one below, but most Arduinos have the majority of these components in common:

**Power (USB / Barrel Jack)**

Every Arduino board needs a way to be connected to a power source. The Arduino UNO can be powered from a USB cable coming from your computer or a wall power supply (like this) that is terminated in a barrel jack. In the picture above the USB connection is labelled -(1) and the barrel jack is labelled- (2). The USB connection is also how you will load code onto your Arduino board.

**Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF)**

The pins on your Arduino are the places where you connect wires to construct a circuit (probably in conjunction with a breadboard and some wire. They usually have black plastic ‘headers’ that allow you to just plug a wire right into the board. The Arduino has several different kinds of pins, each of which is labeled on the board and used for different functions.

**GND (3):** Short for ‘Ground’. There are several GND pins on the Arduino, any of which can be used to ground your circuit.
**Integral analysis approach for different types of Soil**

**5V (4) & 3.3V (5):** As you might guess, the 5V pin supplies 5 volts of power, and the 3.3V pin supplies 3.3 volts of power. Most of the simple components used with the Arduino run happily off of 5 or 3.3 volts.

**Analog (6):** The area of pins under the ‘Analog In’ label (A0 through A5 on the UNO) are Analog In pins. These pins can read the signal from an analog sensor (like a temperature sensor) and convert it into a digital value that we can read.

**Digital (7):** Across from the analog pins are the digital pins (0 through 13 on the UNO). These pins can be used for both digital input (like telling if a button is pushed) and digital output (like powering an LED).

**PWM (8):** You may have noticed the tilde (~) next to some of the digital pins (3, 5, 6, 9, 10, and 11 on the UNO). These pins act as normal digital pins, but can also be used for something called Pulse-Width Modulation (PWM). We have a tutorial on PWM, but for now, think of these pins as being able to simulate analog output (like fading an LED in and out).

**AREF (9):** Stands for Analog Reference. Most of the time you can leave this pin alone. It is sometimes used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

**Reset Button**

Just like the original Nintendo, the Arduino has a reset button (10). Pushing it will temporarily connect the reset pin to ground and restart any code that is loaded on the Arduino. This can be very useful if your code doesn’t repeat, but you want to test it multiple times. Unlike the original Nintendo however, blowing on the Arduino doesn’t usually fix any problems.
Power LED Indicator

Just beneath and to the right of the word “UNO” on your circuit board, there’s a tiny LED next to the word ‘ON’ (11). This LED should light up whenever you plug your Arduino into a power source. If this light doesn’t turn on, there’s a good chance something is wrong. Time to re-check your circuit!

TX/RX LEDs

TX is short for transmit, RX is short for receive. These markings appear quite a bit in electronics to indicate the pins responsible for serial communication. In our case, there are two places on the Arduino UNO where TX and RX appear – once by digital pins 0 and 1, and a second time next to the TX and RX indicator LEDs (12). These LEDs will give us some nice visual indications whenever our Arduino is receiving or transmitting data (like when we’re loading a new program onto the board).

Main IC

The black thing with all the metal legs is an IC, or Integrated Circuit (13). Think of it as the brains of our Arduino. The main IC on the Arduino is slightly different from board type to board type, but is usually from the ATmega line of IC’s from the ATMEL company. This can be important, as you may need to know the IC type (along with your board type) before loading up a new program from the Arduino software. This information can usually be found in writing on the top side of the IC. If you want to know more about the difference between various IC’s, reading the datasheets is often a good idea.

Voltage Regulator

The voltage regulator (14) is not actually something you can (or should) interact with on the Arduino. But it is potentially useful to know that it is there and what it’s for.
The voltage regulator does exactly what it says – it controls the amount of voltage that is let into the Arduino board. Think of it as a kind of gatekeeper; it will turn away an extra voltage that might harm the circuit. Of course, it has its limits, so don’t hook up your Arduino to anything greater than 20 volts.

### 2.3.2 Moisture sensor

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content.

Reliable and affordable moisture sensors with a simplified calibration process for obtaining the water content information of soil/soilless substrates were limited. An unilateral sensitive capacitive soil moisture sensor, based on the improved ECH2O sensor probe structure, was presented.

![Fig. 2.3: Moisture sensor](image)

Depending on the soil physical properties and goal of the soil moisture measurement, some devices are more effective than others. Firstly, it must be considered that although volumetric moisture is a more intuitive quantity, in fine texture soils water
is strongly retained by solid particles and therefore may not be available for plant absorption and other processes like flow. The desired sampling frequency is an important factor since response times of different sensors vary over a wide range (i.e., some devices require soil moisture to equilibrate with the sensor matrix). Thirdly, soil physical properties (texture, shrinking/swelling) may influence the suitability of the selected method, because some of them require good soil-instrument contact. On the other hand, depending on soil type and hydrologic conditions (precipitation and evapotranspiration), some instruments might have higher maintenance requirements than others.

2.3.3 Electrical conductivity

The common laboratory conductivity meters employ a potentiometric method and four electrodes. Often, the electrodes are cylindrical and arranged concentrically. The electrodes are usually made of platinum metal. An alternating current is applied to the outer pair of the electrodes. The potential between the inner pair is measured. Conductivity could in principle be determined using the distance between the electrodes and their surface area using the Ohm's law but generally, for accuracy, a calibration is employed using electrolytes of well-known conductivity. Industrial conductivity probes often employ an inductive method, which has the advantage that the fluid does not wet the electrical parts of the sensor. Here, two inductively-coupled coils are used. One is the driving coil producing a magnetic field and it is supplied with accurately-known voltage. The other forms a secondary coil of a transformer. The liquid passing through a channel in the sensor forms one turn in the secondary winding of the transformer. The induced current is the output of the sensor.[10]
This topic discusses:

1) How, with field verification, soil EC can be related to specific soil properties that affect crop yield, such as topsoil depth, pH, salt concentrations, and available water-holding capacity.

2) Soil EC maps often visually correspond to patterns on yield maps and can help explain yield variation and
3) Other uses of soil EC maps, including developing management zones, guiding directed soil sampling, assigning variable rates of crop inputs, fine tuning NRCS soil maps, improving the placement and interpretation of on-farm tests, salinity diagnosis, and planning drainage remediation.

### 2.3.4 Temperature Sensor

![LM35 sensor](image)

Fig 2.6: LM35

The most commonly used type of all the sensors are those which detect Temperature or heat. These types of temperature sensor vary from simple ON/OFF thermostatic devices which control a domestic hot water heating system to highly sensitive semiconductor types that can control complex process control furnace plants.

![Sensor Principal](image)

Fig 2.7: Sensor Principal
There are many different types of Temperature Sensor available and all have different characteristics depending upon their actual application. A temperature sensor consists of two basic physical types:

- Contact Temperature Sensor Types – These types of temperature sensor are required to be in physical contact with the object being sensed and use conduction to monitor changes in temperature. They can be used to detect solids, liquids or gases over a wide range of temperatures.

- Non-contact Temperature Sensor Types – These types of temperature sensor use convection and radiation to monitor changes in temperature. They can be used to detect liquids and gases that emit radiant energy as heat rises and cold settles to the bottom in convection currents or detect the radiant energy being transmitted from an object in the form of infra-red radiation (the sun).

The two basic types of contact or even non-contact temperature sensors can also be subdivided into the following three groups of sensors, *Electro-mechanical*, *Resistive* and *Electronic* and all three types are discussed below.

**The Thermostat**

The Thermostat is a contact type electro-mechanical temperature sensor or switch, that basically consists of two different metals such as nickel, copper, tungsten or aluminum etc, that are bonded together to form a Bi-metallic strip. The different linear expansion rates of the two dissimilar metals produces a mechanical bending movement when the strip is subjected to heat.

The bi-metallic strip can be used itself as an electrical switch or as a mechanical way of operating an electrical switch in thermostatic controls and are used extensively to control hot water heating elements in boilers, furnaces, hot water storage tanks as well as in vehicle radiator cooling systems.
The Bi-metallic Thermostat

The thermostat consists of two thermally different metals stuck together back to back. When it is cold the contacts are closed and current passes through the thermostat. When it gets hot, one metal expands more than the other and the bonded bi-metallic strip bends up (or down) opening the contacts preventing the current from flowing.

On/Off Thermostat

There are two main types of bi-metallic strips based mainly upon their movement when subjected to temperature changes. There are the “snap-action” types that produce an instantaneous “ON/OFF” or “OFF/ON” type action on the electrical contacts at a set temperature point, and the slower “creep-action” types that gradually change their position as the temperature changes. Snap-action type thermostats are commonly used in our homes for controlling the temperature set point of ovens, irons, immersion hot water tanks and they can also be found on walls to control the domestic heating system. Creeper types generally consist of a bi-metallic coil or spiral that slowly unwinds or coils-up as the temperature changes. Generally, creeper type bi-metallic strips are more sensitive to temperature changes than the standard snap ON/OFF types as the strip is longer and thinner making them ideal for use in temperature gauges and dials etc.
Although very cheap and are available over a wide operating range, one main disadvantage of the standard snap-action type thermostats when used as a temperature sensor, is that they have a large hysteresis range from when the electrical contacts open until when they close again. For example, it may be set to 20°C but may not open until 22°C or close again until 18°C. So the range of temperature swing can be quite high. Commercially available bi-metallic thermostats for home use do have temperature adjustment screws that allow for a more precise desired temperature set-point and hysteresis level to be pre-set.

2.3.5 Thermistor

The Thermistor is another type of temperature sensor, whose name is a combination of the words THERM-ally sensitive res-ISTOR. A thermistor is a special type of resistor which changes its physical resistance when exposed to changes in temperature.

Fig 2.9: Thermistor

Thermistors are generally made from ceramic materials such as oxides of nickel, manganese or cobalt coated in glass which makes them easily damaged. Their main advantage over snap-action types is their speed of response to any changes in temperature, accuracy and repeatability. Most types of thermistor’s have a Negative Temperature Coefficient of resistance or (NTC), that is their resistance value goes DOWN with an increase in the temperature, and of course there are some which have a Positive
Temperature Coefficient, (PTC), in that their resistance value goes UP with an increase in temperature.

Thermistors are constructed from a ceramic type semiconductor material using metal oxide technology such as manganese, cobalt and nickel, etc. The semiconductor material is generally formed into small pressed discs or balls which are hermetically sealed to give a relatively fast response to any changes in temperature. Thermistors are rated by their resistive value at room temperature (usually at 25°C), their time constant (the time to react to the temperature change) and their power rating with respect to the current flowing through them. Like resistors, thermistors are available with resistance values at room temperature from 10’s of MΩ down to just a few Ohms, but for sensing purposes those types with values in the kilo-ohms are generally used.

Thermistors are passive resistive devices which means we need to pass a current through it to produce a measurable voltage output. Then thermistors are generally connected in series with a suitable biasing resistor to form a potential divider network and the choice of resistor gives a voltage output at some pre-determined temperature point or value for example:

The following thermistor has a resistance value of 10KΩ at 25°C and a resistance value of 100Ω at 100°C. Calculate the voltage drop across the thermistor and hence its output voltage (Vout) for both temperatures when connected in series with a 1kΩ resistor across a 12v power supply.
Integral analysis approach for different types of Soil

![Diagram of a temperature sensor circuit](image)

At 25°C

\[
V_{out} = \frac{R_2}{R_1 + R_2} \times V = \frac{1000}{10000 + 1000} \times 12V = 1.09V
\]

At 100°C

\[
V_{out} = \frac{R_2}{R_1 + R_2} \times V = \frac{1000}{100 + 1000} \times 12V = 10.9V
\]

By changing the fixed resistor value of R2 (in our example 1kΩ) to a potentiometer or preset, a voltage output can be obtained at a predetermined temperature set point for example, 5v output at 60°C and by varying the potentiometer a particular output voltage level can be obtained over a wider temperature range.

It needs to be noted however, that thermistor’s are non-linear devices and their standard resistance values at room temperature is different between different thermistor’s, which is due mainly to the semiconductor materials they are made from. The Thermistor, have an exponential change with temperature and therefore have a Beta temperature constant (\( \beta \)) which can be used to calculate its resistance for any given temperature point.

However, when used with a series resistor such as in a voltage divider network or Whetstone Bridge type arrangement, the current obtained in response to a voltage applied to the divider/bridge network is linear with temperature. Then, the output voltage across the resistor becomes linear with temperature.
Resistive Temperature Detectors (RTD).

Another type of electrical resistance temperature sensor is the Resistance Temperature Detector or RTD. RTD’s are precision temperature sensors made from high-purity conducting metals such as platinum, copper or nickel wound into a coil and whose electrical resistance changes as a function of temperature, similar to that of the thermistor. Also available are thin-film RTD’s. These devices have a thin film of platinum paste is deposited onto a white ceramic substrate.

Resistive temperature detectors have positive temperature coefficients (PTC) but unlike the thermistor their output is extremely linear producing very accurate measurements of temperature.

However, they have very poor thermal sensitivity, that is a change in temperature only produces a very small output change for example, 1Ω/°C.

The more common types of RTD’s are made from platinum and are called Platinum Resistance Thermometer or PRT’s with the most commonly available of them all the Pt100 sensor, which has a standard resistance value of 100Ω at 0°C. The downside is that Platinum is expensive and one of the main disadvantages of this type of device is its cost.

Like the thermistor, RTD’s are passive resistive devices and by passing a constant current through the temperature sensor it is possible to obtain an output voltage that increases linearly with temperature. A typical RTD has a base resistance of about 100Ω at 0°C, increasing to about 140Ω at 100°C with an operating temperature range of between -200 to +600°C.

Because the RTD is a resistive device, we need to pass a current through them and monitor the resulting voltage. However, any variation in resistance due to self heat of the resistive wires as the current flows through it, I²R, (Ohms Law) causes an error in the readings. To avoid this, the RTD is usually connected into a Whetstone Bridge network which has additional connecting wires for lead-compensation and/or connection to a constant current source.
The Thermocouple

The Thermocouple is by far the most commonly used type of all the temperature sensor types. Thermocouples are popular due to its simplicity, ease of use and their speed of response to changes in temperature, due mainly to their small size. Thermocouples also have the widest temperature range of all the temperature sensors from below -200°C to well over 2000°C.

Thermocouples are thermoelectric sensors that basically consists of two junctions of dissimilar metals, such as copper and constantan that are welded or crimped together. One junction is kept at a constant temperature called the reference (Cold) junction, while the other the measuring (Hot) junction. When the two junctions are at different temperatures, a voltage is developed across the junction which is used to measure the temperature sensor as shown below.

Thermocouple Construction

The operating principal of a thermocouple is very simple and basic. When fused together the junction of the two dissimilar metals such as copper and constantan produces a “thermo-electric” effect which gives a constant potential difference of only a few millivolts (mV) between them. The voltage difference between the two junctions is called the “Seebeck effect” as a temperature gradient is generated along the conducting wires producing an emf. Then the output voltage from a thermocouple is a function of the temperature changes.

If both the junctions are at the same temperature the potential difference across the two junctions is zero in other words, no voltage output as \( V_1 = V_2 \). However, when
the junctions are connected within a circuit and are both at different temperatures a voltage output will be detected relative to the difference in temperature between the two junctions, $V_1 - V_2$. This difference in voltage will increase with temperature until the junctions peak voltage level is reached and this is determined by the characteristics of the two dissimilar metals used.

Thermocouples can be made from a variety of different materials enabling extreme temperatures of between -200°C to over +2000°C to be measured. With such a large choice of materials and temperature range, internationally recognised standards have been developed complete with thermocouple colour codes to allow the user to choose the correct thermocouple sensor for a particular application.

Fig 2.10: Arduino Interface with LM35

2.3.6 DC Motor

A DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces
produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of current flow in part of the motor. Most types produce rotary motion; a linear motor directly produces force and motion in a straight line.

DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications. A coil of wire with a current running through it generates an electromagnetic field aligned with the center of the coil. The direction and magnitude of the magnetic field produced by the coil can be changed with the direction and magnitude of the current flowing through it.

A simple DC motor has a stationary set of magnets in the stator and an armature with one or more windings of insulated wire wrapped around a soft iron core that concentrates the magnetic field. The windings usually have multiple turns around the
core, and in large motors there can be several parallel current paths. The ends of the wire winding are connected to a commutator. The commutator allows each armature coil to be energized in turn and connects the rotating coils with the external power supply through brushes. (Brushless DC motors have electronics that switch the DC current to each coil on and off and have no brushes.)

The total amount of current sent to the coil, the coil’s size and what it's wrapped around dictate the strength of the electromagnetic field created. The sequence of turning a particular coil on or off dictates what direction the effective electromagnetic fields are pointed. By turning on and off coils in sequence a rotating magnetic field can be created. These rotating magnetic fields interact with the magnetic fields of the magnets (permanent or electromagnets) in the stationary part of the motor (stator) to create a force on the armature which causes it to rotate. In some DC motor designs the stator fields use electromagnets to create their magnetic fields which allow greater control over the motor.

### 2.3.7 Liquid Crystal Display (LCD)

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.
Fig 2.12: 16X2 LCD

Fig 2.13: Arduino Interface with LCD
**Table no 2.1: Pin Description**

<table>
<thead>
<tr>
<th>Pin No</th>
<th>Function</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ground (0V)</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>Supply voltage; 5V (4.7V – 5.3V)</td>
<td>Vcc</td>
</tr>
<tr>
<td>3</td>
<td>Contrast adjustment; through a variable resistor</td>
<td>V_{EE}</td>
</tr>
<tr>
<td>4</td>
<td>Selects command register when low; and data register when high</td>
<td>Register Select</td>
</tr>
<tr>
<td>5</td>
<td>Low to write to the register; High to read from the register</td>
<td>Read/write</td>
</tr>
<tr>
<td>6</td>
<td>Sends data to data pins when a high to low pulse is given</td>
<td>Enable</td>
</tr>
<tr>
<td>7</td>
<td>8-bit data pins</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>DB0</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>DB1</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>DB2</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>DB3</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>DB4</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>DB5</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>DB6</td>
</tr>
<tr>
<td>15</td>
<td>Backlight V_{CC} (5V)</td>
<td>Led+</td>
</tr>
<tr>
<td>16</td>
<td>Backlight Ground (0V)</td>
<td>Led-</td>
</tr>
</tbody>
</table>
2.4 Working

- In our project we are trying to identify and analyze the type of soil and its properties for that we should know the mechanism of it.
- We are using a servomotor which will rotate for a particular angle which we will set it will rotate and stop after reaching its point.
- We will put three to four soil sample around servomotor when servomotor rotate and reach to first sample which is for soil moisture testing by using the cam and follower soil moisture sensor will dip into the soil and it will start testing it will take some time for testing.
- Same procedure is repeated for testing other two or three properties which are pH testing, EC testing.
- After testing all of the three properties the reading will given to the arduino which will compare these values with the already fixed values which are in our software.
- The signals coming from sensor will interface with the microcontroller through ADC which is inbuilt in arduino this will do the comparison.
- After correlating or compare the result will display on the screen and we will be able to know the type of soil and its corresponding properties.
3.1 Flow chart
Integral analysis approach for different types of Soil

A

MOVE MOTOR IN THE SOIL ALONG WITH SENSOR ASSEMBLE

ANALYSE SOIL

ANALYSIS DONE

DISPLAY PARAMETERS ON LCD

DISPLAY PARAMETERS ON CUSTOMISED SOFTWARE

MOVE MOTOR OUT THE SOIL ALONG WITH SENSOR ASSEMBLE

STOP
3.2 Monitoring Software (C SHARP)

C# is a multi-paradigm programming language encompassing strong typing, imperative, declarative, functional, generic, object-oriented (class-based), and component-oriented programming disciplines. It was developed by Microsoft within its .NET initiative and later approved as a standard by Ecma (ECMA-334) and ISO (ISO/IEC 23270:2006). C# is one of the programming languages designed for the Common Language Infrastructure.

C# is a general-purpose, object-oriented programming language. Its development team is led by Anders Hejlsberg. The most recent version is C# 6.0, which was released on July 20, 2015.

The ECMA standard lists these design goals for C#

- The C# language is intended to be a simple, modern, general-purpose, object-oriented programming language.
- The language, and implementations thereof, should provide support for software engineering principles such as strong type checking, array bounds checking, detection of attempts to use uninitialized variables, and automatic garbage collection. Software robustness, durability, and programmer productivity are important.
- The language is intended for use in developing software components suitable for deployment in distributed environments.
- Portability is very important for source code and programmers, especially those already familiar with C and C++.
- Support for internationalization is very important.
- C# is intended to be suitable for writing applications for both hosted and embedded systems, ranging from the very large that use sophisticated operating systems, down to the very small having dedicated functions.
- Although C# applications are intended to be economical with regard to memory and processing power requirements, the language was not intended to compete directly on performance and size with C or assembly language.
Integral analysis approach for different types of Soil

During the development of the .NET Framework, the class libraries were originally written using a managed code compiler system called Simple Managed C (SMC). In January 1999, Anders Hejlsberg formed a team to build a new language at the time called Cool, which stood for "C-like Object Oriented Language%. Microsoft had considered keeping the name "Cool" as the final name of the language, but chose not to do so for trademark reasons. By the time the .NET project was publicly announced at the July 2000 Professional Developers Conference, the language had been renamed C#, and the class libraries and ASP.NET runtime had been ported to C#.

C#'s principal designer and lead architect at Microsoft is Anders Hejlsberg, who was previously involved with the design of Turbo Pascal, Embarcadero Delphi (formerly CodeGear Delphi, Inprise Delphi and Borland Delphi), and Visual J++. In interviews and technical papers he has stated that flaws in most major programming languages (e.g. C++, Java, Delphi, and Smalltalk) drove the fundamentals of the Common Language Runtime (CLR), which, in turn, drove the design of the C# language itself.

James Gosling, who created the Java programming language in 1994, and Bill Joy, a co-founder of Sun Microsystems, the originator of Java, called C# an "imitation" of Java; Gosling further said that "[C# is] sort of Java with reliability, productivity and security deleted." Klaus Kreft and Angelika Langer (authors of a C++ streams book) stated in a blog post that "Java and C# are almost identical programming languages. Boring repetition that lacks innovation, “Hardly anybody will claim that Java or C# are revolutionary programming languages that changed the way we write programs,” and "C# borrowed a lot from Java - and vice versa. Now that C# supports boxing and unboxing, we'll have a very similar feature in Java.” In July 2000, Anders Hejlsberg said that C# is "not a Java clone" and is "much closer to C++" in its design.

Since the release of C# 2.0 in November 2005, the C# and Java languages have evolved on increasingly divergent trajectories, becoming somewhat less similar. One of the first major departures came with the addition of generics to both languages, with vastly different implementations. C# makes use of reification to provide "first-class" generic objects that can be used like any other class, with code generation performed at class-load time. Furthermore, C# has added several major features to accommodate functional-style programming, culminating in the LINQ extensions released with C# 3.0 and its supporting framework of lambda
expressions, extension methods, and anonymous types. These features enable C# programmers to use functional programming techniques, such as closures, when it is advantageous to their application. The LINQ extensions and the functional imports help developers reduce the amount of "boilerplate" code that is included in common tasks like querying a database, parsing an xml file, or searching through a data structure, shifting the emphasis onto the actual program logic to help improve readability and maintainability.

C# used to have a mascot called Andy (named after Anders Hejlsberg). It was retired on January 29, 2004.

C# was originally submitted to the ISO subcommittee JTC 1/SC 22 for review, under ISO/IEC 23270:2003, was withdrawn and was then approved under ISO/IEC 23270:2006.

The name "C sharp" was inspired by musical notation where a sharp indicates that the written note should be made a semitone higher in pitch. This is similar to the language name of C++, where "++" indicates that a variable should be incremented by 1. The sharp symbol also resembles a ligature of four "+" symbols (in a two-by-two grid), further implying that the language is an increment of C++.

Due to technical limitations of display (standard fonts, browsers, etc.) and the fact that the sharp symbol (U+266F ♯ MUSIC SHARP SIGN (HTML &♯839;)) is not present on the standard keyboard, the number sign (U+0023 # NUMBER SIGN (HTML &#35;)) was chosen to represent the sharp symbol in the written name of the programming language. This convention is reflected in the ECMA-334 C# Language Specification.[9] However, when it is practical to do so (for example, in advertising or in box art), Microsoft uses the intended musical symbol.

The "sharp" suffix has been used by a number of other .NET languages that are variants of existing languages, including J# (a .NET language also designed by Microsoft that is derived from Java 1.1), A# (from Ada), and the functional programming language F#. The original implementation of Eiffel for .NET was called Eiffel#, a name retired since the full Eiffel language is now supported. The suffix has also been used for libraries, such as Gtk# (a .NET wrapper for GTK+ and other GNOME libraries) and Cocoa# (a wrapper for Cocoa).
3.3.1 Main Screen

The main screen shows all the status of sensors. Firstly for establishing a communication we have to insert the port number to which the controller is connected to with PC. Then we have to press start button, a pop up message displays on the screen which shows that the connection between controller and PC is established or not.

Fig 3.1: Main Screen

Fig 3.2: Communication Established

Fig 3.3: Communication Disconnected
Chapter 4

4.1 Advantages

- A common person can analyze the type of soil and grow crops and yields as per the soil characteristics.
- The machines what they are using in laboratories are very costly so our device will reduce cost.
- The device which is available in laboratories are very bulky and large in size so we are trying to make a device which is compact in size and easy to handle.
- The devices which are available in laboratories takes more time for soil testing which is about 1-2 week but our device will give the result in few minutes so time requirement will be less.
- The devices available in laboratories are very costly so we are trying our device should be of less cost as much as possible.
- We get all the soil properties once at a time.
- This project is not only helpful for farmers but also for common person.
4.2 Application

- Now we are checking for two or three soil properties but in future we can determine n number of soil samples characteristics.
- We can determine micronutrients, organic and non-organic materials, water handling capacity, texture, structure.
- We can used in government based production, since, they have to produce large scale so that by considering our device they can use.
- We can also make soil based automated vehicle so by moving here and there they can test soils characteristics.
- We can also check water characteristics and properties.
- We can make self-generating rescue report using soil quality level.
Chapter 5

Conclusion

The current practice of determining soil status based on traditional methods. However, it requires a lot of time of about one to two weeks before getting the results. Through this research, one can be able to determine the soil status, the NPK content pH level and Moisture content etc. in a shorter span of time which is only about five to ten minutes. Also, results with the location where the test was conducted can be viewed by anyone using the web. This development was made by an Arduino based program and other tools which are not yet available when the traditional testing was used.
Chapter 6

Appendix

Coding:

```cpp
#include <LiquidCrystal.h>

LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
char d11[17] = "Anjuman-I-Islam";  //college_name
char d12[17] = "";
char d21[17] = "Kalsekar";
char d22[17] = "Technical Campus";
char d31[17] = "Department of";
char d32[17] = "";
char d41[17] = "Electronics &";  //dept_name
char d42[17] = "Telecom Engg.";
char d51[17] = "Soil Monitoring";  //proj_name
char d52[17] = "System";
char d61[17] = "Project By:";  //grp_no
char d62[17] = "Group No: XX";
char d71[17] = "12ET04";  //tm_name
char d72[17] = "Mundasad Aasiya";
char d81[17] = "12ET06";
char d82[17] = "Patel Misbah";
char d91[17] = "12ET10";
char d92[17] = "Shaikh Uzma";
char d101[17] = "12ET12";
char d102[17] = "Yadav Anjali";
char d111[17] = "Under Guidence";  //guide_name
char d112[17] = "PROF. AWAB FAKIH";
char d121[17] = "Press START";  //start_pb
char d122[17] = "Button";
char d131[17] = "PROCESSING...";  //processing
```
Integral analysis approach for different types of Soil

char d132[17] = "";
char d141[17] = "Moisture content"; // mos_sen
char d142[17] = "is ";
char d151[17] = "Temperature"; // temp_sen
char d152[17] = "value is ";
char d161[17] = "Electric"; // elec_sen
char d162[17] = "Conductivity: ";

int delaytm = 300;
int delaystep = 300;
int delaypb = 1000;
int blinkcount = 5;
int delayblinkON = 600;
int delayblinkOFF = 200;

int mos_sen_pin = A0;
int mos_v1;
int mos_v2;

int temp_sen_pin = A1;
int temp_v1;
int temp_v2;

int elec_sen_pin = A2;
int elec_v1;
int elec_v2;

int count;

int mf = 9;
int mr = 8;
int MON = 2000;
int s1 = 7;  //switch
int s[] = {0, 0, 0};

int LR = A3;
int LG = A4;
int LB = A5;

int moslow = 33;
int mosmed = 64;
int moshi = 100;

void setup()
{
  lcd.begin(16, 2);
  pinMode(mos_sen_pin, INPUT);
  pinMode(temp_sen_pin, INPUT);
  pinMode(elec_sen_pin, INPUT);
  pinMode(s1, INPUT);
  pinMode(mr, OUTPUT);
  pinMode(mf, OUTPUT);
  college_name();
  delay(delaystep);
  dept_name();
  delay(delaystep);
  proj_name();
  delay(delaystep);
  tm_name();
  delay(delaystep);
  guide_name();
  delay(delaystep);
Integral analysis approach for different types of Soil

Serial.begin (9600);

}

void loop()
{
    s[1] = digitalRead(s1);
    for (count = 0; count < 1; count++) {  }
    start_pb();
    delay(delaystep);
    if (s[1] == 1 /*&& millis() - swt > swd*/)
    {
        lcd.clear();
        digitalWrite(mf, 0);
        digitalWrite(mr, 1);
        delay(MON);
        digitalWrite(mf, 1);
        digitalWrite(mr, 1);
        processing();
        delay(delaystep);
        mos_sen();
        led();
        Serial.print("The Moisture content is ");
        Serial.print(mos_v2);
        Serial.print("% ");
        delay(delaystep);
        temp_sen();
        Serial.println(" ");
        Serial.print("The Temperature is ");
        Serial.print(temp_v2);
        Serial.print("°C ");
    }
delay(delaystep);
elec_sen();
Serial.println("");
Serial.print("The Electric Conductivity is ");
Serial.print(elec_v2);
Serial.print("%");
Serial.println();
delay(delaystep);
digitalWrite(mf, 1);
digitalWrite(mr, 0);
delay(MON);
digitalWrite(mf, 1);
digitalWrite(mr, 1);
}
delay(1);
}

void college_name()
{
  lcd.setCursor(0, 0);
lcd.print(d11);
lcd.setCursor(0, 1);
lcd.print(d12);
delay(delaytm);
lcd.clear();
lcd.setCursor(0, 0);
lcd.print(d21);
lcd.setCursor(0, 1);
lcd.print(d22);
delay(delaytm);
lcd.clear();

void dept_name()
{
  lcd.setCursor(0, 0);
  lcd.print(d31);
  lcd.setCursor(0, 1);
  lcd.print(d32);
  delay(delaytm);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print(d41);
  lcd.setCursor(0, 1);
  lcd.print(d42);
  delay(delaytm);
  lcd.clear();
}

void proj_name()
{
  lcd.setCursor(0, 0);
  lcd.print(d51);
  lcd.setCursor(0, 1);
  lcd.print(d52);
  delay(delaytm);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print(d61);
  lcd.setCursor(0, 1);
  lcd.print(d62);
  delay(delaytm);
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```
lcd.clear();
}

void tm_name()
{
    lcd.setCursor(0, 0);
    lcd.print(d71);
    lcd.setCursor(0, 1);
    lcd.print(d72);
    delay(delaytm);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print(d81);
    lcd.setCursor(0, 1);
    lcd.print(d82);
    delay(delaytm);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print(d91);
    lcd.setCursor(0, 1);
    lcd.print(d92);
    delay(delaytm);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print(d101);
    lcd.setCursor(0, 1);
    lcd.print(d102);
    delay(delaytm);
    lcd.clear();
```

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```c
void guide_name()
{
    lcd.setCursor(0, 0);
    lcd.print(d111);
    lcd.setCursor(0, 1);
    lcd.print(d112);
    delay(delaytm);
    lcd.clear();
}

void start_pb()
{
    lcd.setCursor(0, 0);
    lcd.print(d121);
    lcd.setCursor(0, 1);
    lcd.print(d122);
    delay(delaypb);
    lcd.clear();
}

void processing()
{
    lcd.setCursor(0, 0);
    lcd.print(d131);
    lcd.setCursor(0, 1);
    lcd.print(d132);
    for (int blinktm = 0; blinktm < blinkcount; blinktm++)
    {
        lcd.noDisplay();
        delay(delayblinkOFF);
        lcd.display();
    }
}
```
void mos_sen()
{
    mos_v1 = analogRead(mos_sen_pin);
    mos_v2 = 100 - (mos_v1 / 10.24);
    // for (int positionCounter = 0; positionCounter < 40; positionCounter++)
    // {
        lcd.setCursor(0, 0);
        lcd.print(d141);
        lcd.setCursor(0, 1);
        lcd.print(d142);
        lcd.print(mos_v2);
        lcd.print("%");
        delay(delaytm);
        //    lcd.scrollDisplayLeft();
        // }
    lcd.clear();
}

void temp_sen() //°F to °C
{
    temp_v1 = analogRead(temp_sen_pin);
    temp_v2 = temp_v1 / 2;
    // for (int positionCounter = 0; positionCounter < 40; positionCounter++)
    // {
        lcd.setCursor(0, 0);
        lcd.print(d151);
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lcd.setCursor(0, 1);
lcd.print(d152);
lcd.print(temp_v1);
lcd.print(“°C”);
delay(delaytm);
// lcd.scrollDisplayLeft();
// }
lcd.clear();
}

void elec_sen()
{

elec_v1 = analogRead(elec_sen_pin);
elec_v2 = (elec_v1 / 1024) * 100;
// for (int positionCounter = 0; positionCounter < 40; positionCounter++)
// {
lcd.setCursor(0, 0);
lcd.print(d161);
lcd.setCursor(0, 1);
lcd.print(d162);
lcd.print(temp_v1);
lcd.print(“%”);
delay(delaytm);
// lcd.scrollDisplayLeft();
// }
lcd.clear();
}

void led()
{
if (mos_v2 < moslow)
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{
    digitalWrite(LR, HIGH);
    digitalWrite(LG, LOW);
    digitalWrite(LB, LOW);
}

if (moslow < mos_v2 < mosmed)
{
    digitalWrite(LR, LOW);
    digitalWrite(LG, HIGH);
    digitalWrite(LB, LOW);
}

if (mosmed < mos_v2 < moshi)
{
    digitalWrite(LR, LOW);
    digitalWrite(LG, LOW);
    digitalWrite(LB, HIGH);
}

}
References


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