Literature review for measurement of NPK, temperature, humidity of soil

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Review:

Microcontroller

A microcontroller is a small and low-cost microcomputer, which is designed to perform the specific tasks of embedded systems . It is of various size and varies according to their processing speed, number of bits available.

Arduino uno

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins.

Arduino nano

The Arduino Nano is very much similar to the Arduino UNO. The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P.It runs with 16 MHz and features 32 KB of Flash Memory

STM32F103C8T6

The STM32F103C8T6 family of 32-bit microcontrollers based on the Arm® Cortex®-M processor. It offers products combining very high performance, real-time capabilities, digital signal processing, low-power / low-voltage operation, and connectivity, while maintaining full integration and ease of development.

Measurement of NPK

N (nitrogen), P (phosphorus) and K (potassium) contents of soil is necessary to decide how much extra contents of these nutrients are to be added in the soil to increase crop fertility. This improves the quality of the soil which in turn yields a good quality crop.

Measurement of NPK is carried out by following process:

- Conductivity measurement
- Optical method
- electrochemical methods

conductivity measurement

In conductivity measurement technique two or three electrodes of same material are immersed in soil samples. Materials used can be steel, silver, platinum, graphite or copper. An A.C. voltage is applied to electrodes in sample. Another electrode is connected to multimeter to measure the current changes. The A.C. voltage results in movements of ion which in turn results in variability of current of soil sample. Use of A.C. voltage avoids neutralization of ions. Varying current gives varying conductivity. Variability between electrical conductivity and concentration N, P, and K are observed. As concentration increases, variability in electrical conductivity increases. As per concentration of NPK in soil, conductivity of electrode change. The change in conductivity is converted into electrical signal for further electronic control system .

Electrochemical methods

Electrochemical sensors constitute Ion Selective Electrode (ISE) and Ion Selective Field Effective Transistor (ISFET). ISE and ISFET selects particular ion from samples using sensor cocktail. ISEs/ISFETs use different membranes, extraction solutions, and a multi-target system with coated wire field-effect transistor [6, 10]. CW/ FET type of electrochemical sensor uses a platinum wire coated with PVC which acts as the membrane matrix and it uses the cationic glass electrode (CGE) and the valinomycin based selective electrode (VKE) for detection of exchangeable potassium in extracts from soils .

Optical method

The last type of soil sensor technology is optical sensor. Principle of optical NPK sensors is based on the interaction between incident light and soil surface properties, such that the characteristics of the reflected light vary due to the soil physical and chemical properties. Laser Induced Florescence Spectroscopy (LIFS) is optical technique in which analyte in the molecule absorbs radiation at a certain wavelength (usually UV and visible regions). Or Near Infra-Red Spectroscopy (NIR) technique is very widely used for experimental as well as commercial purpose. NIR is a spectrophotometric method that deals with the interaction of near infrared radiation with the sample under investigation. It is based on the absorption of electromagnetic radiation at wavelengths in the range of 780-2500nm. These optical methods are reliable, but time-consuming, complex and high cost per test. This resulted in the limitation of the number of soil samples tested for characterizing the spatial variability of soil nutrients in a field or fields

Measurement of temperature

Soil temperature sensors come in a variety of designs using thermistors, thermocouples, thermocouple wires, and averaging thermocouples. some are listed below

DS18B20 water proof temperature sensor

It provides 9 to 12-bit (configurable) temperature readings over a 1-Wire interface, so that only one wire (and ground) needs to be connected from a central microprocessor.

Soil Thermometer

A thermometer used to measure the temperature of the soil**.** Two forms of the mercury-in-glass thermometer are used for this purpose.

Measurement of soil moisture

It allows the need for irrigation to be quantified in advance of a crop showing signs of distress. Knowing the soil moisture status enables highly efficient irrigation, providing the water as and when required, and eliminating the wasteful use of water when irrigation is not needed.

Capacitive soil moisture sensor

This is an analog capacitive soil moisture sensor which measures soil moisture levels by capacitive sensing, i.e capacitance is varied on the basis of water content present in the soil. The capacitance is converted into voltage level basically from 1.2V to 3.0V maximum.

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Resistive soil moisture sensor

The sensor consists of two probes which are used to measure the volumetric content of water. The two probes allow the current to pass through the soil and then it gets the resistance value to measure the moisture value.When there is more water, the soil will conduct more electricity which means that there will be less resistance. Therefore, the moisture level will be higher. Dry soil conducts electricity poorly, so when there will be less water, then the soil will conduct less electricity which means that there will be more resistance. Therefore, the moisture level will be lower.

Conclusion

We are using the stm32 microcontroller in this project because it is more efficient. All the above methods present for the measurement of NPK in soil are inefficient because it is time-consuming and expensive, so we have decided to use the NPK sensor for measuring nitrogen, phosphorous, and potassium in the soil. Using NPK sensors is more efficient and convenient. It also takes less time to give the result.
There are multiple sensors available for measuring the temperature and humidity of the soil, but we found that the DS18B20 waterproof temperature sensor is better for measuring temperature and the Capacitive soil moisture sensor for measurement of moisture in terms of cost and calibration, so we have decided to use these components.