Comparative Study of Different Methodologies used for Measuring Soil Parameters: A Review

Varsha A. Shukre
School of Computer Science,
Dr.Vishwanath Karad MIT World Peace University,
Pune, India

Supriya S. Patil
Department of Electronic Science,
Abasaheb Garware College
Pune,India

***Abstract*— Soil Parameters plays a vital role to increase the crop yield. Soil parameter includes pH, Humidity, K (potassium), P (phosphorus) and N (nitrogen) etc. Measurement of these parameters is necessary, which gives us an idea to choose the appropriate fertilizers for the deficient component of the soil and improves crop yield.. This paper aims at comparative study of different methodologies available for measuring soil parameters with their pros & cons. This will help to find out the most appropriate method for measurement of soil parameters & scope to enhance it in terms of execution speed, accuracy & cost by designing sensors, interfacing it with an embedded system and using internet of things for real time data monitoring.**

Keywords—embedded systems, Internet of Things NPK, sensors, soil parameters.

I. Introduction

Main occupation of Indian people is an agriculture. India is second biggest producer of fruits and vegetables in the world. Agriculture is the most significant sector of Indian Economy. To fulfill the need of rapidly increasing population while protecting the biodiversity and natural resources is the big task. Therefore there is a need of advanced technology to be used in agricultural domain

Incorrect use of fertilizers reduces quality in fruits, flavor, quality and quantity, vegetable lagging in size etc.

Soil Parameters plays vital role to increase the crop yield. Soil parameter includes pH, Humidity, K (potassium) , P (phosphorus) and N (nitrogen) etc. hydrogen, oxygen, sulfur, Carbon, calcium, boron, molybdenum, magnesium, iron, zinc, and chlorine are considered as most important nutrients of soil and are categorized as:

a. The primary macronutrients: phosphorus (P), nitrogen (N), potassium (K).
b. The secondary macronutrients: calcium (Ca), sulfur (S), magnesium (Mg)
c. The micronutrients: iron (Fe) boron (B), zinc (Zn), chlorine (Cl), manganese (Mn),copper (Cu), nickel (Ni),molybdenum (Mo)

These nutrients are provided by the soil and by the accumulation of fertilizers as compost, manure, and fertilizer salts. Continuous monitoring of these parameters of soil is leading to expand crop productivity. Fertilizers comprising mainly phosphate (P), nitrate (N), and potassium (K) are essential. The three components helps in improving plant development in following ways.

- K – potassium: promotes flowering, fruiting.
- P – phosphorus: promotes root and shoot growth.
- N – Nitrogen: stimulates the growth of leaves and vegetation.

Amount of KPN is dependent on type of a plant and on plant growth status. KPN nutrients decides the amount of fertilizer used and is also dependent on present matters of the soil.

Sensors are very crucial part of any electronic system. A sensor is an object which senses the physical parameter and converts it into electrical signal.

An optical sensor is a device that converts light energy into electronic signals. Fiber optic sensors measures a physical quantity based on its modulation on the intensity, phase spectrum. Fiber optic sensors have advantages like immunity to EMI, high sensitivity, and safety in harmful and explosive environment and long distance distant measurements.

The small size, low cost, inherent safety and ease of installation of FOS are mainly used in various fields like area including numerous chemical, medical analysis, food and intensive care systems etc.

For agriculture uses reliability, low cost, handy, flexibility are necessary concerns for design. The main purpose of this paper is to study different methodologies used for measuring soil parameters and to come up with the most appropriate method for measurement of soil parameters.

II. Literature Survey

“Smartphone Irrigation Sensor” [1] was developed which contains a smartphone to capture digital pictures of the soil near root of crop then processes it using advanced digital image processing algorithms which calculates optically the water contents. An Android application was designed in the smartphone for analysis of the captured image.

After getting the results from image processing algorithm irrigation system can be controlled by Wi-Fi

The result shows that the smartphones can be used as an irrigation sensor which is mainly used for agriculture sector.

The advantage of this system is that it requires only an in situ correction to obtain dynamic range for any soil type.A non-contact type irrigation sensor was used The system depends on a smartphone and quality of its camera.

"Primary Nutrients Determination in the Soil Using UV Spectroscopy" [2] is presented which describes the measurement of different primary nutrients in the soil. UV spectroscopy method is used for determination of primary nutrients in soil. Depending on the type of primary nutrient present in soil, its absorption wavelength varies. This process uses chemical methods.

"Detection of NPK nutrients of soil using Fiber Optic Sensor" was presented in which Measurement of P (phosphorus) ,N (nitrogen), and K (potassium) contents of soil is done by developing a fibre optic sensor based on calorimetric principle. The color sensor uses principle of color absorption by solution.
The sensor which is fabricated has concentric organization of transmitter and receiver. It uses colorimetric principle where sensor output varies when light of particulate wavelength is absorbed by a solution. Aqueous solutions of the soil samples are used for testing and then signal conditioning circuit is used for calibration. The output of which is further given to the microcontroller. According to the deficient factor of the soil, the amount of fertilizer to be added can be predicted.

"Green Growth Management by Using Arm Controller": [4] is presented which designed a system for sensing soil parameters like humidity, pH, sunlight and temperature. P-Hs-220 sensor is used for humidity measurement. LM35 temperature sensor is used for measuring temperature .Semiconductor based sensor is used for measuring primary macronutrients i.e NPK which uses Ion Selective Field Effect Transistors (ISFETs) based micro-sensors which is used for determining NPK contents of soil. Based on the results sufficient amount of water supply is provided and necessary fertilizers can be added for increasing crop productivity.

"Testing/Monitoring of Soil Chemical Level Using Wireless Sensor Network Technology" [5] is presented which uses Wireless Sensor technology and various methodologies for detecting soil nutrients are discussed in this paper. Depending on the level of soil nutrients, agriculturalists can increase the crop productivity which will be cost effective and requires less time. This sensor technology does not give quantity of the macronutrient contents in the soil.

"Electrochemical sensors for soil nutrient detection: opportunity and Challenge" [5] was presented which describes potentiometric electrochemical sensors (ISE and ISFET) for soil NPK detection. ISEs are not suitable for real-time sensing applications because of their response delay. ISFET's are costly and varying repeatability limits their use in practical systems.

III. Available sensors:

Various parameters of soil can be measured by different types of sensors.
Conventional soil KPN testing methods includes soil sampling, sample pretreatment and chemical analysis. Soil sampling is physically done in the field to obtain typical soil samples at a correct deepness Chemical analysis i.e. actual measurement of KPN is carried out by three methods viz. electrochemical methods,conductivity measurement, optical method.

A] Conductivity Measurement Technique:

In this technique two or three electrodes of same material are dipped in soil samples. Platinum, graphite, steel, silver, or copper are used. An A.C. voltage is applied to electrodes. The changes in current can be monitored by using one more electrode is connected to multimeter. As we apply A.C. voltage, there is a movements of ion which changes current in soil sample. Neutralization of ions is avoided by the A.C.voltage.
Changing current provides variable conductivity. Changeability between electrical conductivity and concentration K, P and N are detected. Variability in electrical conductivity increases with increase in concentration [9].and is converted into electrical signal for electronic control system [9].

B] Electrochemical Method:

Mainly soil nutrient levels can be determined by electrochemical methods which are based on the use of an ion-selective field effect transistor (ISFET) and an ion-selective electrode (ISE), with polymer membrane or glass or or Ion-selective membranes are available which selects specific ion from the soil sample.

C] Optical Method:

Optical NPK Sensor uses interaction between soil surface properties and incident light such that the properties of the reflected light differ due to the soil physical and organic properties. Spectrophotometric method that is NIR deals with the interaction of near infrared radiation with the sample under study which is based on electromagnetic radiation absorbtion.
.Laser Induced Florescence Spectroscopy (LIFS) is optical technique in which analyte in the molecule absorbs radiation at a certain wavelength [11,]. Or Near Infra-Red Spectroscopy (NIR) technique is very widely used for commercial also for experimental determination.
These optical methods are consistent but slow, complex and high cost per test which limits number of soil samples

tested for depicting the spatial changeability of soil nutrients in a field [2].

IV. RESULT AND CONCLUSION

Sr.No	References	Proposed sensing technologies	Merits/demerits
1	Adamchuk et al. [5]	Electrochemical and optical method	Chemical method is time consuming
2	Bah A. et al. [8]	Various sensing technologies including optical, mechanical	Optical method has a potential to estimate soil organic matter contents
3	Sinfieldet al. [9]	Nitrate ion selective electrode, reflectance spectroscopy	Chemical analysis requires complex laboratory testing.
4	Gobi Govindan, Srinivasan Gokul Raj [10]	Optical method including LED's and color developing reagents.	Efficient and low power Consumption.
5.	Deepa V. Ramane, Supriya S. Patil, A, D. Shaligram,[2]	Optical method based on the colorimetric principle	Efficient and low power consumption

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