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Design of Soil Nutrient System for Indian Crops

Dinesh B. Bhoyar[1*], Sachin S.Khade[2], Swati.K. Mohod[3], S.Y.Ambatkar[4]

[1, 2,3,4] *Yeshwantrao Chavan College of Engineering, Nagpur*
dinesh.bhoyar23@gmail.com, sac_mob@rediffmail.com,
swati06.mohod@rediffmail.com,zsyambatkar@gmail.com

Abstract

To increase the fertility of crop it is important to determine what is requiring for crop. For any crop 12 nutrients are required. We have developed NPK and PH sensor for soil testing. This will determine the PH and NPK value of the soil .In this paper color sensor with fiber optic is developed for determining the NPK components of soil. To know the soil pH we used a pH sensor.

***Keywords*:** Nitrogen (N), phosphorus (P), potassium (K), potential of hydrogen (pH)

1. Introduction

In order to complete the increasing demands of the food production over the years there is need to look upon the fertilizers that are required. The fertilizers mostly have nitrate (N), phosphate (P) and potassium (K). These fertilizers need to be used in proper proportion. If these fertilizers are used in improper quantity then they might yield crops of bad type. These crops might be bad in color, length, taste etc. Amount of NPK depend on the type of crop and on the status of growth of plant. The quantity of fertilizer [1,12] that is to be used depends upon the present amount of NPK components of soil. To reduce fertilizers the researchers in agro field are also finding ways to increase crop yield. As the components vary over the cultivated field on a small scale many researchers have made an attempt to develop sensors to detect the contents of nutrients. To study the behavior of NPK integrated crop management system has been designed. Based on sensing position and information technology precision agriculture is a farm management strategy that may contribute in optimizing the soil quality. Currently analysis of components of soil is done using the chemicals which is harmful to environment, time consuming as well as costly. Along with the NPK components of soil pH [9] is another important factor that has great importance because of its close resemblance in biochemical processes for e.g, When the pH level is low the growth as well as yield from farm is mostly low whereas if it is high then it is also good .If the pH is neutral then some crops grow good. Acidic and alkaline soils are good sometimes. pH value decrease as the acid nature of soil increases. Soil that has pH less than 7 are “acidic” and when pH is more than 7 then “alkaline”, for pH 7 it is “neutral”.

2. NPK Sensors

2.1. Available sensors [3]

In testing of soil it is very important to get the quantity of components of soil and the quantity of soil components that need to be integrated in the soil. The present soil testing methods include three important steps: 1) Sampling, 2) Pretreatment of sample, 3) Chemical analysis. The measurement of NPK components of soil is done by three techniques i.e. 1) Conductivity method, 2) Optical method, 3) Electrochemical method. [2]The technique of measurement of conductivity has 2 or more electrodes that have

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material of same kind that are dipped inside the samples of soil. Electrodes can be platinum or steel or silver. The conductivity change is then converted into the electrical signal for a system of electric control. Electrochemical sensors consist of selective field effective transistor (ISFET) and ion selective electrode (ISE). ISFET AND ISE select a ion from the samples of soil using a sensor cocktail. They use extraction solutions, various membranes and multiple target system with a coated wired field affect transistor [7]. The principle of a NPK sensor is to interact between soil surface properties and incident light, in a way that characteristics of reflected light differs due to chemical and physical properties of soil. Near infrared spectroscopy (LIFS), Laser induced Florescence Spectroscopy (NIR) and UV spectroscopy technology [8, 11] is broadly used for commercial purpose or experimental use. These methods are trust worthy and accessible, but very time consuming, complicated, and the cost is usually high. This limit the no of soil samples that can be tested for the characterizing the spatial variability of the nutrients of soil in the field.

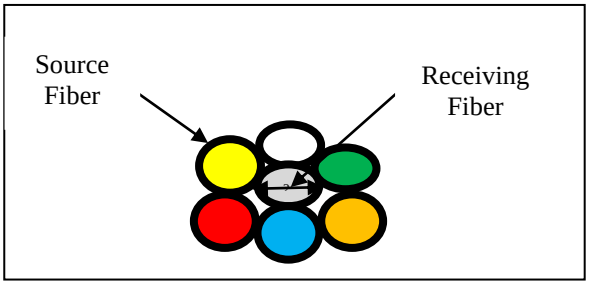

Figure 1 NPK Sensor Probe

2.2. Developed sensor and its working

Plastic fibers and multimode are used to build NPK sensor [7]. The design of NPK sensor is very complex procedure. Different configuration had been reported for chemical sensing .The used configuration is as shown in figure-1. Sensor probe consist of seven fibers arranged in a concentric configuration with a central fiber as a receiving fiber and the other six surrounding fibers as transmitting fibers [11]. Every fiber is a multi-mode plastic fiber of 488 um core diameter with a aperture of 0.47. The length of every fiber is 90mm. Zero emery paper is used to coat the tips of fiber. To avoid the damage of tip, a round shape cut glass plate is pressed fitted to the sensing end. At the other end a circle shaped brass disc is fixed to hold six bright LED's in a circular manner with a one photodiode at the center. Colorimetric principle is used for working of developed sensor. This deals with the measurement of the colored intensity. The color is due to absorption of light waves of particular wavelengths. The NPK working is illustrated as shown in figure-2. The different colored light of different intensity is emitted by different colored LED's. The light is incident on a liquid through multimode. A reflector is placed at some optimum distance .The light travel throughout the solution starting from probe to the reflector and then back, depending on color of properties of the solution, intensities will be received. The intensities can then be plotted to obtain a simple spectrum at discrete wavelength .A simple detection mechanism can be developed from the spectrum obtained.

2.3. System to Measure NPK Components of Soil:

The NPK measurement of soil is shown in figure-3. It is made up of light sources, NPK sensor probe, Optical fiber, signal conditioning system and display. Here we used the different color combinations of light emitting diodes (LED) for accurate

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measurement. We know that light emitting diodes (LED) emits are having wavelength bands which is narrow in width.[6]

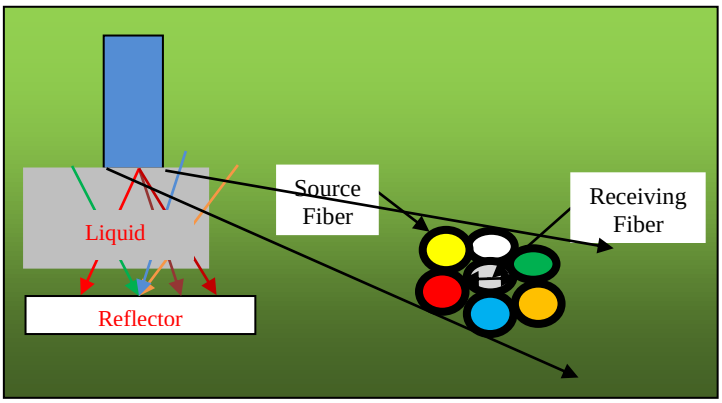

Figure 2 NPK Sensor Working

LED's are also amenable just because of this there is no need of mechanical chopper. These devices are made up of with fluorescent sensors. Instead of LED's we can also use laser diodes. Just only because of maximum drive current it will requires additional heat sinks and that's why they are difficult to handle. The circuit of light emitting diodes (LED) is known as voltage to current converter, buffer and sub-tractor. Then solution will absorbs particular type of wavelength and strength depending upon the NPK values of soil and remaining gets reflected back. By using phototransistor the receiving probe of the sensor catches the reflected light and then it will converted into electrical signal then as per the standard value chart is known the sensor' output will calibrated. Depending upon the color of the solution the output will varies. After that we have to design signal conditioning circuit. The comparison of the current values with microcontroller deficient component will predicted. Then LCD will display component's name and amount required in the soil. After that users can select appropriate type of fertilizers [7] for particular type of soil.

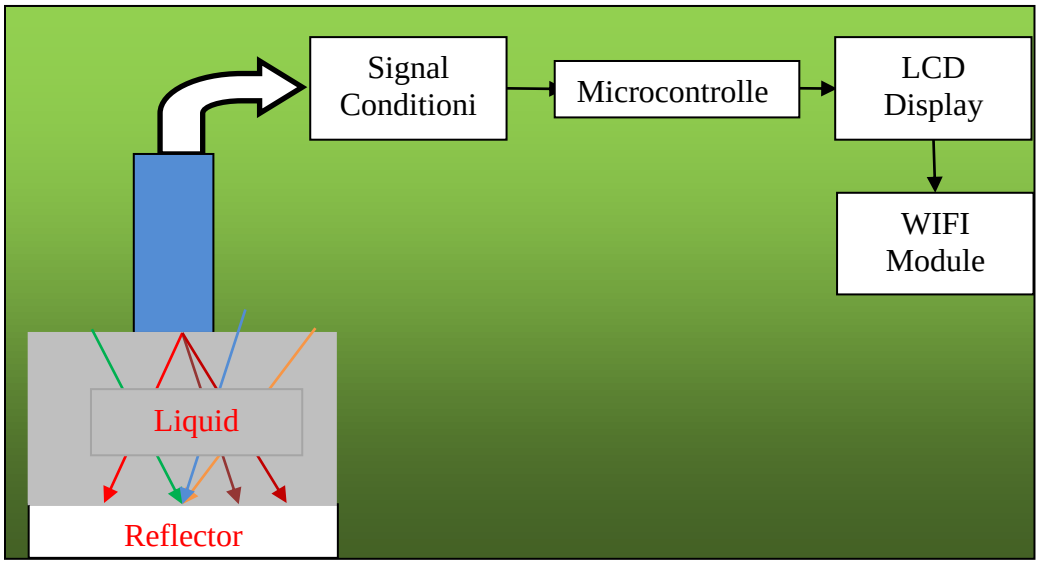

Figure 3 Block diagram of detection system

3. Soil Testing System

3.1. Block Diagram of PH Sensor

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The block diagram of pH sensor for soil is shown in figure 4. A conical shaped [3] sensing electrode (A) interface with a reference electrode (C) through the interfacing insulator (B). The signal conditioning network (G) is connected to the electrodes (A & C).For display the pH value we have to enclose signal conditioning network in thermoplastic casting (D) and connect it to the LCD. Hence the device is now portable, simple and easy to use in pH meter for measuring the pH value. Here we used the Nano particles due to which there is formation of reference electrode which will directly increase the efficiency of the pH sensor.

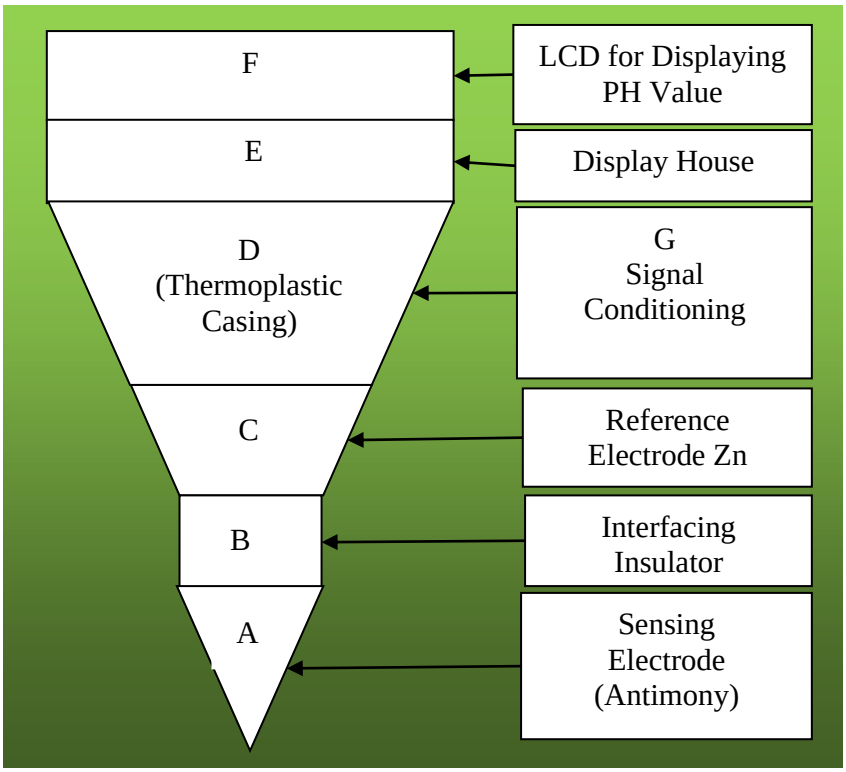

Figure 4 Block diagram of pH sensor

3.2 System of pH measurement of soil

Here are many methods of finding pH of soil. We know that pH sensors are used for measuring semi solid soil, the best pH sensors are made up of sphere shaped glass which helps user to enter the soil devoid the help of the probe. We can also measure soil with help of chemicals using water solution. In it we mixed soil in water with 1:1 ratio in order for calibration of liquid solution using pH electrode. To fight with the salt contained with the soil we have to mix soil with great ionic power buffer solution built of calcium chloride. Here we used distilled water to give estimation of soil pH. When proper water is gathered from the bottom, the pH is found using the pH electrode.

4. Results

The output of the sensor is as shown in the table 1 for various samples of soil. It shows that for different outputs of the soil sample, the outputs are different.

Table 1 Sensor Output

Nature	Values

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Acidic	> 7
Neutral	7
Alkaline	< 7

The output of this system is seen in the diagram for various samples of soil. This shows that for different outputs of the soil sample, the outputs are different. The values obtained at the output are then analyzed with the values given in the microcontroller's table. The table consists of the threshold levels of nitrogen, phosphorus and potassium. Table 1 indicates the three levels for amount of NPK in the sample

Table 1 NPK Sample [7]

Component	Low	Medium	High
Nitrogen	x < 15	15 <x< 20	20 <x< 25
Phosphorus	16<x<20	20 <x< 35	35 <x< 50
Potassium	20<x<25	25 <x< 40	40 <x< 60

When a soil sample with pH = 7 [5] was tested with this sensor, the following results were obtained-

1. **Nitrogen Test-** Value found in the sample was x=14. This indicates that the sample is low in nitrogen and needs appropriate nitrogen fertilizers in it.

2. **Phosphorus Test-** Value found in the sample was x=33. This indicates that the amount of phosphorus in the soil sample is sufficient in the soil.

3. **Potassium Test-** Value found in the sample was x=55. This indicates that the amount of potassium in the sample is very high and there is no need of additional fertilizers for the soil.

The fiber optics NPK sensor is successfully made to detect the amount of nutrients [4] such as Nitrogen, Phosphorus and Potassium in the soil. It is based on aligned arrangement of optical fibers. The principle on which it works is colorimetric principle in which the abstraction of light by the solution outcomes the difference in the result of the sensor. A soil sample solution is prepared which is tested and calibrated using the microcontroller. Hence the sensors are very beneficial for the farmers as they can select the appropriate fertilizers to improve the amount of components that are not up to the mark in the soil and the sensors also reduce the excess use of fertilizers. Therefore in agriculture industries, the fiber optics can be widely used in different applications.

Table 2 Sensor Output

Nature	Values
Acidic	> 7
Neutral	7
Alkaline	< 7

4. Cloud Computing

Cloud computing is a model which is used as network of severs which is hosted on the internet to manage, store, and process the data. It is not the local server or a PC. We have

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used this model [10] in order to help the farmers. The output of the soil samples that will be tested with the sensors will be uploaded on the cloud. The farmers will be able to use this data from wherever they want to.

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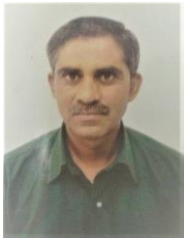
Authors

Dr,Dinesh.B. Bhoyar,
Received B.E.in Electronics Engineering from Shri Guru Govind Singhji College of Engineering (SGGS) Nanded(Govt.Aided) under Swami Ramanand Tirth Marathwada (SRTMU) University in 1999 and M,Tech and PhD from Rashtrasant Tukadoji Maharaj Nagpur (RTMNU)University, Nagpur in the year 2005 and 2016.His areas of interest is wireless communication and VLSI Design. He has published several papers in National and International journals and conferences.

Dr.Sachin S. Khade
He has completed his B.E. from Nagpur University (1998) and M.Tech from RTM Nagpur University (2001) & completed Ph. D from RTM Nagpur University (2018), Nagpur. He has got more than 33 research papers to his credit in various international Journals and Conferences. He has published 2 book chapters in Springer lecture note series. He has research experienced about more than 3 years in the area of MIMO and antenna. He has 6 years of industrial experience and more than 16 years of academic experience.

Swati K. Mohod
Received B.E.in Electronics Engineering and M. Tech in Communication Engineering from Yeshwantrao Chavan college of Engineering, Nagpur under Rashtrasant Tukadoji Maharaj Nagpur (RTMNU) University in 2006 and 2011.Her areas of interest is wireless communication and VLSI Design. She has published several papers in National and International journals and conferences.



Shrikant Y. Ambatkar
Completed B.E. in Electronics Engineering, ,from Nagpur University, in1985 and Master degree in Electronics Engineering in 2013, from Sant Gadge Maharaj Amravati University. He has total 33 years of teaching experience.His areas of interest are wireless communication and Embedded system . He has published several papers in National and International journals and conferences.

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