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IoT based Soil Nutrient Testing System

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Abstract: ***The purpose of this system is to analyse the nutrient content of soil and suggest fertilizer to promote crop growth. The data can be accessed using IoT whenever needed. Aim of the system is to identify the nutrient content in the soil and give the information about the fertilizer required to grow a particular crop. The plant growth is majorly affected by the soil contents. Therefore it is important to take note of the nutrients that are helpful in plant growth. Of the nutrients of crop growth, nitrogen, phosphorous and potassium are the most important elements. So we will majorly focus on obtaining information about these nutrients.***

1. Introduction

Agriculture is the most important sector of Indian economy. As 80% of rural population is involved in farming or agricultural sector, conventional farming practice involves human labors for performing all types of farming activities like watering fields, cultivating crops with required fertilizers etc. For quality and quantity output from agricultural industry soil analysis is a valuable tool for farmers. Therefore a proper soil testing will help to ensure the applications of enough fertilizer to meet the requirements of the crop while taking advantage of the nutrients already present in the soil. There are in all 16 mineral nutrients in soil which are helpful for plant growth which includes macro nutrients and micro nutrients. Some of the nutrients are Nitrogen, Phosphorous, Potassium, Calcium, Magnesium, Sulfur, etc.

Major nutrients for crop to grow healthy are Nitrogen (N), phosphorous (P) and potassium (K). Soil pH is the most commonly measured soil properties. It is also one of the most useful and informative soil parameters because of its relationship to many aspects of soil fertility and plant growth.

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2. Literature Review

2.1 Effective Implementation of Automated Fertilization Unit Using Analog PH sensor and Arduino

The difference in the pH value indicates the deficiency in the macronutrient content, hence automatically providing the soil with appropriate fertilizer.

2.2 Real time soil fertility analyzer and crop prediction

On the basis of this sensed parameters the approximate percentage of NPK nutrient contents present in the soil is determined. This system is able to predict crop only on the basis of the pH value and the electrical conductivity and does not consider any type of nutrient value. This is the results obtained are not accurate and fail to accomplish user requirements.

2.3 Soil Health Card Scheme

It is a scheme launched by the Government of India . Under the scheme, the government plans to issue soil cards to farmers which will carry crop-wise recommendations of nutrients and fertilizers required for the individual farms to help farmers to improve productivity .All soil samples are to be tested in various soil testing labs across the country. Thereafter the experts will analyse the strength and weaknesses (micro-nutrients deficiency) of the soil and suggest measures to deal with it. The result and suggestion will be displayed in the cards.

2.4 Real time soil fertility analyzer and crop prediction

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3. Methodology

3.1 Existing

The primitive way to measure the soil content is by taking soil samples and then sending them to laboratories for further testing. The samples are then tested against chemicals to check the nutrient content. This process is time consuming and cumbersome. This process all together takes about five business days of the date it is received. By the time the sample reaches the laboratories the atmospheric factors that affect the soil have changed and the results obtained are not accurate as it would be if testing was done on the field itself.

3.2 Proposed

The objective of the proposed system is to replace the traditional way of soil testing by a device that can give information about the soil contents within very short period of time .The result obtained by this method will not be as accurate as the existing methodology, but will be sufficient enough to predict the fertilizers to be used. The sensor will give information about the nutrient content in the soil. The obtained information can be used to provide the suitable fertilizers of the field.

The system takes the input from the sensors that measures the nutrient content in the soil (Nitrogen, Phosphorous, Potassium) as well as the pH and the electrical conductivity of soil. Analog to Digital converter is used to convert analog data captured from the sensors to a digital form. This information is then sent to Arduino which intern sends the information to the remotely located device using IoT. The database of this information can be created and can be accessed whenever required.

4. Block Diagram

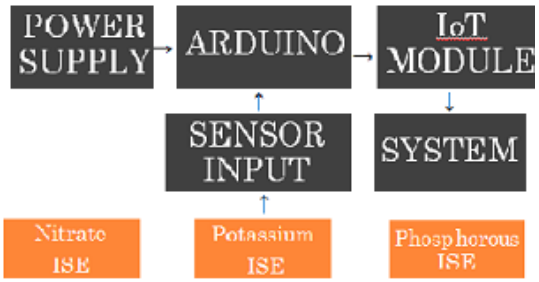

Figure 1: System flow diagram

Figure 1 shows that the system gets voltage input from the ion selective electrode sensor(Nitrate ISE, Potassium ISE, Phosphorous ISE). This information is processed by arduino to get the ion concentration and the amount of fertilizer required for the particular concentration in the given soil. This data sent to cloud using IoT module. We can access this data whenever needed.

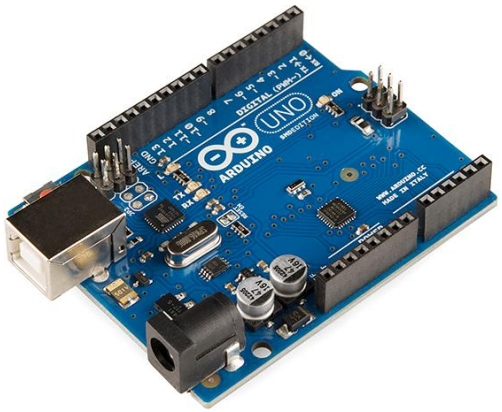

Figure 2: Arduino

Arduino is an open-source electronics 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. The role of IoT is to send the data coming from arduino to the cloud. Our system sends humidity, concentration of nutrients , temperature and amount of fertilizer to cloud.

5. Analysis

Table 1: Concentration Analysis

Level / *Parameters*	*low*	*Medium*	*high*
Concentration	<280	281-420	>421
Nitrate (kg/hectare)	125	100	75

Using ion selective elective electrode, the system measures the nutrient concentration of nitrogen, phosphorous, potassium. According to the measured concentration we will suggest the amount of fertilizer needed for plant. We will send the data using Iot.

Figure 3: Nitrate Ion Selective Electrode

An ion-selective electrode (ISE), also known as a specific ion electrode (SIE), is a transducer (or sensor) that converts the activity of a specific ion dissolved in a solution into an electrical potential. The voltage is theoretically dependent on the logarithm of the ionic activity, according to the Nernst equation. Ion-selective electrodes are used in analytical chemistry and biochemical/biophysical research, where measurements of ionic concentration in an aqueous solution are required.

NERNST Equation

$$E = Eo + 2.3(R\,T/n\,F)\,.\,log\,(a_i)$$

where,
E=measured electrode potential(mv)
E_o=standard potential(mv)
R=gas constant(J/mol K)
T= temperature (K)
F= faraday constant(C/mol)
a_i=concentration of ion(mol/L)
Values of Nernst factor (R T / n F) at temperature 298.15K (25C)

Table 2: Nernst Equation Slope Table

Ionic charge	+2	+1	-1	-2
Ideal slope	29.58	59.16	-59.16	-29.58
Example ions	Ca2+, Cu2+	K+, Ag+	F−, NO3−	S2−

6. Advantages

- It usually takes seven to ten business days for the laboratory to process soil samples, but by using soil fertility tester we can get results instantly.
- Knowing the exact type and quantity of fertilizers your soil and crops need prevents you from wasting money on

unnecessary fertilizers. Moreover, nutrients such as phosphorus and potassium that are part of inorganic fertilizers are limited resources. Their supply is finite thus we need to be cautious in our usage to prevent future shortage of inorganic fertilizers.

7. Conclusion

In this project, we are using ion selective electrode to determine the ion concentration of Nitrogen, Phosphorous and Potassium. The system will also sense the temperature and humidity of soil using DHT11 (temperature and humidity sensor). The output obtained by the ion selective electrode will be compared with the standard values of soil nutrients and the fertilizer is added accordingly. The edge of this project is that it will determine the nutrients accurately and quickly. The other advantage of this project is that it will omit all the steps involved in lab testing making it real time.

8. Acknowledgment

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