IOT Enable Soil Testing & NPK Nutrient Detection

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Abstract- A vast fraction of population of India considers agriculture as their primary occupation. Production of crops plays an important role in our country. Bad quality crop production is often due to either excessive use of fertilizer or using not enough fertilizer. For efficient crop growth, it is essential to measure the level of nutrients present in the soil. The proposed system of IOT enabled soil testing is based on measuring and observing soil parameters. This system lowers the probability of soil degradation and helps maintain crop health. Different sensors such as pH, soil moisture are used in this system for monitoring temperature, humidity, soil moisture and soil pH along with color sensors for NPK nutrients of the soil. The data sensed by these sensors is stored on the cloud and analyzed based on which suggestions for growth of the suitable crop is made. A Wi-Fi module interfaced with Arduino is used for displaying test result data along with a list of particular crops suitable for the tested soil. A web portal is also created which gives information about the fertilizer(s) required for their crops. This paper presents a study of soil and the relevant parameters involved in the prediction of suitable crops to avoid the problem of soil infertility and to improve the quality of crops. This system is designed by keeping the needs of farmers in mind which results in its capacity to make suggestions via mobile application

Keywords – Color sensor, Internet of things, Soil Testing, NPK Nutrient Detection

I. INTRODUCTION

Soil testing is used to do chemical analysis of soil and to find status of fertility of soil. Soil testing also plays an important role in prediction of required nutrients of the crops. Soil testing further includes testing of soils for properties like pH, moisture and nutrients required for effective crop growth like Nitrogen, Potassium and Phosphorus. Other tests for determining appropriate atmosphere conditions for growing of the crop are also necessary to be performed. These tests include monitoring of humidity and temperature of the atmosphere.

The measurement of Nitrogen, Phosphorus and Potassium, (i.e. N, P, K respectively) levels of soil is vital to make a decision what quantity additional contents of those nutrients are required to extend fertility of soil. The standard of soil is thus enhanced which subsequently provides a better yield quality of crop. In the present work, colour detector which primarily uses fibre optic technology has been integrated with the system to read N, P and K levels as high, medium and low of the sample soil. The absorption of colour is the primary principle of colour detector. It is helpful in dispensing solely the specified quantity of fertilizers within the soil.

The remaining paper is organized as follow: Section II describes Literature Survey, Section III describes proposed scheme, Section IV discusses results obtained and its analysis, Section V is conclusion.

II .LITERATURE SURVEY

This section deals with various literature work done under the topic of Internet of Things (IoT) and automated soil testing:

[1]Measurement of 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. In the present work fiber optic based color sensor has been developed to determine N, P, and K values in the soil sample. Here calorimetric measurement of aqueous solution of soil has been carried out.

[2]The purpose of this project is to provide an embedded based system for soil monitoring and irrigation to reduce the manual monitoring of the field and get the information via mobile application. The soil is tested using various sensors such as pH sensor, temperature sensor, and humidity sensor. The obtained sensor values are sent to the field manager through the Wi-Fi router and the crop suggestion is made through the mobile application. Automatic irrigation system is carried out and crop image is captured.

[3]The main objective of the project is to provide an automatic irrigation system and check the amount of nitrogen (N), phosphorus (P), and potassium (K). The N, P, and K amounts in the soil sample are determined by comparing the solution with color chart. This will describe the amount of N, P, and K as high, medium, and low. Whenever there is a change in temperature and humidity of the surroundings, these sensors sense the change in temperature and humidity and give an interrupt signal to ARM 7 Processor, thereby initiating the irrigation. All this functioning will be updated to the user by email sent by the system PC through IoT.

[4]In the proposed system, it determines the crops which are suitable for the particular soil type. It will analyze moisture content, temperature and humidity in soil at real time and it will also suggest the crops based on determined pH of soil. This system is proposed to help the farmers to increase the production and the suggestions are made through the mobile application.

In [5], Author created an intelligent streetlight management system based on LED lamps, designed to facilitate its deployment in existing facilities. In this two modules are build first is An Intelligent streetlight management system based on LED lamps which provides a smart and intelligent system for saving of non renewable sources of energy. Second important aspect implemented in this research work deals with the flow of traffic and the pollution levels at various places by monitoring the fundamentals of the air quality controls. Analysis is carried out using R programming language.

III. PROPOSED ALGORITHM

3.1. Components and their Specifications –

This system uses following components for implementation of this project:

- pH sensor: pH sensor detects soil pH level and forwards the reading to the controller. It is designed for Arduino Controller and can easily detect pH values without additional circuit requirements.
- GSM: Communication between a microcontroller and the GSM Network is activated by GSM Module. It is ashort form of Global System for Mobile Communication.

- DHT11 Humidity and Temperature Sensor: It is characterized with basic digital signal output. This sensor is extremely cost-friendly.
- Soil moisture sensor: It reads the levels of moisture content in the soil sample. It shows output is high when soil is low in moisture and vice versa. It also alerts the user to water their plants.
- TCS3200 color sensor: This color sensor is capable of detecting various colors by measuring their wavelength. Color detection is done by a sensor chip present in it. Further, a set of 4 white light LEDs are present which are turned on when an object in placed preceding the sensor.
- NPK testing kit: It is an integrated kit to access primary nutrients (N-P-K) of soil. The chemicals present in the kit help to bring out the color of soil solution based on its nitrogen, phosphorus and potassium content. The color obtained is then used by the color sensor to determine the concentration of individual nutrients.

3.2. Flowchart for NPK Testing–

The diagram shown below represents activity diagram for NPK flowchart, which depicts how the overall process of NPK testing is carried out.

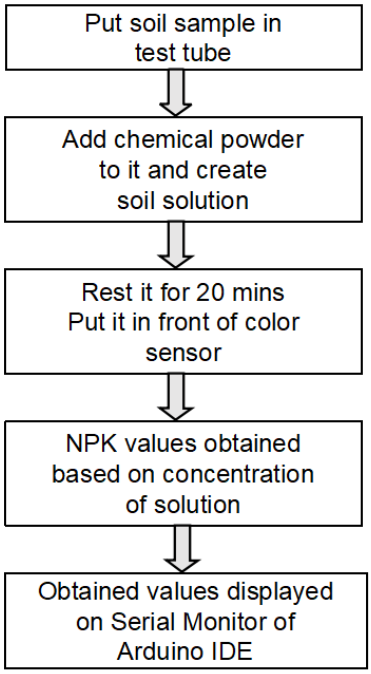

Figure 1. Flowchart for NPK Testing

3.3. Activity Diagram and Flowchart of the System –

The diagram shown below represents activity diagram for soil testing flowchart. which depicts how the overall process of soil testing is carried out.

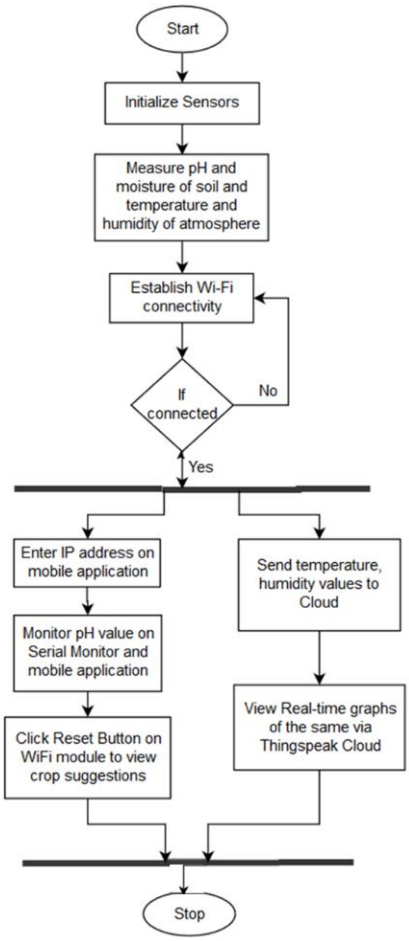

Figure 2. Activity diagram for pH Testing

3.4. Connection Diagram for Soil Testing –

In this setup all the important sensors such as DHT11 temperature and humidity sensor, pH sensor and soil moisture sensor are connected to ESP8266 wifi module and their values are displayed on the serial monitor of Arduino IDE.

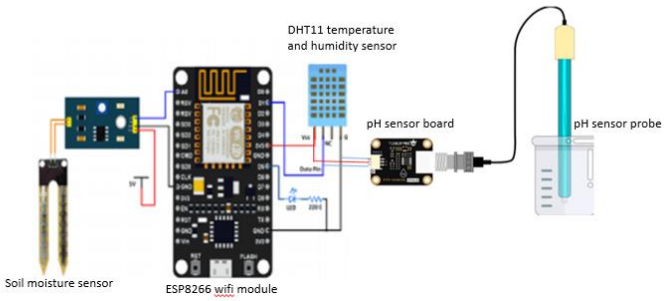

Figure 3. System Connections for Soil Testing

3.5. Working Principle–

Soil testing is used to do chemical analysis of soil and to find fertility status of the soil. Soil testing also plays a vital role in prediction of the required nutrients of the crops. It further includes testing of soils for properties like pH, moisture and nutrients required for effective crop growth like Nitrogen, Potassium and Phosphorus.

Step 1: The system is formed by connecting a pH Sensor, Humidity Sensor, Soil moisture sensor, Node MCU (Esp8266) WiFi shield, GSM module. Everything is integrated with the help of an Arduino Uno board.

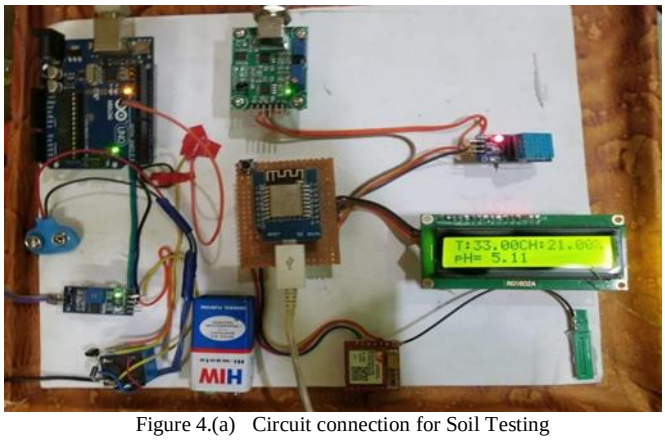

Figure 4.(a) Circuit connection for Soil Testing

Step 2: Here, the pH Sensor measures the level of pH in soil, DHT 11 humidity and temperature sensor measure humidity and temperature of the surrounding atmosphere and soil moisture sensor measures the moisture level of the soil.

Step 3: If the reading denotes that the pH value is below 7 then it is said to be acidic in nature. Whereas if it is above 7 then the soil is basic in nature and pH level 7 means neutral soil. This neutral soil is ideal for many plants.

Step 4: The data read from the DHT11 sensor is sent to the cloud server (Thingspeak.com) and is also displayed on the Arduino IDE Serial Monitor and server's IP address. Suitable crop choices are suggested to the farmers based on the detected pH level and are displayed on the Serial Monitor and Cloud Server.

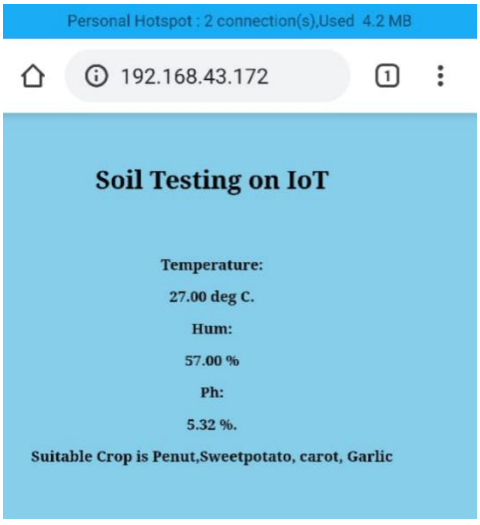

Figure 4.(b) Data displayed on Mobile Application

Step 5: The graphs of temperature and humidity in real time are displayed on the web portal.

3.6. Working Principle for NPK detection –

Measurement of N (nitrogen), P (phosphorus) and K(potassium) contents of soil relies on calorie metric measurement of solution of soil. The colour of a substance is present due to the absorbance of waves of bound wavelengths. The absorption of light ends up in excitation of electrons in its molecule. The colour detector is based on the principle of absorption of color. It helps in determining the N, P, K amounts as high, medium, low, or none.

Step 1: select soil containing different concentrations of Nitrogen, Phosphorus, Potassium and create soil samples in test tubes by using soil testing kit . place the test tube above the color sensor and make sure that there is no interference from any other light source.

Step 2: A photodiode is simply a semiconductor device that converts light into current and TCS3200 colour sensor has an array of these with 4 different filters. We are able to detect the intensity of the different colours by selectively choosing the photodiode filter's readings.

Step 3: The sensing element contains a current-to-frequency convertor that converts the photodiodes readings into a sq. wave with a frequency that is proportional to the intensity of the chosen color. This frequency is then browse by the Arduino.

Step 4: To read and to display the generated output frequency on the serial monitor and to distinguish between different colors and upload it to Arduino.

Step 5 : Monitor the values of .Nitrogen, Phosphorus & Potassium on the serial monitor of Arduino IDE.

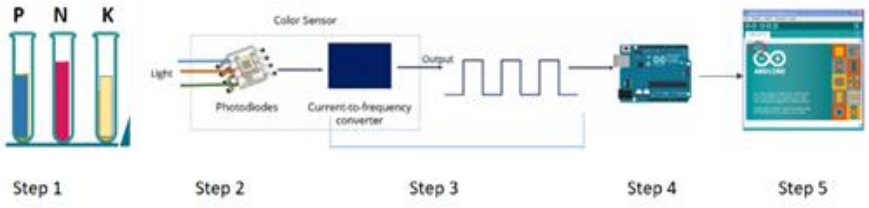

Figure 4.(c) Working Methodology for NPK Testing

IV. RESULT AND ANALYSIS

4.1. Result–

The pH value and soil moisture measured from the respective sensors provides reliable data to farmers and is capable of monitoring agriculture parameters. The output detected from the temperature and humidity sensor can be viewed on the serial monitor of the Arduino IDE as well as on the Thingspeak cloud server. The graphs of the same are plotted on the cloud server which can be seen in the figures below.

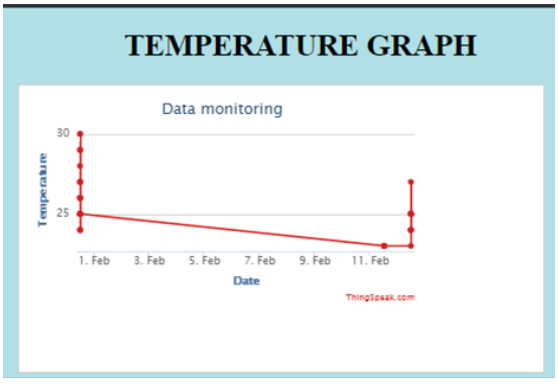

Figure 5. (a) Temperature Graph on Thinkspeak Server

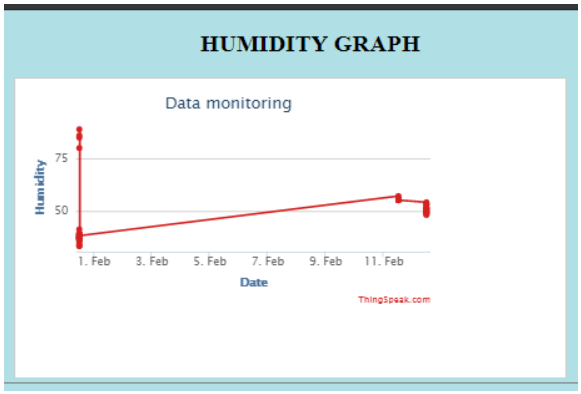

Figure 5. (b) Humidity Graph on thinkspeak Server

4.2. Analysis–

The figures below indicate the soil testing results carried out in various regions of Nagpur city. It is observed that the parameters such as soil moisture ,pH & NPK statistics of soil differ from region to region based on the morphological properties, physical properties and chemical properties of soil.

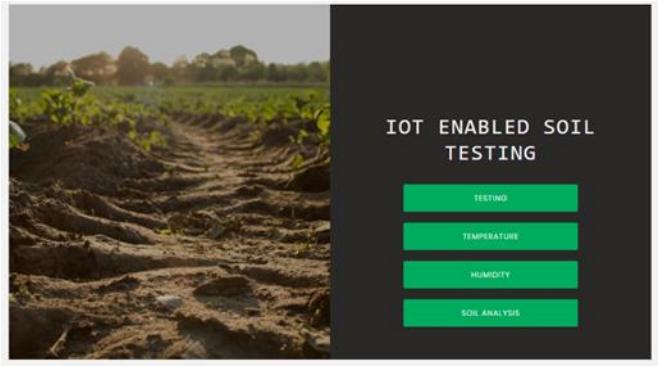

Figure 6. (a) Soil Testing Portal

The figure below indicate the soil testing results carried out in various regions of Nagpur city.

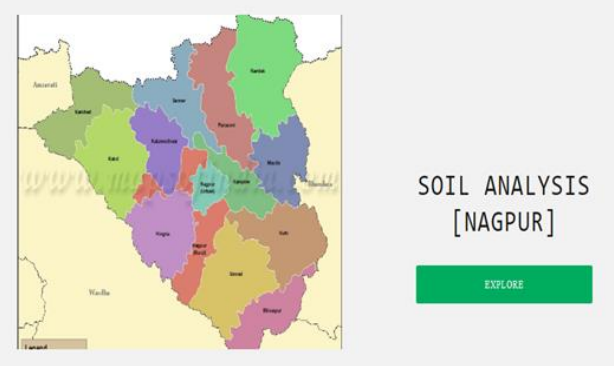

Figure 6. (b) Soil Analysis Map(NAGPUR)

It is observed that the parameters such as soil moisture ,pH & NPK statistics of soil differ from region to region based on the morphological properties ,physical properties and chemical properties of soil. therefore shown below is the soil data analysis.

SOIL ANALYSIS

REGION	Ph	MOISTURE	TEMPERATURE	HUMIDITY	NPK-STATS
KATOL	8.9	3.4	45	65	CLICK-ME
KALMESHWAR	6.9	0.3	52	66	CLICK-ME
UMRER	8.9	5.6	40	65	CLICK-ME
HIGNA	5.6	0.4	32	22	CLICK-ME

Figure 6. (c) Soil Data Analysia

The figure below indicate the NPK statistics of various region .which displays its values in percentage and has a pie chart representation

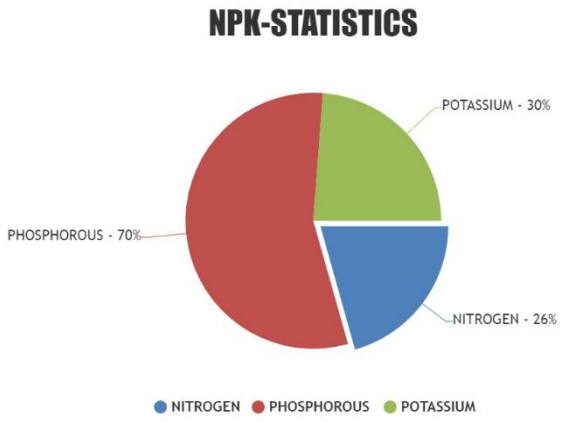

Figure 6. (d) NPK Statistics

V. Conclusion

IOT based Automated Soil Testing reduces the efforts of farmers to transport soil samples to laboratories. As compared to the manual testing, this project will reduce time required for testing soil. Application of this project will significantly reduce the cost over the time. This system helps in maintaining soil health and crop health increasing cultivation, productivity and profit of farmers.

The project can be mounted on a PCB and a handy device can be made, to use its functionality with convenience. Weather Forecasting systems can be appended for better farming. Security aid like Intrusion detection system can be appended to the system. Fire detection systems can be added for safety purposes.

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