JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

SOIL DEPLETION: TO MEASURE NPK VALUES IN DIFFERENT TYPES OF SOILS

U.Mohan Venkata sai
Department of Computer Science and Engineering
Kalasalingam Academy of Research and Education
Krishnankoil, Virudhunagar, India
9920004667@Klu.ac.in

T.Sravanth
Department of Computer Science and Engineering
Kalasalingam Academy of Research and Education
Krishnankoil, Virudhunagar, India
9920004206@klu.ac.in

P.Yeswanth varma
Department of Computer Science and Engineering
Kalasalingam Academy of Research and Education
Krishnankoil, Virudhunagar, India
9920004104@klu.ac.in

A.Sai vara prasad
Department of Computer Science and Engineering
Kalasalingam Academy of Research and Education
Krishnankoil, Virudhunagar, India
9920004014@Klu.ac.in

Abstract-
Agriculture is essential to the growth of our nation's economy. The primary determinants of crop output are soil fertility and Moisture content. Most fertilisers are suggested in accordance with the nutrients found in the soil. An adequate amount of fertiliser must be recommended after a soil nutrient analysis, which is primarily carried out in a lab. Soil nutrient measurement by hand takes a lot of time. Many farmers cultivate the same crop on their land year round without doing laboratory soil testing, which causes the soil to lose its fertility. A system that uses wireless sensor networks which allow for remote monitoring of soil fertility as well as other factors like temperature, pH, and moisture has been proposed for precision agriculture. This information is sent to the cloud, and the associated the values are shown on a mobile app. The suggested software solution for the Internet of Things (IoT) is intelligent enough to suggest how much water and fertiliser to use in order to enhance the soil's quality and guarantee the crop's best possible growth.

Keywords - Soil Moisture, Sensors, Nitrogen, Phosphorus, Potassium, Mobile Application

I. INTRODUCTION

Food production originated in agriculture. A valuable resource in agriculture is soil. The cycle of production is significantly influenced by the chemical and physical properties of the soil. One Soil analysis is a useful instrument used by farmers to increase crop output. Soil testing is essential for crop growth in this sense. Farmers can amend the soil with the proper amount of organic or inorganic nutrients. The primary soil macronutrients that affect yield maximisation ar e nitrogen (N), phosphorus (P), and potassium (K). Fertiliser over- or under-application can significantly reduce yield rates and lead to lower-quality agricultural output. The growing population raises the need for agriculture generate growth. Agricultural techniques must be automated in order to boost productivity. Fertilisers must be added in sufficient amounts to preserve crop quality. The amount of fertiliser that has to be added depends on the soil's current NPK values. Measuring the parameters of the soil is crucial for site-specific applications in agricultural farming areas. The rise of the Internet of Things has led to a transformation in farming practices from traditional to smart farming, since it provides wireless technology for measuring several soil properties. With the development of technology, precision farming has made it possible to continue meeting agricultural demand. The two main things that increase the need for precision agriculture are low cost and low labour. Crop quality is preserved by regular monitoring of NPK levels as well as soil pH, temperature, and humidity, which enables farmers to expand their cropping . Systems now in use only measure a limited number of characteristics or only provide findings for a limited number of crops.

The following are the system's salient features:
1. A single, comprehensive real-time soil monitoring system that works with a variety of crops.
2. A sensor will be used to measure the temperature, pH, moisture content, and other soil parameters in addition to the macro nutrients nitrogen, phosphorus, and potassium.
3. The system uses the IoT cloud from Amazon Web Services (AWS) to store data and is coupled with Arduino and NodeMCU (ESP8266).
4. A user-friendly smartphone application is created to provide soil data and the amount of fertilizer that is suggested for various crops based on the soil's nutrient content.

The approach and solution used to solve the problem are covered in this paper. From now on, we will talk about the findings and how the smartphone app helps to view the temperature, pH, and measure the soil's moisture content in real time and recommend how much fertilizer is needed for the intended crop.

II. Literature Survey:

A thorough study of the literature reveals that numerous researchers have conducted in-depth studies on various crop yields, soil pH, and NPK levels. For example, Samia et al. (2012) investigated how compost, urea, and NPK affected the growth and yield of soybeans in Sudan's semi-arid region. Research by Yulin et al. (2017) compared soil analytical techniques for calculating the amount of potassium fertiliser needed for wheat in response to the different potassium demands of the plants in the glasshouse. Even though it is generally acknowledged that pH affects soil nutrients, there hasn't been much research done to estimate the level of nutrients in the soil based on pH. However, other researchers, such Salve et al. (2015), created a remote sensing tool to monitor many aspects of rural environments, including temperature, stickiness, and NPK in addition to additional factors that may hold significance. With this, fertiliser may be applied to the appropriate areas of the farmland while keeping a safe distance from overfertilizing the crops. Additionally, Deepa et al. (2018) shown in their study that measuring the soil's N, P, and K concentrations is essential to determining how much additional of these nutrients should be supplied to the soil to boost fertility. As a result, the soil becomes better, producing higher-quality crops. A colour sensor based on fibre optics was created to ascertain the soil sample's N, P, and K levels. In this case, the soil's aqueous solution was measured using colorimetry. The principle of colour absorption by the solution underlies the colour. It aids in identifying the amount of N, P, and K as high, medium, low, or non existent. The sensor probe is designed to work with the appropriate signal conditioning circuits to designed to identify the soil's lacking component. It is helpful in distributing the soil's necessary amount of fertilisers.

III. Proposed work :

The suggested system uses a variety of hardware and software components to continuously monitor the properties of the soil, including temperature, pH, moisture content, and nutrients. This suggests the appropriate amount of fertiliser, enabling farmers to apply the fertiliser correctly and guarantee optimal crop development, thus improving crop productivity.

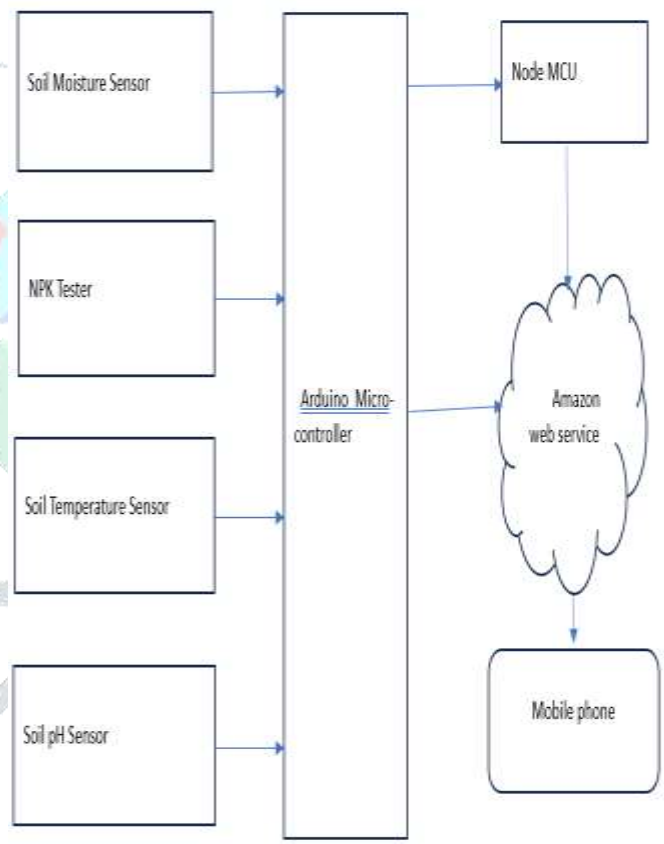
Crop rotation: Planting distinct crops in rotation helps to preserve soil fertility and reduce soil depletion. It allows the soil to recover and top off the vitamins utilized by the previous crop.

A. METHODOLOGY :

Analysing the soil's moisture and nutrients is the major goal. The block diagram of the suggested system, which connects several sensors via an ESP8266 Wi-Fi module and an Arduino microcontroller, is explained in Figure 1. The Node MCU and Arduino are linked through the Tx and Rx pins to facilitate the sending and receiving of sensor data. The sensors send their data to the AWS cloud. Device SDKs for transferring sensor data are provided by AWS IoT. AWS IoT offers MQTT connections for sensing devices, enabling customers to link these devices to the Internet for data processing and exchange that guarantees data security and upholds dependability. Wireless Sensor Networks are made up of linked embedded devices that provide many facilities for minimal effort and low power measurement.

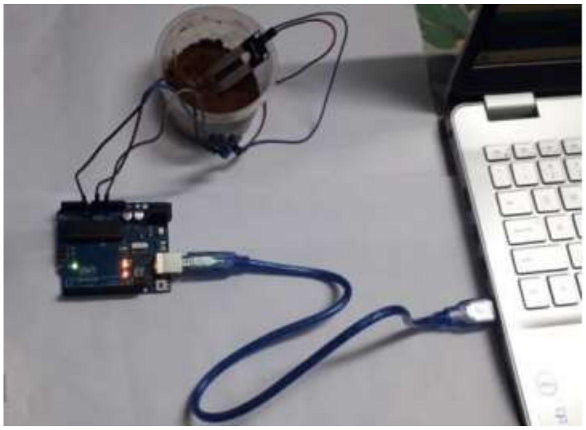
Developers may rapidly and effectively construct, deploy, and manage cloud applications with the help of AWS, a cloud platform. Resources on the AWS cloud are reachable with appropriate safety. The advantages of AWS cloud include cost effectiveness, dependability, speed, storage, backup, recovery, and ease of accessibility. Additionally, a mobile application that offers details on the different properties of the soil is developed. With this knowledge, the farmer can use it to decide which crop to cultivate.

-



B. SOIL MOISTURE SENSOR :

The soil moisture sensor is used to determine the volumetric water content of the soil. The dielectric constant and electrical resistance of the soil are measured.This is used to measure the soil's moisture content. There are two probes in the soil moisture sensor. These probes are inserted into the soil to determine the moisture value. Farmers are assisted in better managing the irrigation system by the data gathered from the sensor.



The hardware integration of the soil moisture sensor is shown in the figure above.The image display an app screenshot and the moisture value of the soil that is kept in the database is shown. The mobile application also shows the values of temperature, pH, potassium, phosphorous, and nitrogen.

C. NPK SENSOR :

The soil fertility tester is used to determine how much nitrogen, phosphorous, and potassium are present in the soil. Here's how the aforementioned components are used:
Nitrogen: Aids in encouraging the development of leaves and other vegetation. It is essential for both protein synthesis and photosynthesis.
Phosphorus: Assists in encouraging root growth and weather resistance.
Potassium: Aids in the movement of sugars and the production of fruit and flowers. It is necessary to insert the soil fertility tester. The analogue deflection voltage would change as a result of a chemical reaction and be transformed to a digital value.

The Formula below can be used to obtain the N, P and K Values:

$$Nm = \frac{(Av - Nc\text{-}low) \times (Ntgt\text{-}upp - Ntgt\text{-}low)}{(Nc\text{-}upp - Nc\text{-}low)} + Nt\text{-}l$$

The aforementioned algorithm can also be used to determine the N and P and K values.

D. SOIL TEMPERATURE SENSOR:

The soil temperature sensor is used to determine the soil's temperature. These sensors come in a range of configurations that make use of thermistors and thermocouples. The voltage The sensor's operational base Tan be seen by reading across the diode. The electrical impulses that are transmitted by the sensors are translated into several measurement units, including Fahrenheit, Kelvin, and Celsius. The gadget generates an analogue signal that is directly proportional to temperature by amplifying the voltage differences.

E. SOIL PH SENSOR;

The soil's pH value indicates whether the soil is naturally acidic or basic. The soil's pH level affects the nutrients and microbes that are available. The extent of the The pH scale runs from 0 to 14, with 7 denoting neutrality. Less than 5.5 denotes severe acidity, less than 6.5 shows moderate acidity, neutrality is indicated by a pH value between 6.5 and 7.5, alkalinity is indicated by a pH value over 7.5, and strong alkalinity is indicated by a pH value above 8.5. To display the pH value, an electrical potential difference is measured between a reference electrode and apH electrode.

Through pins 10 and 11, the NodeMCU and Arduino Uno can connect, and data is serially transmitted to the AWS IoT cloud. The smartphone app created with the Android Studio would concentrate on the AWS Mobile SDK and other front-end development tools including UI design tools. The desired APIs for accessing the sensor data are made available.

HARDWARE SPECLIZATION :

This section describes the prototype's hardware specifications, which highlight the device's physical characteristics. It explains the components of the prototypes and how they connect to the device's general purpose. The system's central processing unit is the Raspberry Pi. The prototype made use of the Raspberry Pi 4 Model B. The aforementioned model is the newest and features a quad core, 64-bit ARM-Cortex A72 processor operating at 1.5 GHz. These specs are appropriate for processing data from acquired photographs to the fullest extent possible. The prototype's touchscreen display on the Raspberry Pi helps the user operate it. The graphical user interface of the system incorporates a pre-defined process that users can click on. The Raspberry Pi The dimensions of the touchscreen display are seven inches by seven inches. The test tubes where the soil samples were tested in compliance with the instructions included with the soil test kit are photographed by the Raspberry Pi Camera. For processing, it is linked to the Raspberry Pi. The prototype's Raspberry Pi NoIR infrared camera board V2 model is this one. Its 8 Megapixels of resolution allow it to capture images at 1080p.

One element of the prototype that allows users to simultaneously set the test tubes in an upright posture is the built-in test tube rack. It offers safe and temporary storage for test tubes, whether or not they contain chemicals. While taking pictures of the soil sample treated with STK, the To take the picture, the test tube has to be placed in a certain way. It is best to tilt the test tube to measure the pH, nitrogen, and phosphorus content of the soil. In addition, the test tube for potassium needs to be upright in order to capture an image of the soil sample that has been treated with STK. The test tube holder allows the tube to be held in the preferred location for the best possible picture-taking procedure. It is positioned in front of the Raspberry Pi camera in a deliberate manner to prevent blurriness.
The backdrop colour of the STK-treated soil sample must match for the photos to be clear. When taking pictures of the pH level, nitrogen, and phosphorus, a white background is needed; for potassium, a black background is needed. The black and white the background platform can be detached to

save up space inside the prototype. The test tube is properly lighted by the key light before being photographed for the best possible quality. When there is low lighting in the environment, it is helpful. Light emitting diodes (LEDs) and a potentiometer make up the key light. It is possible to change the crucial light intensity to ensure that the right illumination is potentiometer to be adjusted. Furthermore, because test tubes are constructed of glass and are prone to glare when light is shone upon them, the adjustable key light helps to prevent glare in the tube.

IV. BLOCK DIAGRAM:

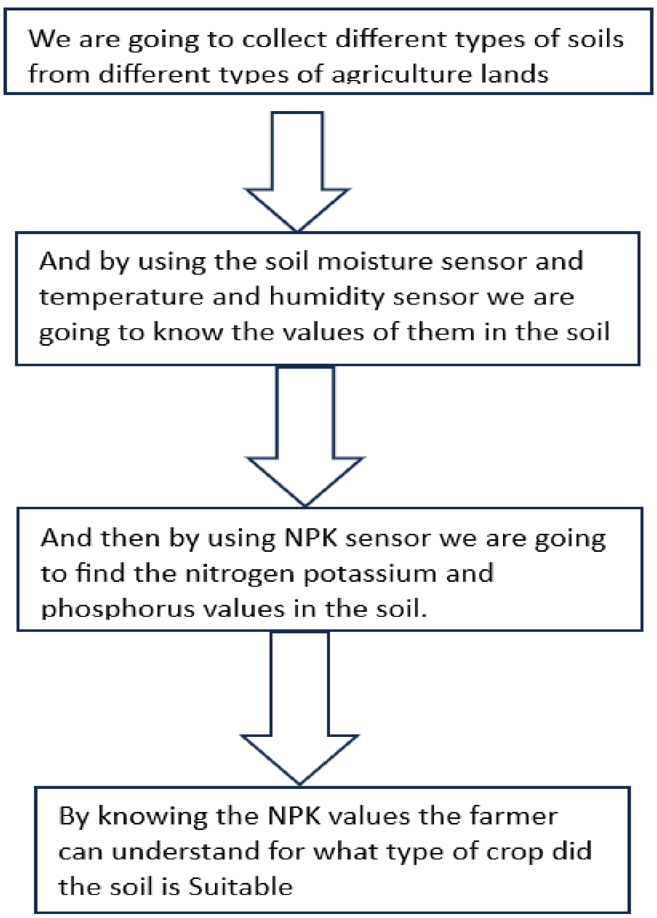


Fig 1 : Work flow of Agricultural Crops

V : DATA COLLECTION:

Terascore is a matrix that summarises the essential information regarding soil health by analysing a large number of data points from farm and industry statistics. bits of data regarding the condition of the soil utilising a six-foot-deep soil sensor.

Evaluation of effectiveness of the prototype

The percentage of the right actual task completed as opposed to the predicted task of the prototype is what determines efficacy. The following five parameters are being tracked: (i) soil pH level; (ii) potassium level; (iii) phosphorus level; (iv) nitrogen level; and (v) appropriate crop and fertiliser advice.

Soil primary macronutrients

There are fifty tests conducted for each soil parameter at each level. Testing the prototype's efficacy—particularly its ability to reliably detect the primary macronutrients and pH level of the soil in the STK-treated soil sample—is one of the study's goals. Utilising (1), the quantity of attempts that the appropriately calculated threshold was noted, added, and divided by the total number of trials (i.e., 50 trials).

The percentage efficacy of potassium, phosphorus, and nitrogen. The low level has a 90% rating for nitrogen, while the high and medium levels have 92% ratings. Every nitrogen level was considered to be extremely effective. In the case of phosphorus, the high and While the low level has an 88% mark and is viewed as effective, the medium have marks of 92% and 96%, respectively, interpreted as high effective. With ratings of 92% and 96%, respectively, the sufficient and deficient levels of potassium are considered to be highly effective.

Soil pH level

The percentage efficacy of the pH level of the soil. Out of all the calculated ratings, the soil pH values 5.4, 6.0, and 7.2 have received the highest rating of 98%. A 96% grade is assigned to the pH values of 4.0, 4.4, 5.2, 6.4, and 7.6 in the soil. A soil pH rating of 94% values of 4.8 and 5.0 were observed. The soil pH values of 5.8 and 6.8 exhibited the lowest rating of 92% among all the levels.

Crop and fertilizer recommendation

Through manual inspection, the prototype's capacity to recommend crops and fertilisers was assessed. Fifty trials were observed during the examination. Following the mapping process by which the prototype provided crop and fertiliser recommendations, this will be manually cross-referenced to the provided crop and Department of Agriculture's Regional Soils Laboratory's fertiliser suggestion. By using (1), the number of crops and fertiliser recommendations that the prototype accurately recommended was counted, added, and divided by the total number of trials. The prototype's efficacy in suggesting crops and fertiliser appropriate for the provided soil sample was evaluated at 96%. This is also thought to be quite successful.

Validation of the data gathered

The data collected from the prototype was compared with the Regional Soils Laboratory's data. The study's soil sample samples were subjected to routine laboratory testing. Every pH and NPK level in the soil is included in the validation. It also has recommendations for crops and fertiliser.By comparing the Regional Soils Laboratory's advice with that of the prototype. The prototypes provide the appropriate amount along with crop and fertiliser recommendations in this way.

Acceptability of the prototype:

The acceptability of the prototype by potential users, such as farmers, researchers, and staff members of the Department of Agriculture and Regional Soils Laboratory, is another aspect of the study's goal. Thirty people make up the sample population: fifteen farmers, five employees of the Regional Soils Laboratory, and five employees comprising five researchers and the Department of Agriculture's Region 5. A survey questionnaire based on the technology acceptance model was the research tool used to assess the prototype's acceptability. The adoption of the newest technology, or prototype, is influenced by the user's view of its application in work performance or goal achievement, which is determined by the technology acceptance model.

VI.RESULTS:

Through the use of this technology, the output for various soil parameters for various soil samples is acquired, and the required quantity of fertilisers is given, hence minimising the usage of extra fertilisers, increasing the yield as a result. Technology advancements have led to more accurate results, which has increased cultivation. Because precision agriculture provides real-time response data, farming operations become more accurate.

Farmers may ensure optimal utilisation by applying the proper amount of fertiliser with the help of recommendation systems. Think of the ideal values of nitrogen, phosphorus, and Kr as being Nr, Pr, and Kr and Potassium for a certain crop, with Nm, Pm, and Km representing the measured amounts of Phosphorous, Nitrogen, and Potassium.

VII.CONCLUSION :.

The following conclusions were reached in light of the findings: i) The prototype's image processing function, which serves as the main method for determining the pH and primary macronutrient levels of the soil, is very effective; ii) The prototype's crop and fertiliser recommendation capabilities are also highly regarded. Effective; iii) The prototype's acceptability, as determined by 30 respondents who were potential users, demonstrated a high percentage in terms of parameters using the Technology Acceptance Model in terms of the prototype's ease of use and had an adjectival description of excellent with an overall weighted mean of 4.85. The study's findings lead to the following suggestions: (a) The prototype is currently reliant on a commercial power source, so includes built-in independent power sources, such as power banks, making it portable; and (b) Uses the most recent or current Raspberry Pi model to avoid any lag or delays in the prototype's processing capability.

Precision agriculture has expanded to fulfil the growing global need for food by utilising technologies that reduce costs and simplify data collection and use, allow for better adaptation to changing environmental circumstances and make the most use of available resources. Smaller farms can now profit from these technologies as well, even if large farms were the first to adopt them. By leveraging tools found in smart phones, pertinent software, and smaller-scale equipment. Furthermore, these technologies are helping with issues like pollution, global warming, and conservation that go beyond farms.

More autonomous farm vehicles as well as better wireless data transmission and gathering from smaller, smarter unmanned aerial and unmanned ground vehicles are expected to be improvements in precision agriculture in the future. These smaller vehicles can monitor the state of farm equipment in addition to crop and soil conditions, which enables farmers to provide better machine maintenance and repair. Generally speaking, agricultural practices will continue to incorporate process enhancements discovered in the field of industrial manufacturing. Typically, a LoRa-based gateway uses cellular technology to transmit data to the Teralytic cloud. However, if a dependable cellular connection is unavailable at the location of the gateway, we can use a satellite enabled system.

In real time, this device records and reports the temperature, pH, K, N, P, and moisture content of the soil. Therefore, a software system that shows the measured values of

soil characteristics and offers suggestions for fertiliser to grow a particular crop. In addition to soil macronutrients like N, P, and K, a crop's progressive growth also depends on a number of micronutrients that affect yield, such as copper, iron, manganese, molybdenum, and zinc. With the right integration of additional components and requirements, the system can be expanded to measure these factors. RECOGNITION The writers extend their heartfelt gratitude to the Director of ICAR-SBI, Coimbatore, the Management and Principal of Sri Ramakrishna Engineering College, and the Science and Engineering Research Board (SERB) of DST for their financial support.

REFERENCES:

[1] Shylaja.S.N and Dr.Veena M.B, “Real time monitoring of soil nutrient analysis using wireless sensor networks”, International Conference Energy Communication, Data Analytics and Soft Computing(ICECDS), IEEE, pp.3059-3062, 2017.

[2] Dhanunjaya Naik and Dr. G.Prasanthi, “IoT Based Soil Moisture and Temperature Monitoring Device for Irrigation Water Pump”, International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES), Vol. 3, Issue 10, pp.39-43, October-2017.

[3] Madhumathi R, “Elucidating Farmers towards Smart Agricultural Farm Building through Cloud Model”, International Conference on Computing, Communication and Networking Technologies (ICCCNT), IEEE, 2019.

[4] Salve Akshay, Sagar Sonali, Patne Mahesh, Jangam Omkar,” Soil nutrient identification using arduino and electrochemical sensor”, International Research Journal of Engineering and Technology [IRJET], Vol. 5, Issue 2, pp.1327-1329, 2018.

[5] R.Sindhuja and B.Krithiga, “Soil Nutrient Identification Using Arduino”, Asian Journal of Applied Science and Technology (AJAST), Vol. 1, Issue 4, Pages 40-42, May 2017.

[6] Sabina Rahaman, Harshitha M, Anusha R, Bhargavi YR, Chandana M, “Detection of NPK Ratio Level Using SVM Algorithm and Smart Agro Sensor System”, International Journal of Latest Research in Engineering and Technology, Vol. 3, Issue 7, pp.11-15, July 2017.

[7] Reshma U N , Prithvi P Bangera , Chethana H C, Kavya Nadig N C , Keerthi D S, "Raspberry Pi based Soil Parameters Monitoring Device using Sensors", International Journal for Research in Applied Science &Engineering Technology (IJRASET), Vol. 6, Issue 5, pp.1051- 1057,2018.

[8] Akshay Badhe, Sandeep Kharadkar, Rushikesh Ware, Pratik Kamble Prof. Shilpa Chavan, "IOT Based Smart Agriculture and Soil Nutrient Detection System", International Journal on Future Revolution in Computer Science & Communication Engineering, Vol. 4, Issue 4, pp.774 – 777, 2018.

[9] Muthunoori Naresh, P Munaswamy, "Smart Agriculture System using IoT Technology", International Journal of Recent Technology and Engineering (IJRTE), Volume-7 Issue-5, pp.98-102, 2019.

[10] P.R. Harshani, T.Umamaheswari, R.Tharani, S.Rajalakshmi, J.Dharani, "Effective crop productivity and nutrient level monitoring in agriculture soil using IoT", International Conference on Soft Computing and Network Security (ICSNS), IEEE, 2018.

[11]Marianah Masrie, Mohamad Syamim, Aizuddin Rosman, Rosidah Sam and ZuriatiJanin, "Detection of Nitrogen, Phosphorus, and Potassium (NPK) nutrients of soil using Optical Transducer", 4 th International Conference on Smart Instrumentation IEEE, 2017.

[12]Prachi Sharma and Dr. D.V. Padole, "Design and Implementation of Soil Analyzer using IOT", International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS), IEEE, 2017.

[13]John Carlo Puno, Edwin Sybingo, Elmer Dadios, Ira Valenzuela, Joel Cuello, "Determination of Soil Nutrients and pH level using Image processing and Artificial neural networks", IEEE, 2017.