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IoT based Soil Nutrients Analysis and Monitoring System for Smart Agriculture

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***Abstract*: Soil fertility is an important factor in determining soil quality as it reflects how well the soil can support plant growth in agriculture. Soil sensor and Arduino can be used to quickly determine the nutrient content of the soil. Nitrogen, phosphorus, and potassium are all considered as important nutrient source components. These components should be measured in order to determine how much extra nutrient content should be added to the soil in order to increase the crop fertility. Soil fertility can be detected by using NPK sensors. Soil nutrient concentration data can help us to determine whether the soil used to support plant production is nutrition deficient or abundant. The nutrient content of the soil samples can be obtained in various ways by using sensing element or mass spectrogram. However, the spectral analysis method is inconvenient, where the records are only 60-70% accurate. By comparing the spectrum analysis method with classic wet chemistry methods, the accuracy of the products needs to be fully resolved due to a scarcity of data. Hence, to detect soil nitrogen, phosphorous, and potassium, a soil NPK sensor should be used. By utilizing a soil NPK sensor, which is of limited cost, fast and easy, elevated, and transportable. Its advantage over a standard detection approach is that it provides extremely fast measurements with accurate data. This paper analyzes and compares different nutrient levels in soil by using kernel density estimation algorithm and machine learning.**

Keywords: Smart Agriculture, Soil sensor, Soil Nutrients, Kernel density estimation, NPK sensor, Precision Agriculture.

1. Introduction

Farming is essential for the growth of agricultural land. Agriculture employs roughly 70% of India's population and accounts for being one of the national capital [1]. Agricultural issues have always hampered the country's development. Smart farming, which entails modernizing the conventional farming methods, is the only solution to this challenge. As a result, the goal of this project is to make agriculture smarter through the use of automation and IoT technology [2].Agriculture, as the major source of foods and other raw materials, is considered as a source of present in the population.This also offers outstanding and profitable career options.The expansion of the agricultural sector is prompted by the strengthening of the country's economic status. However, some farmers keep practicing old farming methods, resulting in low production and food [3]. However, yields increased when automation was applied and humans were simply replaced to automata. As a result, modern science and technology to boost yields in the agricultural sector, it must be used [4]. Many papers describe the use of wireless sensor networks that gather data from various sensors and transfer it to a centralized server via a wireless protocol. The farmers will face challenges to feed the increasing number of populations. The impactful use of new technologies to increase farming effectiveness will assist farmers in meeting the need of increased population. IoT-related automation will be intended to improve the way a farmer works for multiple tasks.

A high-level overview of the sensor which is based on soil monitor system like temperature, various wetness, light, humidity, and pH value stay altogether leisurely by means of soil sensor [5]. The Internet of Things by using the framework of unique When the sensor gives lighting dependent and lighting the emit diodes to detect the nutritional quantities. Nutrients can be provided to the soil when it has been lacking in nutrients.Smart agriculture remains a wide message that encompasses agriculture besides nutrition making strategies that's why we arepracticein IoT, bigdata then sophisticated statisticstechnologies. The Internet of Things is the term used to describe the detecting connectivity, computerization, and analysis knowledgehooked on traditional farming progress.

1. Related Works

Agronomy crops, soil, farms, animals, warehouses, and just about anything else that has an impact on productivity are tracked using sensor-based control systems [6]. Drones, robotic systems, and actuation are examples of smart farm vehicles.Smart greenhouses and hydroponics are examples of connected farm areas. In this paper [7-9] they review about all the sensors which are used in IoT of Agriculture and mention its uses about crop yields, storing, marketing strategies, and risk evaluation in the future.

The farm owners are now using laboratory testing for check the soil fertility of their lands.The farmers, on the other hand, will have to wait a long time for the results.Even though farmers notice a result, which are sometimes incorrect.The reason for this may be due to the testing team's incompetence or substandard samples sent for testing.A few farmers use automation to test their crops, because this is limited to those who have massive areas.

Plants take macronutrients and micronutrients from the soil that they require for growth. Macronutrients are those that are required in big amounts, whereas micronutrients are those that are required in little amounts [9-11]. The primary macronutrients arenitrogen, potassium, and phosphorus (NPK) other nutrients are called secondary macronutrients. The principal goal of soil difficult is to guarantee that available nutrients are managed efficiently and effectively, as well as to determine the optimum dose levels required to generate maximum yield [12]. Nitrogen, potassium, phosphorus are the key important elements ofprogress and development of plants. The nitrogen being the most important. Plants that are lacking in nitrogen appear unwell they are generally yellow, feeble, and yield little fruit.

Plants with inadequate Phosphorus have frail, wiry stems with thin stems. Their growth is restricted or inhibited, and older leaves develop a dark bluish-green hue.When the soil lacks enough potassium to support the entire plant, the plant's leaves begin to show the first signs of deficiency [13-14]. The most typical sign of potassium shortage is yellowed tissue around the edges of certain leaves. Potassium shortage can also result in the lightening of entire leaves.

In such a summary, a system was created to address the issue of genuine time and preserved monitoring the data to examine soil nutrients anywhere at time to determine different kinds of crops should be cultivated and that can be done with a soil to achieve higher and better crop yields, as well as making a huge system wireless data automatic control over a cell device, which can reduce worker wages and farmer effort.

2. PROPOSED SYSTEM

The proposed system uses a variety of hardware and software components to display soil characteristics such as nitrogen, phosphorus, potassium in real-time. This recommends the desired amount of fertilizers, which could assist farmers in increasing crop production by assisting them in making a best fertilizer selection and ensuring the best crop growth.

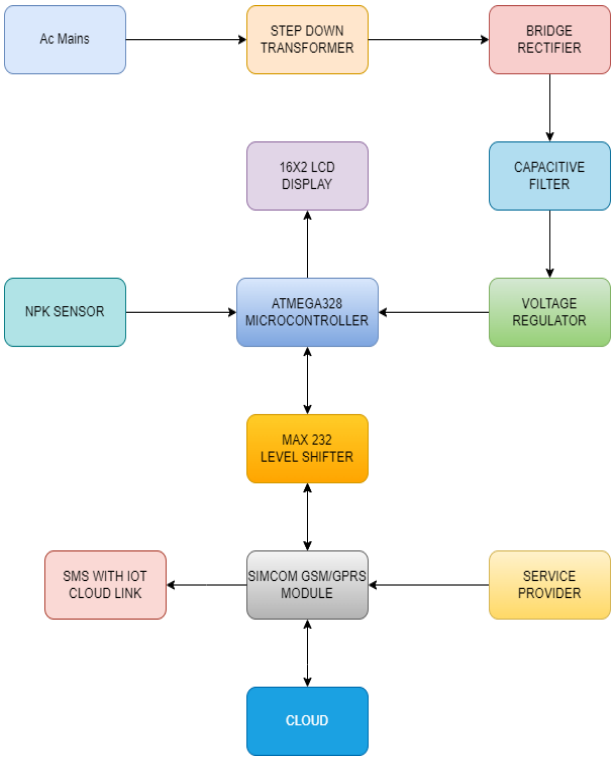

Fig.1. Soil Nutrients System using IoT System

Several hardware devices are used which are Arduino UNO, transformer(0-12V/1A), GSM voice modem,16x2 LCD, IC Voltage Regulator and NPK Sensor. The ATmega328P microprocessor is used in this Arduino Uno microcontroller board. Arduino is open project that develops sensor tools aimed at creating numeral gadgets and communicating things that contains sense and regulator carnal items. It emerges with most everything it will get your microcontroller up and running to connect it to a computer through USB or use an AC-to-DC converter to charge [15]. A computer, some other Arduino boards, or any other microcontrollers can all be conveyed in using the Arduino Uno.

Fig.2. Arduino UNO

TRANSFORMER (0-12V/1A): A transformer utilizes electromagnetic induction to transfer the electrical energy between two or more circuits. When a conductor is uncovered for varying the magnetic fields, electromagnetic induction in order to produce an electromotive force. In electric power applications, the transformers are used to increase or decrease the alternating voltages [16]. A step-down transformer with a larger secondary winding than the primary can be developed. This winding allows the voltage to be stepped down. The inductance utilizes two electronic characteristics to change the voltage of electricity from high to low or low to high.

Fig.3. Transformer

GSM VOICE MODEM: Any GSM modem can accept any kind of data. The GSM network acts similarly to a SIM card and a cellular phone, each by its personalindividualmobile number. This modem's RS232 port could be used to communicate and expand software components. It is an advantage of being used. This same SIM800C is an entire dual-band GSM/GPRS alternative in an SMT module with a manufacturing interface, while the SIM800CS is a quadrilateral band general packet radio service module that operates on frequency ranges GSM850MHz and provides call, SMS, network, and facsimile efficiency in a slight footprint for each long battery life [17].

Fig.4. GSM Voice Modem

LCD DISPLAY: This is an E-blocks-specific digital camcorders and cameras. It has limits of only nine way andelectrical type connection and a sixteen character, two line alphamerical LCD display. This enables the device to connect to the majority of E-Block Input and output ports. The LCD screen needs serial data, which is described in detail in the user manual below. A 5V power supply is also required for the display. This demonstration also needs a 5V current supply. It would take care not much of 5V, if there will origin harm to the expedient. E-blocks Multi software or a 5V fixed regulated power supply is recommended.

The 224 different characters and symbols are displayed here on 16 x 2 intelligent alphanumerical point matrix display. The technical requirements for trying to connect the unit, that either involves a solo power supply it gives a 5 voltage, are included in this display [18].

Fig.5. LCD Display

IC VOLTAGE REGULATOR: The main purpose of an IC regulator in a electric has been maintain their exact current that the supremacy supply follows. The condenser is usually interconnected to the IC regulator's two terminals like input and output when using a regulator [19].

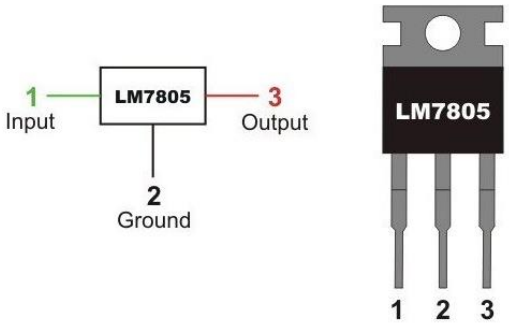

Fig.6. Voltage Regulator

The semiconductor material used in them has a fixed rate of current and voltage, a regulated power supply is critical for several digital equipment. If there is any deviation from the flat amount, the machine may be effected.

NPK SENSOR: The Soil is measured by NPK sensor to sense the value. It can show all the three values in single device. Then it will display a high accurate value in a very lost cost. The response time of this sensor is less than ten seconds. It makes a good interchangeability. The NPK sensor which is used for performance that is consistent. The device is connected of a specially prepared alloy that can endure a lot of external pressure and is not easily damaged. It is much protected and perfectly sealed, inside it has an alkali corrosion resistant, it could be covered in a soil or it's directly going to the water till long resistance dynamic detection. The quick measuring method are like to give a perfect measure located, and it will omit

stonestherefore they have no other hard substance, hold a sensor. They had another method is known as buried measurement method, After such a duration of stabilisation, measurements and records can be taken for several days, months, or even years[20].

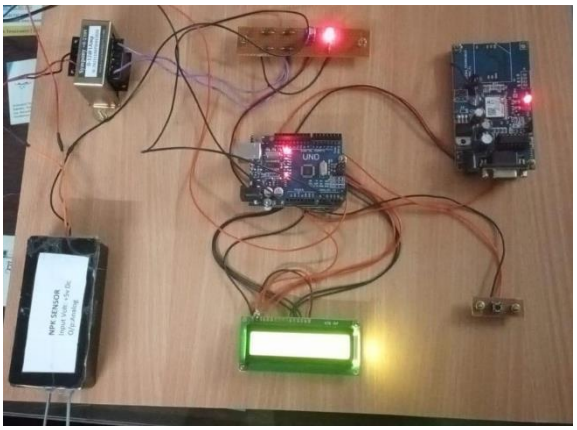

Fig.7. IoT System Architecture of Soil Sensor.

3. Data collection

Understanding exactly what processes were used to gather the data, the types of data obtained, and the amount of sample soils are collected in different places. The soil types and amounts of data acquired by soil nutrients vary greatly. The extent to which data is collected is determined on the analyses goal. The system of the proposed approach is depicted in the following section. There are several stages in the proposed system. Our methodology contains phases are collecting soil samples, after in that soil we have to insert a NPK sensor it will take a little amount of time and it show a value of nitrogen, phosphorus, and potassium after we click the start button the data loaded to the server and it connects to IoT platform and its shows values. ThinkSpeak is one of the best Internet of Things which is used for hardware devices that are connected to the software application and analyse the values.

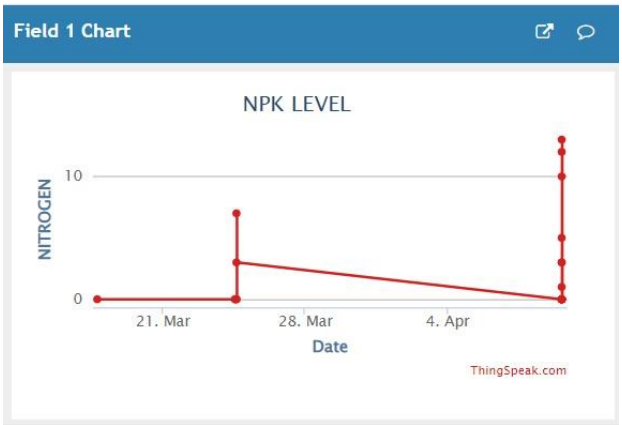

Fig.8. ThingSpeak Cloud Chart for Nitrogen

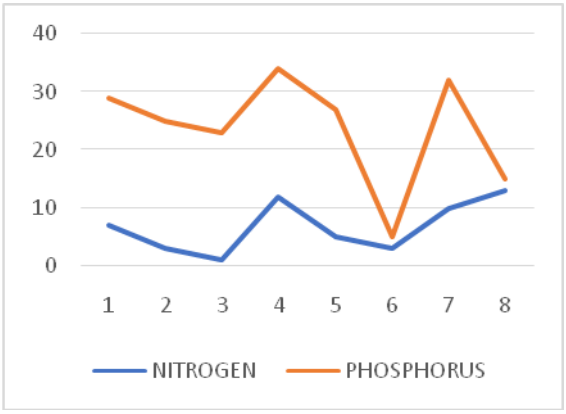

Fig.9 ThingSpeak Cloud Chart for Phosphorus and Nitrogen

The above figure assured in the thingspeak IoT platform. The graph shows all the nutrients level of the soil.

4. Result and Discussion

Kernel density estimation must have tool for estimating the probability density functions that allowed users to understand the investigated probability distribution more thoroughly than when using a typical histogram.in KDE. To insert a dataset it gives a smooth graph.Kernel Density Estimation initiates by plotting the figures and endeavoring to create a delivery curve.

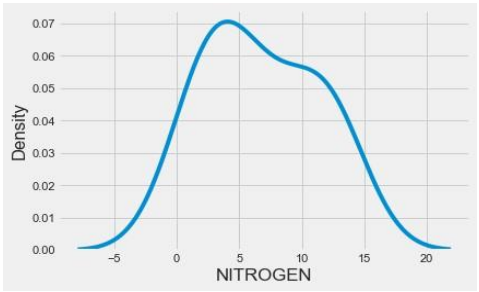

Fig.10 Nitrogen in KDE

The Figure 10 shows the density of the nitrogen and phosphorus level in the soil after applying KDE Algorithm

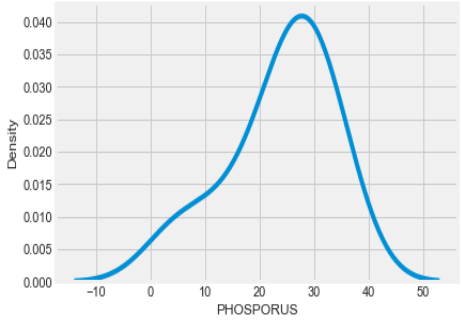

Fig.11. Phosphorus in KDE

The above chart shows the density of the Phosphorus level in the soil after applying KDE Algorithm

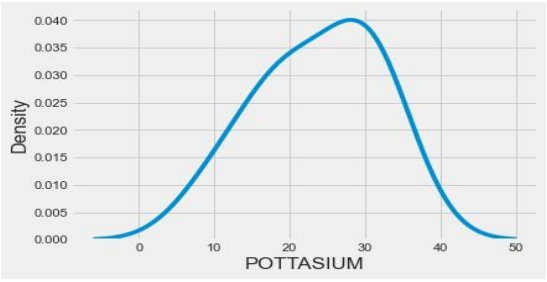

Fig.12. Potassium in KDE

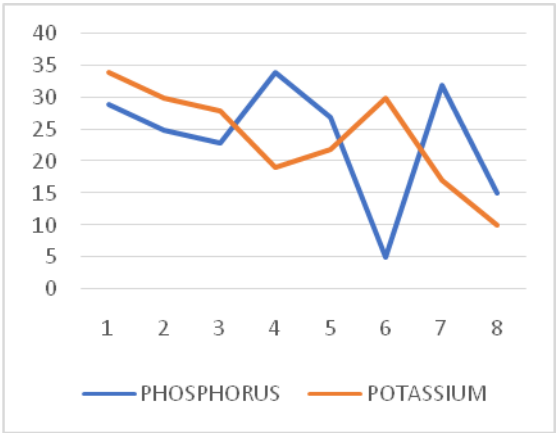

Fig.13. Histplot of Nitrogen

The above figures are collected in the proposed data sample. The data samples are collected in various places. Eight samples are used in for our research. From the figure 12 & 13 it gives the values between two nutrients and analyses for the real-time dataset. The above output displays the comparison of two nutrients.

5. Conclusion and Future

In this research work, a novel scheme has been successfully developed to detect soil quality and provide information on the quantity and further the nature of fertilizer could be used in upcoming generation.The goal of designing such a system from small to marginal range growers at a minimal cost was finally obtained [21-24]. Landowners could now check their soil themselves for a really minimal price and then make a decision on the category and number of enricher to be using, due to an increase in crop production. In this conclusion we are improves the features that are data is stored in a cloud we can see our data at any time. The data are displayed in graph format by using IoT. The platform can also be improved by incorporating various crops that are suitable for all type of soils with varying levels of nutrientsobtainability. In this future work, demonstrated the lack of nutrients can be identified in the soil and we suggest some nutrients has been added for this plant.

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