iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VII **Month of publication:** July 2022

DOI: https://doi.org/10.22214/ijraset.2022.45320

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

IOT based soil NPK monitor via Asynchronous Web-Server using NodeMCU

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Abstract: ***The process of transforming on agricultural production and farming is rising and expanding as a result of the increasing need for food. Utilizing IOT in agricultural and crop production will increase its dependability for farmers, which is a pressing necessity. Crop yield must be enhanced as a result of the population's fast growth. The soil content N (nitrogen), P (phosphorus), and K (potassium) such as are more crucial for producing crops that are more productive. We can assess the crops's rate of nutrient absorption based on the minerals found in the soil. Agricultural yield suffers as a result of the low supply of nutrients. The term "macro nutrients" refers to the main nutritional requirements for required plant development. But for greater development, the proper balance of fertiliser is needed. Due to poor crop yields, labour shortages, high labour costs, a lack of knowledge about advanced cultivation techniques, excessive utilisation of chemical fertilisers and pesticides, and other physical factors, farm owners are experiencing numerous difficulties, and the percentage of agriculture practise has been rapidly declining well over recent years. Producers must've been aware of the quantity of soil nutrients existing in their field in order to limit the abuse of chemical fertilisers. Most farmers don't show any interest in transporting soil samples to testing facilities and waiting for the results, which would be the usual technique for evaluating the level of soil nutrients. Smart farming is the solution to the issues the sector is now experiencing, with a priority on fostering innovation and creativity within agro and crop production. Sensors and IOT devices can be used for that too. Agricultural workers could very well monitor their agricultural production, crops or farm lands and obtain the necessary information and data. Well with support of sensor systems, microcontrollers, web servers IOT unites the entire system. This nutrition monitor displays the elements like nitrogen, phosphorus, and potassium. The ESP8266 NodeMCU would also have to be linked to users local area network in order for user to develop a responsive ESP8266 NodeMCU web server that can be accessible from any device that has a web browser using the Arduino IDE. This implies that the smartphone or PC must be linked to the same network as the ESP8266 NodeMCU device.***

Keywords: IoT technology (IoT), ESP82666 NodeMcu, Soil nutrient, NPK, NPK sensor, MAX485 TTL to RS485, Webserver, Mobile browser

I. INTRODUCTION

Agriculture output depends heavily on accurate and precise soil monitoring. A soil monitoring system powered by the IoT technology (IoT) is said to monitor or supervise soil characteristics and send the necessary information to farmers wirelessly in order to increase agricultural or crop production yields.

All emerging economies depend heavily on agriculture. Due to the isotropic climate in nations such as India, planters are unable to fully exploit their agriculture resources.

Due to poor crop yields, labour shortages, high labour costs, a lack of knowledge about modern farming practises, excessive utilisation of synthetic fertilizers and pesticides, agro-chemicals and other physical factors, agricultural workers are experiencing various difficulties, and the share of cultivation practices has been steadily falling over the recent times. Agricultural workers should be aware of quantity of fertilisers existing in their ground in order to limit the abuse of chemical fertilisers. Numerous producers don't appear to be interested in carrying samples of soil to testing facilities and waiting for the results, which is the usual method to determine the distribution of soil micronutrients.

The interplay between soil and plant characteristics determines how edit is produced. The biological, physical, and chemical state of the soil reflects the maximum crop production (SOIL NUTRIENTS). Agricultural workers may learn regarding their soil monitoring remotely with the use of sensing devices , microcontrollers and IoT network. The dosage of NPK is dependent on the trim kind and the stage of crop growth. The main factor in massively increasing yield in India has been fertilizers. Excessive fertiliser use degrades the health of the soil, contaminates the groundwater, and, in the event of surface run, pollutes neighbouring water sources. This also renders crops reliant on synthetic fertilisers.

Salts build up on the fields as a result of the extreme evaporation, rapidly reducing its productivity.

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Producers will be forced into a downward spiral of indebtedness, excessive fertiliser usage, water waste, and low production if they don't have a clear knowledge of the need to grow crops wisely.

Agricultural production will now transition from resource-based to knowledge-based technologies. The scarce and depleting wetlands are being severely strained by this situation, as well as by growing industrialisation and urbanisation. The ecosystem as well as the supply line can suffer irreparable harm if remedial action is not done.

In a matter of minutes, the optimal fertiliser dosage may be estimated. The level of NPK should be maintained since the macronutrients alter agricultural production. In order for farmers to make a profit without harming the soil terrain and ecosystem, the level of these micronutrients shall increase or indeed decline.

Despite taking a soil specimen, this experiment will determine how many nutrients are available in the soil. With this technique, farmers may rapidly as well as remotely assess the nutritional quality of their land. By doing this, we may strategically avoid overfertilizing the crop production while yet applying fertiliser where that is needed. By doing so, excessive usage of chemical fertilisers and ecological imbalance are avoided. Without harming the soil, crop production will increase.

N, P, and K are the nutrients that are displayed on this nutrient monitor. The ESP8266 NodeMCU has to be connected to your local area network since we'll be using the Arduino IDE to create a functional ESP8266 NodeMCU web server that can only be viewed from any gadget that has an internet browser. This implies that the smartphone or PC must be linked to the same network as the ESP8266 NodeMCU device.

II. LITERATURE SURVEY

1) The "Green Growth Management by Using Arm Controller" was given by Bachkar Yogesh Ramdas and Prof. S.G. Galande [1]:

Bachkar Yogesh Ramdas, Prof. S.G Galande, (March 2014), “Green Growth Management by Using Arm Controller”, International Journal of Engineering Research and Applications, Vol. 4, Issue 3

In this study, the author developed a scheme that requires instruments to monitor the soil's wetness, humidity, and phosphorus content while also checking up on the heat and sunshine in a crop land. By gathering sensor readings, this mechanism can gather an optimum level of liquid for drip irrigation and phosphorous for plants. This 's major goal is to boost crop yield by providing the right volume of fluid and fertilization. This system produces a workable alternative for use in agricultural monitoring and controls that has been designed, developed, and refined.

2) Purvi Mishra, Sudha Mapara and Preeti Vyas, (Nov 2015) “Testing/ Monitoring of Soil Chemical Level Using Wireless Sensor Network Technology”, International Journal of Application or Innovation in Engineering & Management Volume 4, Issue 11 [2]:

The Testing/Monitoring of Soil Chemical Level Using Wireless Sensor Network Technology [2] that We explored and led us to the conclusion that wireless sensor technology can assist farmers in knowing the precise moment to deliver fertilisers & composting to the crops in order to boost production, reduce timeframe, cost, & labor. The Nitrogen, Phosphorus, and Potassium values of the ground could be measured with this sensing technique.

3) Jianhan Lin, Maohua Wang , Miao Zhang, Yane Zhang, Li Chen, “Electrochemical sensors For Soil Nutrient Detection: Opportunity And Challenge”, pp 1362-67 [3]:*

The researchers of this article explained how soil sampling creates the foundation for nutritional recommendations and fertiliser formulas. In this work, potentiometric electrochemical sensors (ISE and ISFET) for soil NPK detection were briefly reviewed. In soil analysis, the advantages and disadvantages of electrochemical sensors were examined. We discovered that such benefits of potentiometric electrochemical sensors are piqueing interest in their applicability in soil chemical analysis after investigating electrochemical sensors for soil nutrient detection: opportunity and challenge [3]. These have the capacity to quickly and automatically identify soil nutrients across many targets. They consequently have to contend with the difficulty of their dependability.

III.MATERIALS AND METHODS

A. Different Range of Sensors

Different types of sensors could be used to identify abnormal soil characteristics. The three phases of the traditional soil NPK testing procedures are typically soil sample, specimen pre-treatment, and chemical analysis. Even now, representative soil specimens were collected physically in a region at the appropriate depth. Conductivity measurement, optical method, and electrochemical methods are indeed the three main approaches used in chemical analysis, or the real monitoring of NPK, to examine the amount of essential minerals.

B. NPK SENSOR (Nitrogen, Phosphorus, and Potassium)

A JXCTIOT firm in Weihai, China manufactures the JXBS-3001 Soil NPK sensor. The austenitic 316 steel probes that has been used in affordable, quick-responding, highly precise, and compact NPK sensor enable it to function without any corrosion toward a longer duration while resisting rust, salt-alkali, and electrolytic reactions. Strong epoxy glue is used to enclose its protective shell, preventing moisture against penetrating the sensor's central core and ensuring the sensor's long-term functionality.

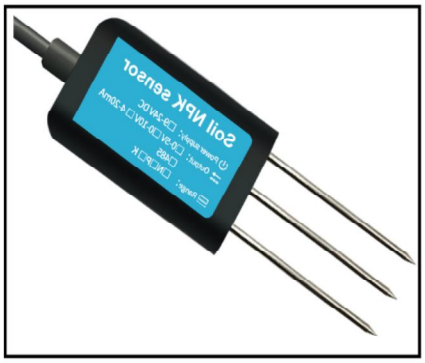


Fig. 1 NPK SENSOR (Nitrogen, Phosphorus, and Potassium)

This optical electrical sensing senor is used to identify soil gases (N) i.e nitrogen, the phosphorus (P), and metallic elements (K) such as potassium. In order to increase agricultural output for certain micronutrients area divisions, this sensor is necessary to determine the amount of extra insides to be applied to the soil land. It can raise the soil's quality and decrease its unintended usage of pesticides to improve the soil. The sample area unit NPK value is based on how well each element is absorbed by sunshine. The electrical optical device functions as a tracking or monitor module and also is made up of a light-weight detector photodiode and three LEDs as an excitation source. Each nutrient's optical occurrence is taken into account while choosing the LEDs' frequency. So, every nutrient's optic appearance is taken into account while choosing the LEDs' frequency. The photodiode converts the leftover lighting which is reflected by the reflectors to electricity after the nutrient permeates the LED's sunlight. To understand these concepts, the system incorporates a Microcontroller, which raises the inductive load outcome into a readout on an alphanumeric display The sensor's hardware might produce results with great sensitivity, consistent signal, and minimal energy cost. The sensor module has an IP68 rating for water and dust resistance.

Through screening on various soil samples, the optical electrical device will look at the NPK topsoil content values.

The above sensor-module doesn't need any chemical components. It'll have a Modbus comms connector, so we have to use an intermediary Modbus module to communicate it to microcontrollers instead of directly. By just sticking the probing in the soil, users would test the amount of nitrogen, amount of phosphorus, and amount of potassium in real-time using most microcontrollers, including Uno and Esp8266. The kind of ground, including such acidic or alkaline soil, is also detected by this sensor module. In order to link the sensor with Arduino or esp8266 microcontroller, users have to have an auxiliary Modbus module, notably RS485/MAX485. The above sensor operates in the ambient temperature of 41-113 degrees F and functions with an operating voltage range of 9v-24V with a maximal energy usage of less than 0.15watts (5-45Celcius). Because they feature transmission speeds of 2400, 4800, and 9600, many micro - controllers, notably Uno, PIC micro - controllers, the microcontrollers arduino family, and ESP8266, ESP32, and so forth., support this soil NPK sensor. One such soil NPK sensor module is claimed to be capable of detecting nitrogen [N], phosphorus [P], and potassium [k] in the range of 0 to 2000 mg/kg (mg/litre), with either a correctness of 2 percent and a reading precision of 1 mg/Kg (mg/litre).

C. Converter module for MAX485 TTL to RS485



Fig. 2 Converter module for MAX485 TTL to RS485

With using half-duplex transmission, the MAX485 TTL to RS485 converter unit aids throughout the conversion of TTL data to RS485 inputs. Even in electrically loud surroundings, this module provides long - distance telecommunications up to(1.2 kilometres yet utilizing 300 µA electricity. This component is excellent for industry sectors since it enables communication across 32 units at a transfer rate of 2.5 Mbps using a master and slave setup (linear/multidrop). The data transfer rate reduces proportionately because the length expands. To allow the receiver to drive HIGH through a digital pin on the microcontroller, the receiver output(RO), which emits the signal, must be linked to RX Receiver Enable(RE).Driver Enable (DE): This is typically jumpered to the RE pin and is active HIGH by default. Driver Input (DI): Since the microcontroller requires data input, DI should be linked to TX. VCC: Must be linked to a 5 volt power source. B: Data 'B' inverted line. links to the screw pin as well, as seen in the picture. Data Set A: Non-inverted line. links to the screw pin as well, as seen in the picture. Ground: GND

D. ESP8266 NodeMCU

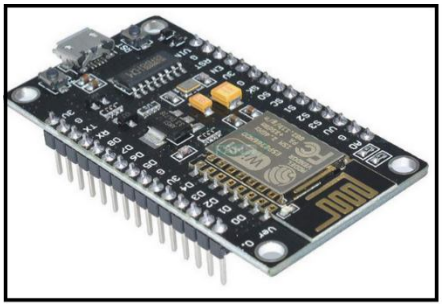


Fig. 3 ESP8266 NodeMCU

The ESP8266 NodeMCU development platform is fairly well-liked and widely spoken in the online community. It is built using the ESP-12E Wi-Fi chip, which flawlessly combines the principles of simple programming with the Arduino IDE or Arduino Software and Wi-Fi functionality. It has always been built using the ESP-12E Wi-Fi unit, which flawlessly combines the principles of simple programming to the both Arduino IDE plus Wi-Fi capabilities.

Well with CH340G USB-TTL Serial chip, the NodeMCU V3 is an open-source ESP8266 development kit that can be used on a board. The CH340 microprocessor family is well-known for being an inexpensive substitute for something like the CP210x.CH340 is extremely dependable including in industry sectors while being less expensive.On each supported platform, it has also been tested and shown to be stable.It has a built-in USB port, making it simple to use with the Arduino IDE or NodeMCU Lua.It goes without saying that the sector has seen a growth in Iot systems, increasing the importance of linking items.Wi-Fi technologies and other techniques are only a few of the ways we may link remaining items.The ESP8266 serves as the foundation for the open-source NodeMCU infrastructure. It provides the ability to link items in order to speed up information transmission via Wi-Fi networks.

Additionally, similar to Arduino microcontroller, the ESP8266 NodeMCU microcontroller houses a number of essential components on a single circuit board system. Voltage regulators, an ADC, GPIO pins, Micro-USB interfaces, as well as other components will be visible. The ESP8266 NodeMCU is notable for supporting complete Wi-Fi to enable Wi-Fi connection to a client or server. Additionally, the device is a system - on - chip (SoC) made by the Chinese enterprise Espressif. The ESP8266NodeMCU is notable for supporting complete Wi-Fi to permit Wi-Fi connection to a client or server. Additionally, the device is indeed a system - on - chip (SoC) rendered by a Chinese industry Espressif.

E. WebServer

Using the internet network, web server can visualize information data in accordance with the requests that have been made with uses HTTP communication as information transmission and is really helpful for IoT projects . Web Server is an open user interface display that would be used to display data from input in the form of sensors or other devices.

In this project, we'll find using the Arduino IDE and ESP8266 NodeMCU to build a soil monitor web server. The NPK sensor is used to monitor the levels of potassium, phosphorus, and nitrogen in soil. As it displays measurements for N (nitrogen), P (phosphorus), and K (potassium) on the web page, this web server will function as a soil nutrient monitor. On a web page, the sensor values will automatically update. Because we build an asynchronous web server library and Server-Sent Events (SSE) server. Asynchronous web servers may be easily built using the ESP Async Web Server library.

This nutrition monitor displays the elements like nitrogen, phosphorus, and potassium. The ESP8266 NodeMCU would also have to be linked to users local area network in order for user to develop a responsive ESP8266 NodeMCU web server that can be accessible from any device that has a web browser using the Arduino IDE. This implies that the smartphone or PC must be linked to the same network as the ESP8266 NodeMCU device.

F. Methodology

The paper's analysis about methods and materials are briefly covered in the parts that follow. Figure 1 displays a possible technical flow diagram.

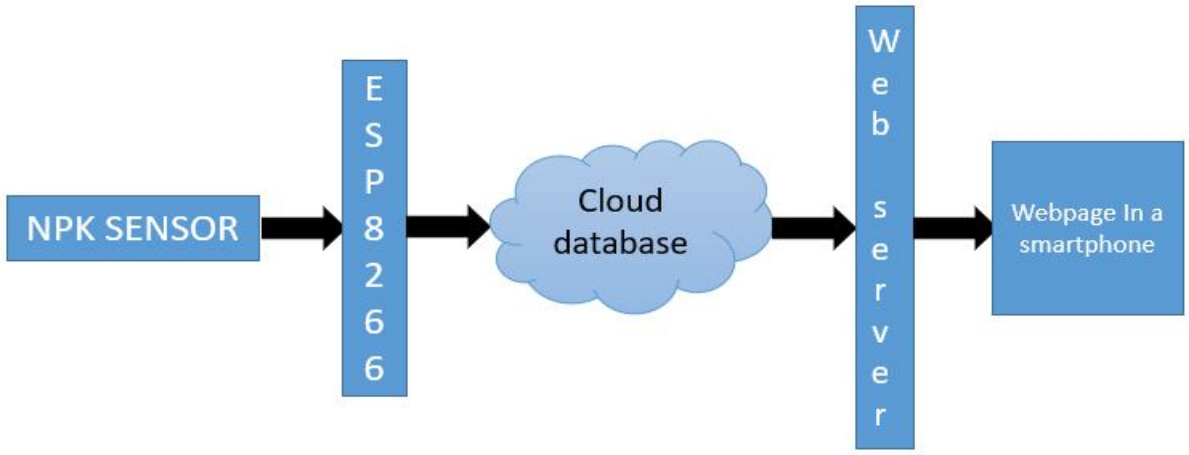


Fig. 4 Flow Diagram

NPK Soil Sensor & Arduino make it simple to monitor the nutrient composition in the level of the soil. To calculate what further nutritive value has to be applied to earth to boost crop fertilization, measurements of soil N (nitrogen), P (phosphorus), and K (potassium) content are required.NPK sensors are used to measure soil fertility. Nitrogen, phosphorous, and potassium make up a significant portion of soil fertiliser. Knowing the concentration of nutrients in the soil can inform us of nutritional abundance or shortage in soils that support plant growth.

The Nodemcu Application programming code that is authorised in the Nodemcu software system as an IP address to be displayed on the web page using an internet that can be monitored from a smartphone, The NPK sensor module operations to trace micronutrients and therefore can operate if the probe of the sensor module is injected into the soil which they want to detect. The results detected by the sensor will be processed and displayed on webpage using this IP address.

A Modbus Controller can be instructed by Modbus instructions to do many of the major indicators such as modify the value in one of its registers, which is written to Coil and Holding registers. I/O port reading: Obtain information from the Discrete and Coil ports. The instruct the gadget to transmit back any number of values from its Coil and Holding register. The Modbus address of the device for which a command is meant is contained in the request (1 to 247). An query framework is another name for the Modbus ip. Even while greater connectivity could get the instruction, only the specified component will react and take action.While monitoring the values of Nitrogen (N), Phosphorous (P), and Potassium (K), the NPK Sensor includes three separate inquiry frames (K).

The code is used to retrieve the soil nutritional content again from sensing element through Modbus and interface the soil NPK sensor with ESP 8266 Microcontroller. The command can be sent by the user, who can then get the value in HEX code. To obtain the measured soil overall nutritional information, the HEX code must be translated into decimal.

The web server and sensor will both start up once the user uploads the programme code to the Esp8266. The sensor module will take some time to stabilise, and the initial reading can be off. The user may immerse the sensor module into the ground to obtain the NPK reading once the sensor has stabilised. The amount of Nitrogen, Phosphorous, and Potassium, that also make up the soil's ammonium content, will be shown as mg/Kg. Unfortunately, a lot of farmers continue to use old-fashioned agricultural techniques, which results in poor crop and fruit yields. But anywhere there is automation, machines that operated automatically took the place of people. Most people use sensors that gather information from several sensor kinds and transfer it to cloud storage through wifi. The data collected provide more details on certain soil conditions, allowing for remote monitoring in exchange. To increase agricultural output, soil conditions are not adequately yet so they must be properly monitored.

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IV. SOIL NUTRIENT TESTING, MONITORING, AND RESULTS EMPLOYING CONCEPT OF INTERNET OF THINGS

Users may begin testing the project but once the Arduino IDE and ESP 8266 has been successfully updated with the program. Insert the NPK sensors into the surface soil. Start all these Serial Monitors at this point to see if transfer of data is occurring or not. The NPK sensor node's Serial Monitor displays data from the NPK sensor, such as the percentage of soils and the amount of NPK as mg/Kg. The receiver/gateway portion receives the data wirelessly. The information is compiled and uploaded to the webserver by the nodeMCU. Users just need to access the Dashboard's webpage interface. All the soils NPK data will be displayed on the Webserver.

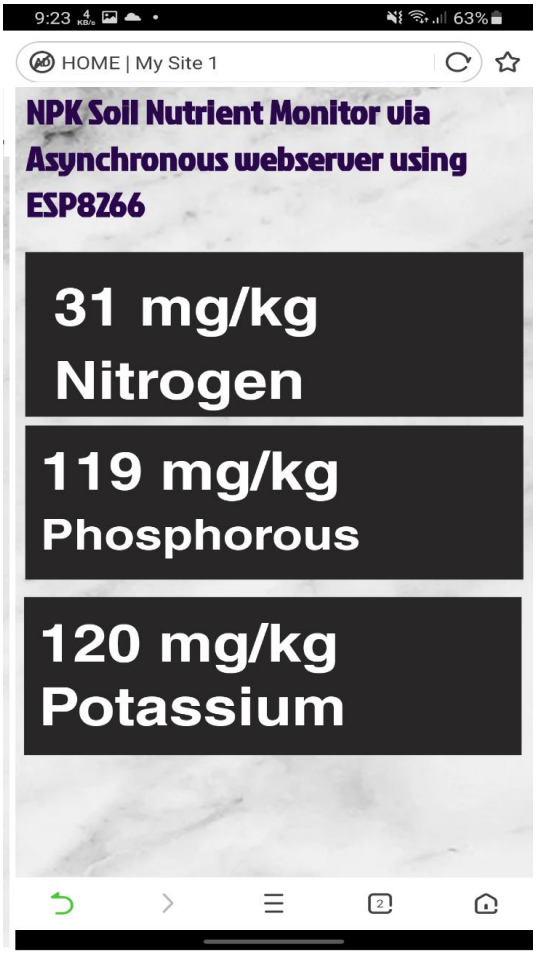


Fig. 4 Webpage for Displaying NPK sensor data

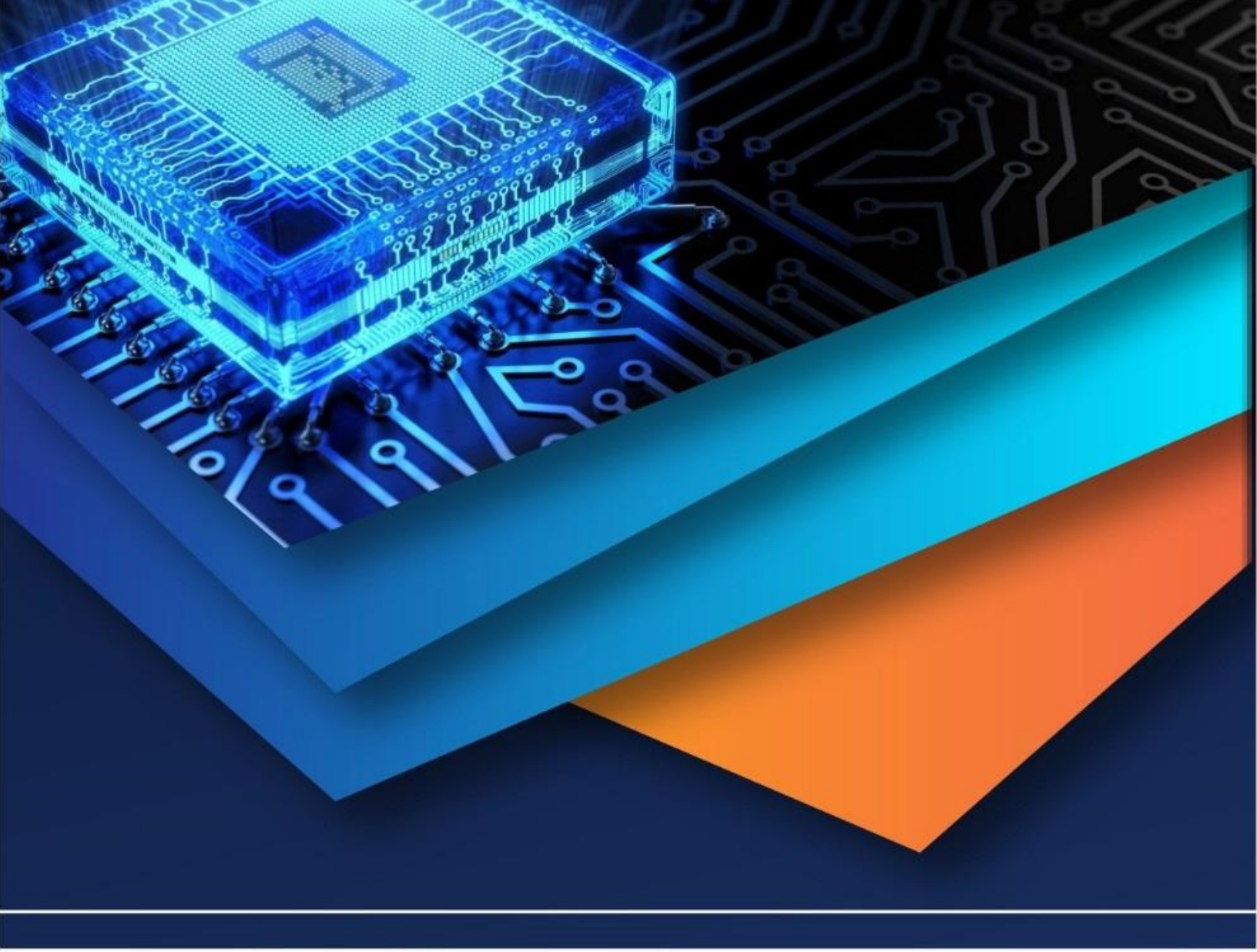
V. CONCLUSIONS

This study's finding may be summarised as follows:

To make it simpler for agriculture and farmworkers to sow seeds, the NPK sensor-module will monitor the nutrients in the soil and send the data to the web server online so that it can be monitored via any device that is having a web page. It is simpler to monitor soil nutrient levels thanks to the data the sensor reads being uploaded to webserver. To identify the presence of soil macro-nutrients, a variety of sensors (NPK) have indeed been studied, and it's determined since, altogether, these approaches have shown to be identical. Nevertheless, independently measuring the nutrients yet presents a problem since of multiple factors, like the cost of spectrometers as well as other sensor methods.

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[1] The "Green Growth Management by Using Arm Controller" was given by Bachkar Yogesh Ramdas and Prof. S.G. Galande [1]:
[2] Purvi Mishra, Sudha Mapara and Preeti Vyas, (Nov 2015) "Testing/ Monitoring of Soil Chemical Level Using Wireless Sensor Network Technology", International Journal of Application or Innovation in Engineering & Management Volume 4, Issue 11
[3] Jianhan Lin, Maohua Wang* , Miao Zhang, Yane Zhang, Li Chen, "Electrochemical sensors For Soil Nutrient Detection: Opportunity And Challenge", pp 1362-67



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