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Design Of Smart Fertilizer Chain System From Factory To Farmer

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Abstract— **The presence of Nitrogen (N), Phosphorus (P), and Potassium (K) in the soil is estimated and identified utilizing a device called an optical transducer. This sort of transducer is utilized to decide the amount of each of these elements additionally required as external supplements to the soil for soil richness. This assists by improving soil quality and reduce the utilization of fertilizers that are not required. The incident light of every supplement chooses the example's N, P, and K value. The optical transducer is executed as a light source with three LEDs and a photodiode as a detecting component in a recognition sensor. The frequencies of LEDs are picked to compare to every supplement's retention band. The supplement retains the light from the LED, which is then changed by the photodiode. Since the gadget gathers information utilizing a Boltduino microcontroller, the information from the transducer is sent to the cloud for processing with the help of IoT technology. This Design used blockchain technology and data management to render fertilizer sales only when the field's NPK levels are low. Here made a Decentralized app (Graphical user Interface) at PoS, point of sale. Since it is linked to the cloud and uses blockchain technology, promise transparency at its best. As a result, every penny of fertilizer subsidy provided by the government benefits farmers. It also cuts down on the amount of fertilizer generated, supplied, and used. Hence soils are saved from overuse of fertilizers and groundwater nitrogen pollution is reduced.**

Keywords— NPK, Optical transducer, Internet of things, Decentralized app, Blockchain

I. INTRODUCTION

There are many nutrients in the soil. Among them, NPK levels (Nitrogen, phosphorous and potassium) are mainly used for plant growth. Nitrogen helps the plant grow in its roots and below parts, Potassium is used by plants to grow their leaves and Phosphorous to grow the stems and branches. An agricultural system that offers a thorough strategy to address the soil variability in order to increase profitability, optimize output, and enhance the quality of production [1]. Every crop should be rich in those nutrients, to make the farmers or owners get a better yield and to win their daily bread. And also, can see that many scams taking place regarding subsidies. This is the motivation for this work, so came up with a new idea that saves the pockets of the farmers and implemented it in the form of this model. The previous researchers and scientists found many different ways to calculate the NPK levels. After a lot of research, it is found that best way to calculate the NPK levels from the soil is by using a special sensor named Optical transducer [2]. These values are again sent into the cloud so that they can further be used for the determination of fertilizer amount using a microcontroller. These values are again examined and compared with the threshold values of the ideal soil. And after comparison, these are sent into webpage which is built using Blockchain Technology. The main reason behind the usage of blockchain technology is that it is secure and transparent to everyone. So, developed a decentralized application (Dapp) that estimates the required fertilizer amount for the soil. By this, can reduce the cost of fertilizers to a farmer as going to provide them with the required proportion. Precision farming creates a network of "smart farms" by fusing the Internet of Things with blockchain. This combination results in increased independence and adaptability [3]. Blockchain has quickly emerged as a crucial technology in several applications for precision agriculture. Researchers are thinking about creating blockchain-based IoT systems for precision agriculture since smart peer-to-peer systems are needed for monitoring, securing, and analyzing agricultural data. In order to convert agricultural data from traditional ways of storing, sorting, and distribution into a digital format that is more trustworthy, irreversible, transparent, and decentralized, blockchain technology is essential. Next section explains the methodology along with experimental setup and section III describes the result analysis and finally future scope is given.

II. METHODOLOGY

The overview of the components is discussed below. The main and heart of project is the optical transducer. It is nothing but a combination of a light transmission system and a light detection system.

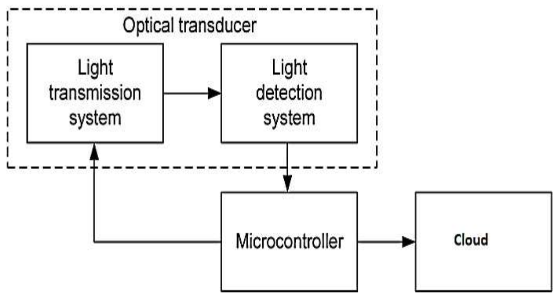

Figure 1:Block Diagram of Optical Transducer connected to Microcontroller[4]

The light transmission system mainly consists of 3 LEDs, Red, Blue and Green. The main reason behind the usage of these colours is that the wavelengths of these are nearly equal to wavelengths of Nitrogen, Phosphorous and

Potassium. The Blue LED wavelength is nearer to Nitrogen, the Green LED wavelength is nearer to Phosphorous and the Orange or Red LED wavelength is nearer to Potassium which is shown in below Table-1 which shows the respective nutrient absorption wavelengths and LEDs wavelength in nanometers (nm).

Nutrient	Absorption wavelength(nm)	LED Type	Wavelength (nm)
Nitrogen(N)	438-490	LED 1	460-485
Phosphorous(P)	528-579	LED 2	500-574
Potassium(K)	605-650	LED 3	635-660

Table-1: Optical characteristics of NPK and LEDs[3]

The light detection system, uses a photodiode as receiver which collects the light rays [5]. It is connected to the microcontroller as per the block diagram as shown in figure-1. The photodiode is a type of sensor that collects the light rays and sends them to microcontroller which is Arduino for the next steps.

The Arduino is connected to various components like photosensor diode module, LEDs, IDE from laptop etc., which are shown in figure-2 below. This Arduino takes the readings from the photodiode and displays them on its integrated development environment (IDE) as shown in figure-2.

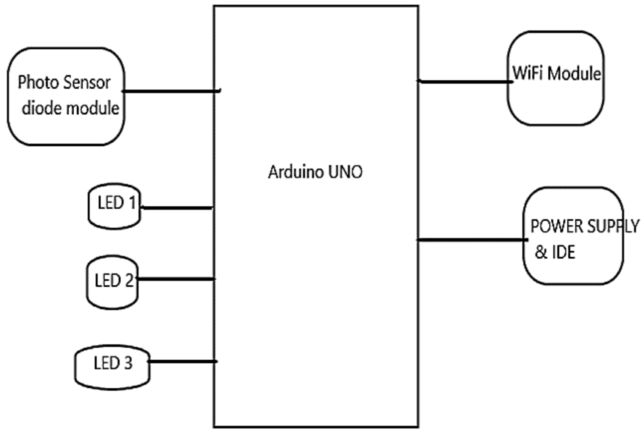

Figure 2: Arduino UNO with connected components

After that, Arduino is again connected to Boltduino which helps us to push the data into the cloud. The main reason behind the usage of the BoltIot Kit is that it has an in-built Wi-Fi module [6]. It has its IDE (Integrated Development Environment) where it can code and execute. Using this, can able to integrate different tools and devices into it. This is again connected to blockchain setup, where the values of NPK will be taken as inputs and shows the output as the amount of fertilizer [7] needed to that respective farmer.

A. EXPERIMENTAL SETUP

Before this process, put a reflector which is a normal mirror under the soil at a 1cm distance. When this light transmission system allows the light to fall into the soil, the light of these nutrients which are nearer and equal to the wavelengths of incident light will hit back. Then the light rays hit back are reflected to the light detection system, which is the second part of the optical transducer. These values are sent to Arduino. As it has its IDE, it gives the continuous values of the voltages on the console screen. It will be an advantage if all the Optical transducer system is soldered properly. It reduces the error probability.

It was observed and noted those records in the form of a table. The average or mean value is calculated of those values to get the best value as output. The mean value is again compared to the threshold values of the ideal soil which is already calculated. The practical implementation of the optical transducer system and Arduino is shown in figure-3 below. Now have the NPK values. So, next step is to push or store the values into the cloud. For this work used the BoltIot kit for the implementation of IoT in the project [8]. The NPK values from the Arduino have been collected by the Boltduino and have to do some setup initially. First, need to connect the Boltduino to the device in which we are going to use Boltduino IDE. When the Boltduino is successfully connected to the device, the Blue LED light on the Boltduino blinks.

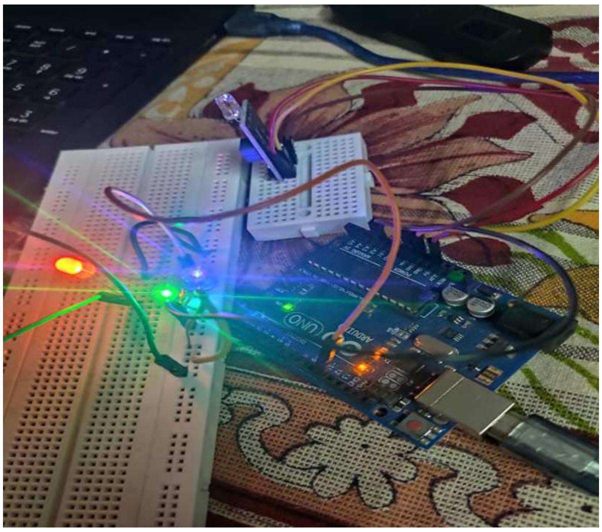

Figure 3: Practical Implementation of Optical transducer and Arduino UNO

Now, need to enter our credentials to log into the Boltduino IDE. Once it is opened, need to have a secured connection between the Boltduino device and IDE. The Blue LED and Green LED light blink together when the connection is established securely. As shown in the below figure, named Boltduino as 'temperature sensor'.

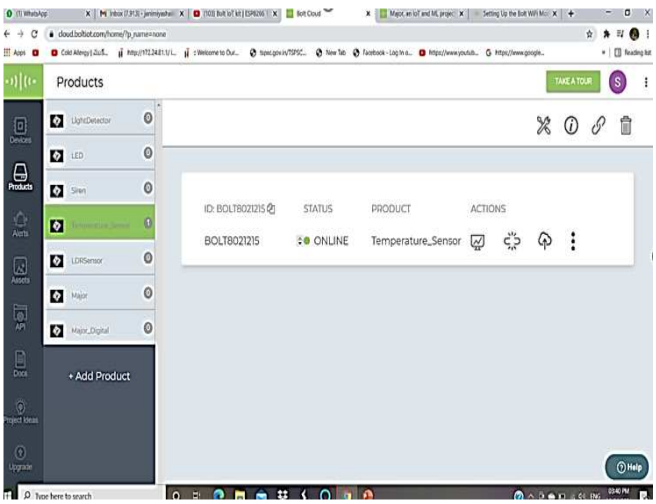

Figure 4: Set up of Boltduino IDE

We can add many Boltduino devices to IDE depending on our usage. On the left side of the webpage, it can be seen so many products. So, the product which is currently being used can be known by seeing status and product name. By clicking on the monitor symbol which is in the action's column, can view the data that's pushed from Arduino. Next to the monitor symbol, we have the link symbol which signifies the connection between product and IDE. Next to that, the symbol signifies the data is deployed to the cloud. After deployment, get the result in another webpage by clicking on the View button.

This data is sent into the Blockchain part for further analysis. Here, has a webpage where the data is taken and displays the records of each transaction of different ports. After the data is pushed to the cloud, the main application of this project is to be discussed. Here developed a Blockchain that is hosted locally on laptop and used JavaScript and Node.js to build the Blockchain and can run multiple nodes at different ports to achieve decentralization. The ports on which ran the nodes are 3001,3002,3003,3004. Here used these four ports as 4 nodes and deployed blockchain. Before getting to the core of Blockchain, let us see how to connect the 4 nodes and their working as a decentralized network. Used Postman to send requests. There is an endpoint in the code 'register-and-broadcast-node', which is used to register one node with the other. Connect the nodes one by one, in the same way, connect every node and can see the status after the establishment of the connection. After connecting the ports, and can now push the data from the PoS interface to the Blockchain and then use a mine endpoint to mine the data get from the PoS interface. It validates the data and pushes it to the decentralized network i.e., to every node which is linked. After that, implemented the nodes using JavaScript language. During this process, the API ensures that every endpoint is working and are intact.

As it is known that Blockchain is used for transparency and to validate transactions. So, developed a Dapp interface. The decentralized app is developed using HTML, Tailwind CSS and JavaScript. The front-end interface of the same is shown in figure-5 below.

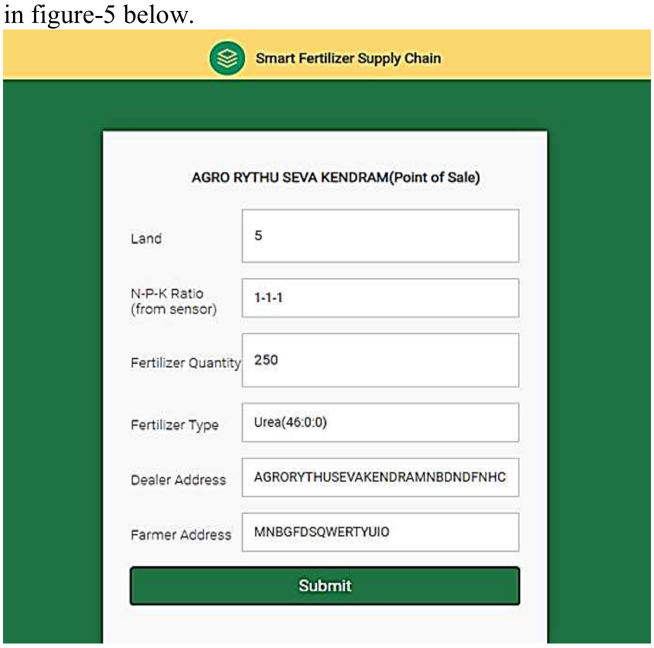

Figure 5: Agro Rythu Seva Kendram Web Page

As it can be seen that, added the input fields like Land, N-P-K Ratio, Fertilizer Quantity, Fertilizer type, Dealer Address and Farmer Address. The Dealer Address and Farmer Address use the SHA-256 Algorithm [9] which makes it more secure.

The entire idea of decentralization is of no use if there is no common interface to verify the transactions. That's where database interface 'SFSC: Blockchain database' comes in. Here used HTML, CSS and Angular for data retrieval. It provides you with the details of a transaction if you have transactionID, the DealerAddress or the Farmer Address. This way, you can check the farmers' recent transactions of fertilizer before doing another transaction and figure-6 which shows the same interface of Blockchain Database.

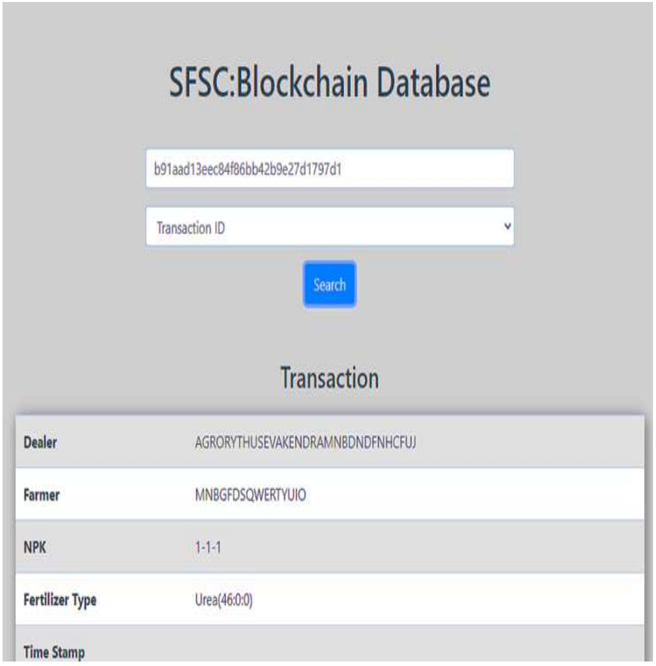

Figure 6: Blockchain Database

III. RESULTS AND DISCUSSION

From observation, found that the optical transducer fetches the values of NPK from the soil and provides it to Arduino IDE as shown in figure-7 below, in form of voltages. The values are displayed on the console screen of the IDE.

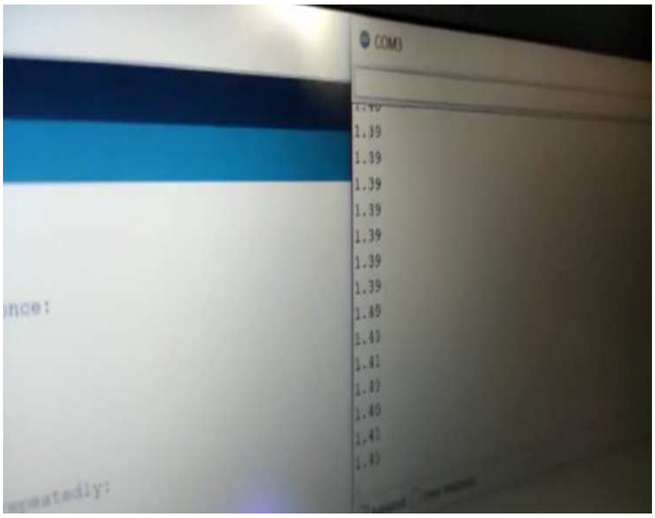

Figure 7: Arduino IDE showing Output of values

Now by analyzing these results with different types of soils like red soil, Black soil etc., made a table-2 as shown below.

Soil Nutrient	Low	Medium	High
Nitrogen(N)	0.31<x<2.508	2.508<x<2.708	x>2.772
Phosphorous(P)	1.617<x<1.848	1.914<x<2.178	x>2.2244
Potassium(K)	1.056<x<1.452	1.518<x<1.848	x>1.914

Table 2: Threshold level comparison table

By analyzing Table-2 above, can say that if a soil whose values of NPK are in the range of the table values, they can be considered as Low amount of NPK or medium or high respectively. For example, let the value is "2.61" when Nitrogen LED is used. So from the table, can say that the soil has a medium amount of Nitrogen. Similarly, can also check with other nutrients (P and K) using other LEDS and can say whether the soil has a high or low or medium amount of nutrients. This gives us an idea of how the soil is and how it can be made ideal. Now it can prescribe the farmers to add fertilizers to the soil in a required proportion so that it can make the soil more fertile for farming. From the above results, found that for Potassium, the values are very smaller when compared to the other two nutrients (Nitrogen and Phosphorous). If these values are in the ratio 4:2:1, then consider that the soil is perfect (ideal). After fetching these values from the optical transducer through Arduino, now deployed the data into the cloud using Boltduino and BoltIot IDE [10].

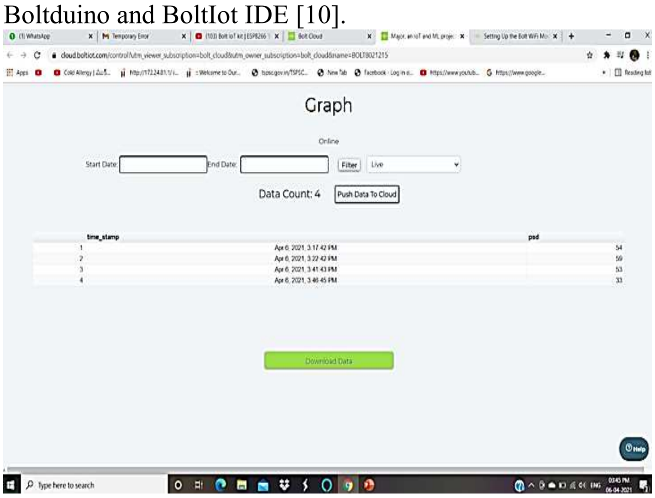

Figure 8: Boltduino Output webpage

As shown in the figure, outputs obtained on the View page of Bolt IDE. These values are obtained from the photosensor diode (PSD). Data count signifies how data is pushed into the cloud. By clicking on the download data option, store the data on the device. It can also display the output even on mobile using the "Bolt IoT App". It can display the output in the form of charts and graphs on the View page. As you can see the URL in each webpage shows 'localhost:3001/blockchain', which means 'blockchain' endpoint is hit on port 3001.

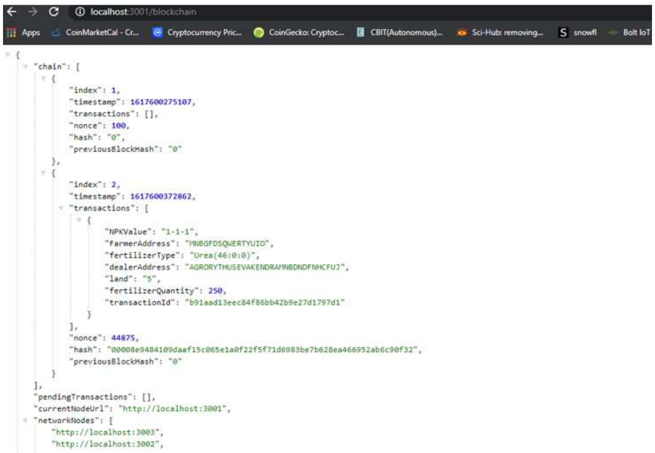

Figure 9: Port 3001

It can be seen clearly in the values that are pushed to the blockchain after hitting the mine's endpoint. The field values "NPKValue",FarmerAddress,FertilizerType, DealerAddress, land, FertilizerQuantity, TransactionId are appended into the chain. This happens in every port because they are connected and decentralized. You can't alter the database from one node. This makes it more secure and prevents it from cyberattacks and can be able to see the outputs of different ports with each having data of other ports linked to each other like a chain by Postman API.

Figure 10: Port 3002

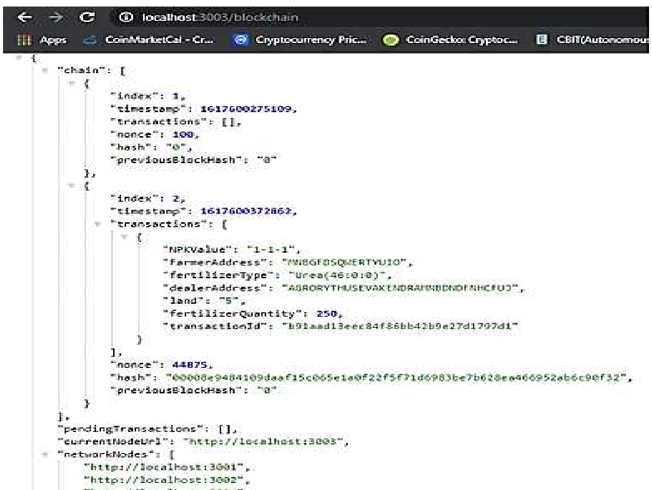

Figure 11: Port 3003

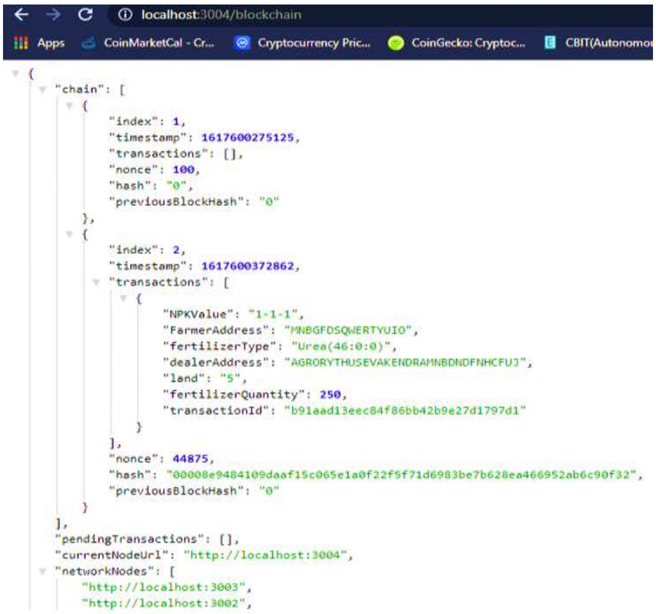

Figure 12: Port 3004

CONCLUSION AND FUTURE SCOPE

A. *Conclusion*

The Project " Design of Smart Fertilizer Supply Chain" is successfully designed, developed and tested. It is developed by integrating features of all the hardware components used. The presence of every module is reasoned out and placed carefully thus contributing to the best working of the unit. By integrating two cutting edge technologies, promise to provide a robust, cost-effective, secured, transparent and smart fertilizer supply chain, where farmers get benefitted the most and the authentic soil fertility is saved for future generations. No one can scam the fertilizer chain as it is automated.

B. *Future Work*

The system can be further improved by developing it to automate the Blockchain and check the recent transactions of the farmers instantly. It is believed that the project has a lot more potential than what here offers. Here felt like developing the idea in every way possible and automate the blockchain the recent transaction of the farmer instantly and also trying to send SMS alerts to the farmers about the NPK level of their farms. Along with NPK, it can use different sensors and bring out efficient, accurate and precise information about the nutrient levels and how they are being affected by the different factors.

REFERENCES

[1] Ahmed, U., Lin, J.C.W., Srivastava, G. and Djenouri, Y., 2021. A nutrient recommendation system for soil fertilization based on evolutionary computation. Computers and Electronics in Agriculture, 189, p.106407.

[2] Agarwal, S., Bhangale, N., Dhanure, K., Gavhane, S., Chakkarwar, V. A., & Nagori, M. B. (2018, July). Application of colorimetry to determine soil fertility through naive bayes classification algorithm. In 2018 9th International Conference on Computing, Communication and Networking Technologies (ICCCNT) (pp. 1-6). IEEE.

[3] Edwin Prem Kumar, G. and Lydia, M., 2022. Impact of Internet of Things in Agriculture. In Proceedings of International Conference on Data Science and Applications (pp. 243-251). Springer, Singapore.

[4] Marianah Masrie, Mohamad Syamim Aizuddin Rosman, Rosidah Sam and Zuriati Jani(2017), Detection of Nitrogen, Phosphorus, and Potassium (NPK) nutrients of soil using Optical Transducer, Proc. of the 4th IEEE International Conference on Smart InstrumentationJ.

[5] Rose Ellen N. Macabiog, Nemilyn A. Fadchar, Jennifer C. Dela Cruz(2020), Soil NPK Levels Characterization Using Near Infrared and Artificial Neural Network, 2020 16th IEEE International Colloquium on Signal Processing & its Applications.

[6] Jhansi Sri Latha, A., NagaSai Manojna, C., Padma Ashalesha, C.N.L., Balamurugan, K.S. (2022). Wearable Tag for Human Health Monitoring System. In: Smys, S., Balas, V.E., Palanisamy, R. (eds) Inventive Computation and Information Technologies. Lecture Notes in Networks and Systems, vol 336. Springer.

[7] Ferrag, M. A., Shu, L., Yang, X., Derhab, A., & Maglaras, L. (2020). Security and privacy for green IoT-based agriculture: Review, blockchain solutions, and challenges. IEEE access, 8, 32031-32053.

[8] Srinivasan, S., Sundar, R., Immanuel, S. J. H., Belvadi, R., & Sathiyanarayanan, M. (2020, October). Bitcoin Alert System using Bolt IoT Integrated with Blockchain. In 2020 International Conference on Smart Technologies in Computing, Electrical and Electronics (ICSTCEE) (pp. 575-580). IEEE.

[9] Patel, H., & Shrimali, B. (2021). AgriOnBlock: Secured data harvesting for agriculture sector using blockchain technology. ICT Express.

[10] Prachchhak, G., Bhatt, C., & Thik, J. (2019). Data logging and visualization using bolt IoT. In International Conference on Advanced Computing Networking and Informatics (pp. 155-164). Springer, Singapore.

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