IOT Based Precision Agriculture using Wireless Sensor Networks

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Abstract - Agriculture plays a major role in the economic development of India, therefore we need to carry out new technologies for Precision Agriculture. Manual method for soil analysis gives inaccurate value because there is a difference between soil samples at the field and measuring in the laboratory with technologies. In India, it is required automated distribution of fertilizers and technologies. Because most of the farmers using traditional types of farming which gives less amount of productivity with respect to efforts. The productivity of India is less as compared to other countries. To enhance productivity and profit margin, the adaptation of new technologies can help us to a great extent. So, this paper based on a survey of Wireless Sensor Network because these technologies useful for precision of agriculture. This paper presents the study of Wireless Sensor Network that can be applied in agriculture for automated farming. This will help the end-users like farmers to make the right decision, gain better yield, and economic advantage.

Index Terms: Wireless Sensor Network, Precision Agriculture, Soil Nutrient, Crop Productivity.

1. INTRODUCTION

Soil Analysis is one of the valuable tools in the Agriculture field for yielding good crop. Soil Analysis helps farmers to determine the values of nutrients needed for efficient and economical production. Most Soil usually has a very high supply of nutrients. But whenever new crop gets harvested the nutrients in the soil get used for crops. Because low nutrition growth of crops doesn't happen properly. To get better proper crop yield, the nutrients must be restored in the soil. Hence farmers need to know the right proportion of Nitrogen (N), Phosphorus (P), and Potassium (K).

In the 21st century, Farmers need to use precision farming to improve their crop yields. To calculate the ratio of NPK we are using the Wireless Sensor Network nodes. These notes are placed at a specific distance so we can get precise calculations of NPK values. But for big farms, we will need a very large number of nodes. So, to overcome this problem we are using the cubic spline method. which is a type of interpolation. In this, we can estimate a method of constructing new data points within the range of the discrete set of known data points. By this method, we can reduce the nodes so it will be economical for farmers.

2. WIRELESS SENSOR NETWORK

Wireless Sensor Network is an emerging technology that helps the development of precision agriculture. WSN comprises of sensors and micro-controllers to process the data, battery or source of powers, base station to transmit the data. Recent trends and advancements in WSN technology have carved the path for the development of less cost. Low consumption of power and multi-functioning sensor nodes. Sensor node deployed at different places senses the different environmental parameters at that place and the processes the data accordingly. Sensor nodes can monitor parameters like soil fertility, temperature, humidity, moisture, etc. WSN has a wide range of applications in fields of agriculture, military, industries. In the agricultural field, WSN can be used for real-time monitoring of data on the field. In our case, it is to monitor the NPK fertilizer values.

NPK Fertilizers

There are six essential nutrients like nitrogen (N), phosphorus(P), potassium(K), magnesium (Mg), sulphur(S), calcium (Ca) that helps to grow plants. They help to create new cells. Out of these NPK are the most required nutrients for plants. Nitrogen is responsible for giving plants green colouring. Phosphorus helps to grow roots and fruit development. Potassium also plays a part in root growth as well as stem development. So determining the NPK value of the soil will help in calculating the optimal value of the fertilizer required.

3. ARCHITECTURE DESIGN

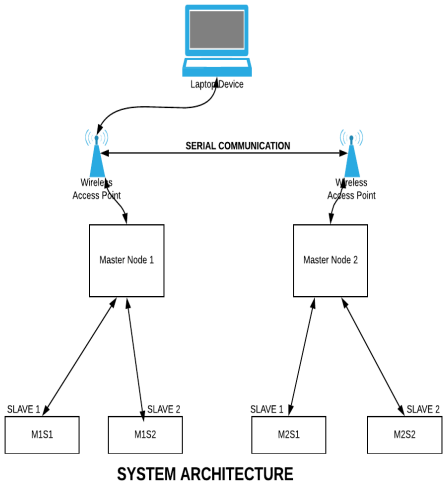

Fig. 01 – System Architecture

In given fig, we are using two master nodes and four slave nodes and one base station. Each master node connects to two slave nodes. the slave nodes of master node M1 called M1S1, M1S2 and other slave nodes of Master M2 are called M2S1 and M2S2. All slave nodes send data to their respective master node M1 and M2 for Sensing, collecting, storing, and processing the sensed data and then transmitting that data to the appropriate base station.

4. LITERATURE REVIEW:

V. Grimblatt et al. [1] proposed solution integrates IoT to monitor precisely agriculture. It acts as a sensor of main parameters that influence growth. It can increase and optimize crop throughput by using appropriate mathematical models. This control is not limited to the plant itself but also its environment.

S.Bhanumathi et al.[2] shows that the various related attributes like location, pH value from which alkalinity of the soil is determined. Along with it, percentage of nutrients like Nitrogen (N), Phosphorous (P), and Potassium (K) Location is used along with the use of third-party applications like APIs for weather and temperature, type of soil, nutrient value of the soil in that region, amount of rainfall in the region, soil composition can be determined.

J. P. Kumar et al. [3] proposed that diagnostic absorption at a few specific wavelengths because of NPK fertilizer Suphala mixed in soil. They developed a quantification equation between the diagnostic depths and the fertilizer concentration in soil. The challenging task was to verify whether the developed equations remain valid for low to very low concentrations of fertilizers.

M. Masrie et al. [4] shows that the developed integrated optical sensor was able to detect the NPK nutrients in soils. The output responses for high NPK were found at 32.0 volts for Nitrogen, 4.6 V for Phosphorus, and 19.8 V for Potassium.

R. Sumiharto et al.[5] the paper includes the research process consisting of gathering soil image dataset, preprocessing, feature extraction, and training the neural network model with the backpropagation algorithm.

NS Gill and ML Verma [6] shows that tomato crop npk values are detected in various season and various types of soil.Analyse crop NPK under different treatement without fertilizer.

K. K. Ghanshala et al.[7] proposed an approach of smart crop monitoring is presented through Internet of things (IOT). A 4 level framework is proposed namely sensing devices, sensor data level, base station level, edge computing and cloud data level for smart crop monitoring. Method proposed here focuses on analysing the soil nutrients (eg. NPK), soil moisture, temperature and humidity through a sensor node designed using arduino.

Mahammad Shareef Mekala et al. [8] A survey: energy-efficient sensor and VM selection approach in green computing for X-IoT applications, International Journal of Computers and Applications. This paper reviews energy-efficient sensor, resource-based VM selection approaches for X-IoT applications. It is prompted to distinguish measurement functions, architectures, VM scheduling mechanism challenge

Madhura U K et al. [9] proposed that NPK, Electrical conductivity. The ph of soil using Arduino UNO. In this, they use a sensor node application, in which sensors are connected to multiple sensors and one gateway node which receives data from sensors. For remote use, they use a battery, solar panel, boot converter to better use at any moment and can charge continuously and get electricity. Use a GSM module for accessing the cloud.

S. N. Shylaja et al.[10] shows that the sensor measures the soil fertility in terms of N, P, and K. The sensor undergoes a chemical reaction when inserted into the soil, which leads to change in an analog deflection voltage. The analog deflection voltage is then converted into a digital value. The measured values of such voltage deflection are mapped and N, P, and K values are derived.Develop a WSN for monitoring and measurement and analysis of soil nutrients. Also, suggest the right choices of the crop to the farmer.

Prof.Manish.B.Giri et al. [11] they mainly use wireless network sensors for predicting NPK, moisture, humidity values of soil. They use master and slave nodes to cover the maximum field and get results on the field at that time. WSN reduces human effort and reduces electricity use as it can identify moisture, humidity using sensors.

Santosh Warpe et al.[12] paper presents a study of the WSN network which suggests required fertilizer for particular crops with less human effort and maximum profit. This helps farmers to suggest optimum fertilizer using smart farming.

Amrutha A et al.[13] shows that chemical methods and algorithmic method (by using microcontroller,sensor,etc) difference is given.Lab testing require few days and algorithmic method can done in 30min.Describe about farmer issue and give solution of automaic detection of soil by reducing labour and time.

R. G. Regalado and J. C. Dela Cruz [14] shows that A device was created with an MCU and color sensors that determined the RGB values by using Gizduino X as the MCU and TCS3471 for the first sensor and an LDR-RGB color sensor. A program was made using vb.net that processed the data and provided nutrient recommendations for every plant included in the soil test kit.

Jin-Hyuk Chun a et al. [15] It shows the effect of NPK fertilization on rocket salad vegetables.it analyses different ratios of NPK improve quality of GSL levels. Rocket salad has higher concentration of K and less with N and P which show improvement of GSLs contents. N concentration above 5mM and K concentration less than 2.5mM, the GSL level amount was on average 13.51.

Dhanapriya.M*,Maheswari.R[16] It analyzes the content of micronutrients and macronutrients present in the soil. The amount of nutrients available to roots is the main factor to produce the crops. It analyzes that macronutrients and micronutrients are important to the growth of plants. Macronutrients like N, P, K are needed in large amounts.

L.E.D. Smith, G. Siciliano, [17] It explains the excessive use of fertilizer observed in the farming system in china. The efficient use of fertilizer and water resources improves the agriculture field, food safety. Overall, it shows that it requires improving the mitigation framework that holds central policy directives.

Terry L. Roberts ,[18] It analyzes how cadmium affects human health. The main effect of cadmium on human health is kidney disease. cadmium found in all agriculture soils i.e. Phosphate rocks. Levels of cadmium in agriculture soil can be increased through atmospheric deposition like forest fires, soil erosion, and air pollution. So, there is some limit to add Cd in P fertilizers. Scientific literature suggests that Cd would accumulate through p fertilizer in soils should less than 60mg Cd/kg P2O5 which leads to much less human health risk.

Mohamed Rawidean Mohd Kassim et al.[19] In this paper, they use WSN in the greenhouse using IOT based technology. They compare their result with the threshold values of the crop. The paper shows that automated irrigation is efficient than scheduled irrigation.

Alfredo Aires et al.[20] It shows how nitrogen and sulfur fertilization impact on glucosinolates in specific plants such as broccoli, cabbage, mustard. Overall, it means the impact on some pungent plants. It analyzes that broccoli sprouts did not require N and S fertilization to improve GSLs levels. It is important to improve GSLs levels for pungent plants to increase growth.

5. EXISTING SYSTEM

Climate change is continuing to impact on agriculture and crops. Impact of climate and weather, people must begin to transform the way we adopt such changes. To enhance and maintain food security and growth of crops in the field we need to transformative adaptation in agriculture. Therefore, to enhance growth of crops and crop productivity we need to examine NPK values of particular soil which can suggest right fertilizer. In rural areas, farmers can determine the maturation and growth of crops and by applying their experience they can conclude how much fertilizer supposed to be used for specific soil. But the case is that proportion is not always correct for all crops. So, there are many existing systems to determine NPK values of soil and suggest right proportion of fertilizer that needed.. Newtons Forward Difference (NFD) Method is used for the distribution of fertilizers to crops.

The Identification steps involved are:

- Setup sensors and nodes:

Putting all the sensors such as Master and Slave in the field at actual points. Using the NPK sensor to determine the NPK values.

- Image Acquisition and Analysis: Capture the image of the NPK sensor where we are getting combined values of NPK.
- Sending wireless signals:

The captured image of the NPK sensor is now sent to the base station.

- Analysis of NPK values:

Combined values are separated out and compared with the standard values of NPK for a given crop.

6. CONCLUSION

This paper presents a study of WSN that provide fertilizer values of a particular soil. WSN Technology in agriculture helps to improve the crop yield as well as it reduces the labor cost and time. Using Wireless Sensor Network, we can make optimum use of resources and get maximum profit. The system that we proposed which monitored and pass the NPK values of soil. The instantaneous value and NPK data, given system, provided the right fertilizer to the particular crop using Cubic Spline Method. The system can increase the overall profit of farmers without human efforts.

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8. REFERENCES

[1] V. Grimblatt, G. Ferré, F. Rivet, C. Jego, and N. Vergara, "Precision Agriculture for Small to Medium Size Farmers — An IoT Approach," 2019 IEEE International Symposium on Circuits and Systems (ISCAS), Sapporo, Japan, 2019.

[2] S.Bhanumathi, M.Vineeth and N.Rohit. Crop Yield Prediction and Efficient use of Fertilizers, 2019.

[3] J. P. Kumar, S. Deshpande, and A. Inamdar, "Detection ofFertilizer Quantity in Soil Using Hyperspectral Data," 2018 9th Workshopon Hyperspectral Image and Signal Processing: Evolution in Remote Sensing(WHISPERS), Amsterdam, Netherlands, 2018.

[4] M. Masrie, A. Z. M. Rosli, R. Sam, Z. Janin and M. K. Nordin,"Integrated optical sensor for NPK Nutrient of Soil detection," 2018IEEE 5th International Conference on Smart Instrumentation, Measurement andApplication (ICSIMA), Songkla, Thailand, 2018.

[5] R. Sumiharto and R. Hardiyanto, "NPK Soil Nutrient Measurement Prototype Based on Local Binary Pattern and Back-Propagation,"2018 IEEE International Conference on Internet of Things and Intelligence System (IOTAIS), Bali, 2018

[6] NS Gill and ML Verma ,"Nutrient uptake and yield of cherry tomato under NPK fertilization", Journal of Pharmacognosy and Phytochemistry 2018; 7(3): 2076-2082

[7] K. K. Ghanshala, R. Chauhan and R. C. Joshi, "A Novel Framework for Smart Crop Monitoring Using Internet of Things (IOT)," 2018 First International Conference on Secure Cyber Computing and Communication (ICSCCC), Jalandhar, India, 2018, pp. 62-67.

[8] Mahammad Shareef Mekala & P. Viswanathan (2018): A survey:energy-efficient sensor and VM selection approach in green computing for X-IoT applications, International Journal of Computers and Applications, 2017.

[9] Madhura U K, Akshay P, Akshay J Bhattad, Nagaraja G S, "Soil Quality Management using Wireless Sensor Network",2nd IEEE International Conference on Computational Systems and Information Technology for Sustainable Solutions 2017.

[10] S. N. Shylaja and M. B. Veena, "Real-time monitoring of soil, nutrient analysis using WSN," 2017 International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS), Chennai, 2017, pp. 3059-3062.

[11]Dr.Manish Giri, "Wireless Sensor Network Application in Agriculture for Monitoring Agriculture Production Process ", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), Issue 5, May 2016.

[12] Santosh Warpe, Ravi Singh Pippal,"A Study of Fertilizer Distribution System for Agriculture using Wireless Sensor Network". International Journal of Computer Applications (0975 – 8887) Volume 147 – No.2,August 2016 .

[13] Automatic Soil Nutrient Detection and Fertilizer Dispensary System ,Amrutha A, Lekha R, A Sreedevi ,2016 International Conference on Robotics: Current Trends and Future Challenges (RCTFC).

[14] R. G. Regalado and J. C. Dela Cruz, "Soil pH and nutrient (Nitrogen, Phosphorus and Potassium) analyzer using colorimetry," 2016 .

[15] Jin-Hyuk Chun a, Silbia Kim a, Mariadhas Valan Arasu b, Naif Abdullah Al-Dhabi b, Doug Young Chung a, Sun-Ju Kim." The combined effect of Nitrogen, Phosphorus, and Potassium fertilizers on the contents of glucosinolates in rocket salad Saudi Journal of Biological Sciences, 23rd August 2015.

[16] Dhanapriya.M, Maheswari.R, "Estimation of micro and macronutrients in the soil of remote areas", Journal of Chemical and Pharmaceutical Sciences, 2015.

[17] L.E.D. Smith, G. Siciliano, "A comprehensive review of constraints to improved management of fertilizers in China and mitigation of diffuse water pollution from agriculture",1 November 2015.

[18] Terry L. Robertsa, "Cadmium and Phosphorus Fertilizers: The Issues and the Science",Elsevier, Procedia Engineering 83 (2014) 52 – 59,2013.

[19] (Mohamed Rawidean Mohd Kassim, Ibrahim Mat, Ahmad Niza, "Agriculture Application, International Conference on Computer, Information and Telecommunication System (CITS), 2014.

[20] Alfredo aires, Eduardo A S Rosa, Rosa Carvalho "Effect of nitrogen and sulfur fertilization glucosinolates in the leaves and roots of broccoli sprouts (Brassica oleracea var.italica)". ResearchGate August 2006.