Grenze International Journal of Engineering and Technology, July Issue

Analysis of Fertilizer Distribution in Agriculture using Wireless Sensor Networks: Review

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***Abstract*—India is an agriculture-based country; the Indian economy is predominantly dependent on the agriculture sector. The agricultural yield primarily depends on the fertility of the soil and the appropriate use of the fertilizers. The current method to measure soil nutrients yields lesser accuracy due to difference in time when soil sample was collected and measured in the laboratory. To address this challenge and increase the profit percentage, we need to adopt new technologies for precise agricultural practices. We propose the system with Wireless Sensor Network for monitoring the NPK values using sensor nodes. The system will recommend the optimum required fertilizer value by analyzing the soil nutrients of the land.**

***Index Terms*— Wireless Sensor Network, Precision Agriculture, Soil Nutrient, Lagrange's interpolation.**

I. INTRODUCTION

India is a highly populated country with the dominant part of it working in agriculture. Due to aberration in climate, the farmers are in distress. The fertility of the soil and the appropriate use of fertilizers is crucial for better crop yield. Phosphorus(P), Nitrogen(N), Potassium(K) are the three main components that are crucial for plant growth. For predicting the required quantity of nutrients and enhancing the crop yield, measuring the amount of nutrients already present in the soil is important. Modern methods and technologies are still not adopted by many farmers as they use traditional methods for increasing crop yield. An agricultural monitoring system will help in delivering and managing services for a field and will prompt harvest development in an ideal status. Wireless Sensor Nodes is deploying nodes on the cropland for gathering data at one master base station for analysis [5].

A. Wireless Sensor Network

Wireless sensor networks have emerged as an advancement in precision agriculture. WSN consists of various components such as sensors and microcontrollers for data processing, base station for data transmission, and battery as power sources [6]. Recent advancements in the WSN trends have lead to the improvement of minimal effort and low- power devouring multi-functioning sensor nodes. These Sensor nodes are planted at different locations in the crop land, they measure different environmental parameters, and transmit the data for further processing Sensor nodes can monitor parameters like soil fertility, temperature, humidity, moisture, etc. [4]. There are various applications of WSN in domains like agriculture, defense, and various other industries. In the agricultural, WSN can be used for real-time tracking of data on the field. In our case, it is to monitor the NPK fertilizer values.

Grenze ID: 01.GIJET.6.2.3_1

B. NPK Fertilizers

The plant requires three nutrients that are Phosphorus(P), Potassium(K), Nitrogen(N) which is in short N-P-K. Nitrogen (N) is responsible for the growth of leaves on the plant. Phosphorus(P) enhances the root growth along with fruit and flower development. Potassium(K) improves the overall functioning of the plant. Knowing the NPK value of the soil will help in calculating the optimal value of the fertilizer required.

II. LITERATURE REVIEW

Madhura U K *et. al*. [1] has proposed a system that measures the quality of soil such as N-P-K content, pH, temperature, light intensity, and electrical conductivity. The proposed system uses Wireless Sensor Network to remotely examine the soil and provide end-users like farmers actual results of various soil specifications, that assume a significant job in gaining the soil fertility.

Nasrin Akter Ripa et. al. [2] have theoretically analyzed the formula of Newton's Forward Interpolation method. For analysis of the method, the author chooses a particular Step, Unit Ramp, and Sinusoidal signals. The author has assumed a raising and decreasing function to evaluate the performance of the considered method. Few sampled signal values are calculated and then reconstruction of a signal is done using Newton's forward interpolation formula.

Asmita Singh et. al. [3]. has implemented Modified Z- Stable Election Protocol for a heterogenous environment in the agriculture field to measure soil parameters like moisture, temperature, and water content. The system Wireless Sensor network for real-time monitoring of soil and collected data is further transmitted to the base station. For optimum use of the resources, the base-station displays the data for monitoring the soil parameters.

Marianah Masrie, et. al. [4] explained the working of optical sensors for N-P-K analysis. The integrated optical sensor consists of both network systems; a transmission network and a detection network. The transmission network directly transmits light on the soil placed in a transparent container using an LED powered by Arduino Uno. The detection system detects the soil nutrients intensity by analyzing the leftover light and the signal of light is amplified by regarding the potential contrasts. The outcomes retention reaction of N, P, and K in terms of Voltage.

Rajinder Kumar et. al. [5] have proposed a framework for precision agriculture. The framework utilizes Sensors with low cost, high accuracy, and high range coverage for automated monitoring of the crop field. They deployed temperature sensors, moisture sensors, and humidity sensors and connected with Zigbee for wireless communication.

Sonal Verma et. al [6] have utilized WSN to monitor parameters such as humidity, light intensity, and temperature of the air in a crop field. The system consists of various application-based sensors. The data collected by the sensors is further transmitted to the system terminal through a radio frequency link for logging and analysis.

Dhanapriya.M et. al [7] focused on analyzing the content of micronutrients and macronutrients present in the soil. In the present system, the kit is constructed to determine the nutrient content of the soil. The system consists of GPS and GPRS placed deep in soil with the kit. The test results are used to determine the optimum required fertilizer value for the growth of the plant. Soils are further categorized into three types based on their fertility.

Akshay Tekam et. al. [8] explained about existing methods for precision agriculture using WSN. The author has proposed a system with Wireless Sensor Network for NPK monitoring using sensor nodes. The system uses Range-Kutta Method to analyze the NPK values and recommend the required proportions of fertilizers.

Santosh Warpe et. al., [9] has conducted a survey on Wireless Sensor Networks and Arpit Rawankar, et. al. [10] have mixed soil samples with fertilizers such as KNO3, TSP, (NH4)2SO4 in the concentration range of 0.02-10%. The concentrations of N, P, and K are determined using the atomic masses, molecular geometry, and bond strength using the IR laser beam which passes through the sample. Their objective is to maintain an adequate amount of fertilizers in the field.

Jin-Hyuk Chun et. al.[11] has analyzed the effect of nutrients like Phosphorous (P), Nitrogen (N) and Potassium (K) on crop yield and the overall nutrient content of soil by continuously varying their quantity. The author states that increasing Nitrogen(N) in different brassica crops would decrease the relative quantity of glucosinolates (GSLs), which would further result in decrementing of biological as well as medical values of the vegetables. Therefore, they evaluated the impact of the various distinct amount of nutrient fertilizers and solutions that contain Nitrogen(N), Phosphorus, and Potassium(K) on the overall GSL content of rocket salad (Eruca sativa Mill.)

Herman Sahota et. al., [12] has developed an application for effective soil data collection and processing from already pointed locations in the cropland, to increase the growth of plant yield and mitigate the effect on nature. They conserved the energy by designing a MAC layer. To exclusively fulfill the needs of the application, the Network layer was designed.
Manish B. Giri et. al, [13] studied the use of WSN in drip irrigation techniques while providing water to crops. The paper focuses on the optimum use of water for plants by distributing it amongst the crop. They put moisture sensors to get to know the appropriate amount of water for plants. The author also focuses on pivot irrigation and conventional irrigation in the paper.
Manish B. Giri et. al, [14] focuses on the use of automated sensors using WSN in agriculture to provide more facilities. The proposed system removes the need for human intervention in the drip irrigation process by using sensors and solenoids to operates valves of drip irrigation pipes automatically. Linear programming will help to distribute the amount of water equally to all plants.
Manish B. Giri [15] analyzed the optimum use of available resources for cultivation using a wireless sensor network. The author has proposed a self-controlled irrigation system that uses a piecewise interpolation method for the prediction of moisture values between two points. The multi hoping network communicates from slaves to master nodes using Zigbee(IEEE 802.15.4), In conclusion, the author proves that a huge amount of water and electricity was been saved after implementing the system.
Pratibha Gangurde, Manisha Bhende [16] has analyzed the importance of Wireless Sensor Networks(WSN) in effective and efficient agriculture. The author states WSN can be used for the actual-time analysis of various aspects of the field environment like temperature, moisture, humidity, etc. The system they propose consists of a sensing unit, that collects the data from sensors, and then the data is further processed and decisions will be made on this gathered data. This system will help in alerting and managing disaster situations by giving warnings.
Victor Grimblatt et. al.,[17] to allow small and medium farmers to introduce technology, has implemented a system based on Artificial Intelligence and IoT. The system measures important plant growth parameters through a set of sensors and through actuators it acts to fix some of those parameters to improve soil yield.
Kiruthika M, Shweta et. al.,[18] have explained the necessity of WSN for analysis of the various parameters in the agricultural field to increase crop yield. The author has also determined the need for the use of modern technologies and precision agriculture practice in agriculture, particularly in India.
Deepika P. Rajapirian et. al.,[[19] has explained the traditional and new methods of agriculture. The new methods involve the use of technology for effectively detecting some environmental conditions and crop diseases.

III. Architecture Diagram

Figure 1 shows a Wireless-Sensor-Network having Master-Slave Configuration. The Slave nodes consist of NPK sensors responsible for taking readings on the field, these readings are then transmitted to the master node using ZigBee(IEEE 802.15.4). The Master node on receiving these readings uploads the data onto the cloud using the Wi-Fi module. The data on the cloud data can be accessed using a desktop and can be further interpolated to get the required results.

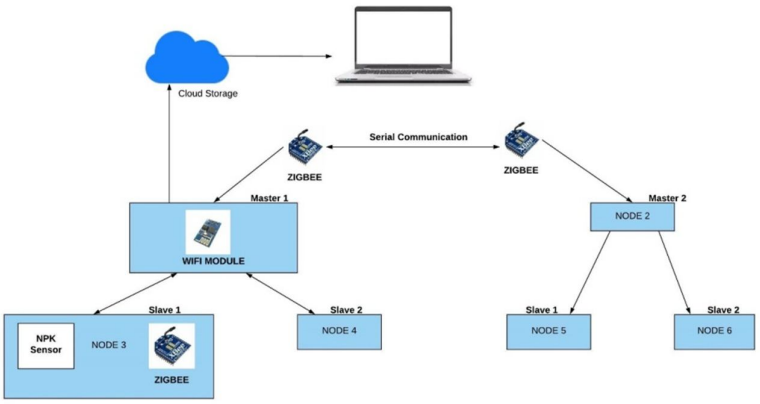

Figure 1. Architecture Diagram

IV. Conclusion

The Wireless Sensor Network (WSN) provides an efficient way to measure soil nutrients and monitor field data from a remote location. The nutritive content present in the soil is measured by the proposed system and also it analyses the collected information and suggests recommendations according to the need of the crop using Lagrange's interpolation method.

Acknowledgment

The authors would like to present special thank of gratitude to

- Prof. Santosh T. Warpe, School of Computer Engineering, MIT Academy of Engineering Alandi, Pune.
- Dr. Manish B Giri, School of Computer Engineering, MIT Academy of Engineering Alandi, Pune.

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