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A Review on Soil Nutrients Monitoring with IoT

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ABSTRACT

In today's world, food scarcity is exacerbated not only by rising population, but also by soil infertility, which results in crop failure. Soil fertility declines after harvesting, necessitating the use of fertilizers to enhance soil fertility and increase nutrients. However, most farmers apply it by hand, resulting in over- or under-fertilization, which alters the soil because it must be used in moderation. We offer a suggestion of using an Internet of Things (IoT) for monitoring and checking the nutrients level in the study because soil nutrients boost productivity, yields, and crop health. Macro and micronutrients, soil PH, temperature, humidity, soil wetness, and sensors for insect repellent and deficiency detection will all be monitored by the system.

Keywords: Soil nutrients, Smart farming, IoT, Sensors and, Crops

1. INTRODUCTION

Macro and micronutrients, soil PH, temperature, humidity, soil wetness, and sensors for insect repellent and deficiency detection will all be monitored by the system. Long-term solutions would necessitate a rethinking of rural development as a result of technological penetration, as well as a shift in agricultural practices toward structural alterations that reflect wiser approaches and benefit farmers [1, 2].

Agriculture is a significant economic sector in Tanzania, accounting for 29.1% of GDP and 67 percent of total employment, as well as being the primary source of industrial raw materials, food, and foreign exchange profits (Ministry of Agriculture, 2017). Tanzanian farmers cultivate a wide range of perennial and annual crops for both food and profit. Cereals, roots, tubers, fruits, and vegetables are among the crops farmed.

The amount of additional fertilizer to be added as additional nutrients to boost soil fertility must be determined by measuring the soil nutrient concentration [3]. Farmers who do not have access to contemporary technology continue to use traditional methods to improve the quantity of plant food in their harvests. Aside from that, market technology is expensive, heavy, and difficult to deploy for less skilled farmers, which is why farmers are still using the manual method to feed their plants. [4]. This enhances the soil's quality, resulting in a higher-quality crop [4, 5].

These minerals support plant growth in many ways: nitrogen promotes leaf and vegetative growth, phosphorus encourages root and growth, and potassium promotes flowering, fruiting, and retains nutrition and water regulation in plant

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cells. [1, 6, 7]. The main goal of this paper is to create a prototype detection system for important soil nutrients, water level, and pH.

Problem statement

Despite the government's efforts to set aside a significant portion of its annual budget for the agricultural sector's growth and development, farmers still face a number of challenges, including insufficient farming techniques, climate change, insufficient soil nutrients, and pest and insect attack on crops. Agricultural soil quality is a measurement of the soil's ability to serve as a suitable growth medium for plants by supplying the essential amounts of water and nutrients. The most common method of soil testing is to conduct chemical tests in laboratories, which takes at least a few days. The farmer calculates the amount of fertilizer needed depending on the size of the field, the crop to be cultivated, and the amount of nutrients present, which is a time-consuming process [8].

Fertilizers are added to the soil to maintain nutrient levels in the event of a shortfall. The majority of farmers prefer to estimate the amount of fertilizer and apply it manually. However, using the appropriate amount of fertilizer is critical, since too much or too little will hurt the plant and lower output [8]. Improper fertilizer use leads to poor crop quality, with plants lagging in color, size, test, and even quantity, and growing slowly or not at all.

Figure 1. Leaves yellowing to extreme fertilizer, source [9]

Figure 2. Plants die for excessive watering and fertilizer, source [10]

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Justification and significance

Agriculture is the backbone of a country's economy, providing people with fundamental ingredients as well as industrial raw materials. Despite the country's continued agricultural growth, inadequate availability to agricultural inputs reduces output. Excess fertilizer causes yellowing and browning of the plant's leaves, as well as leaf drop and failure to grow. Agriculture has undergone a significant transformation as a result of technological advancements, which may be linked to the integration of numerous gadgets and mechanisms in automating tasks [11, 12]. This review attempts to improve the uses of IoT for soil nutrients level while also reducing the unwelcome use of fertilizers in the soil. Maintaining nutrient levels in the soil in the event of a deficiency, and utilizing modern trends and technology to provide a solution to the aforementioned problem, as well as developing sensors to map these nutrient contents.

Related Work

In a precision farming system, soil monitoring utilizing IoT is a significant analytical method for identifying soil nutrients. [13]. The method can be combined with wireless sensor technology to collect real-time soil data online using mobile robot and vehicle-based sensors, resulting in more detailed spatial mapping than traditional soil sampling methods, though the latter can provide more accurate results for estimating the amount of fertilizer to apply to the soil. [14].

Agriculture developed with IoT technology would be extremely beneficial in cultivation. Cultivation will be difficult for a new agricultural area without knowing or monitoring the crucial soil properties and farmers may incur financial losses as a result [15]. Temperature, moisture, light, humidity, and pH value are all measured using various soil sensors. We can determine which crop is suitable for a certain soil characteristic based on information [16].

Similarly, increased food production is required to meet the growing need of a growing population throughout time. Fertilizers including mostly nitrate (N), phosphate (P), and potassium (K) are required to boost crop yields. [5]. The amount of fertilizer to use is also determined by the current levels of NPK nutrients in the soil. The amount of fertilizer to employ is also determined by the soil's current NPK nutrient concentration.

The use of commercial N, P, and K fertilizers has resulted in a significant rise in agricultural crop yields. Excessive use of these fertilizers, on the other hand, has been blamed for contamination of surface and groundwater. Crop cultivation is divided into stages, each of which necessitates different nutrient levels. As a result, a farmer must devote a significant amount of time to monitoring the fields. Various ways for measuring soil nutrients are now available thanks to recent advancements in Wireless Sensor Network (WSN) technology. Farmers can improve agricultural productivity by knowing the level of soil nutrients since insufficient nutrient levels can harm crop yield, while excess nutrient levels can either have the same effect or be wasted. [17].

In addition, the Internet of Things (IoT) plays a vital role in smart irrigation systems. Using innovative technologies in the agricultural industry will be extremely beneficial to the farming process. As a result, soil nutrients are frequently regarded as the most critical nutrients. It provides a brief overview on the most important nutrient detection in soil. A study developed a portable gadget model that may be used to monitor nitrogen concentrations in soil samples [18].

Because of the need to provide precision and quality to the agricultural production chain, the agricultural scenario appears to be one of the most potential application areas for WSN. Because the criteria are so stringent, this necessitates rigorous system design, battery lifespan maximization, robustness, recovery techniques, network flexibility, and re-configurability [19, 20]. It uses a ZigBee-based wireless sensor network to monitor environmental parameters such as weather, soil moisture content, soil temperature, soil fertility, weed identification, water level, crop growth monitoring, precision agriculture, automated irrigation, and agricultural product storage [21].

2. A PROTOTYPIC DESIGN

The suggested system for advanced farming with IoT aims to meet the following requirements: improved crop output and reduced pesticide and fertilizer usage. Automatic soil nutrient monitoring and management, as well as insect repellant. Increasing soil fertility together with crop output allows farmers to receive soil reports immediately to their phones. Obtaining statistical data on soil nutrient levels to aid in determining crop and fruit quality. Analyzing crops and fruits to discover nutrient deficiencies and increase production quality; and, finally, maintaining fertilizer consumption and addition. Then, to keep the land active, use crop rotation (Figure 3).

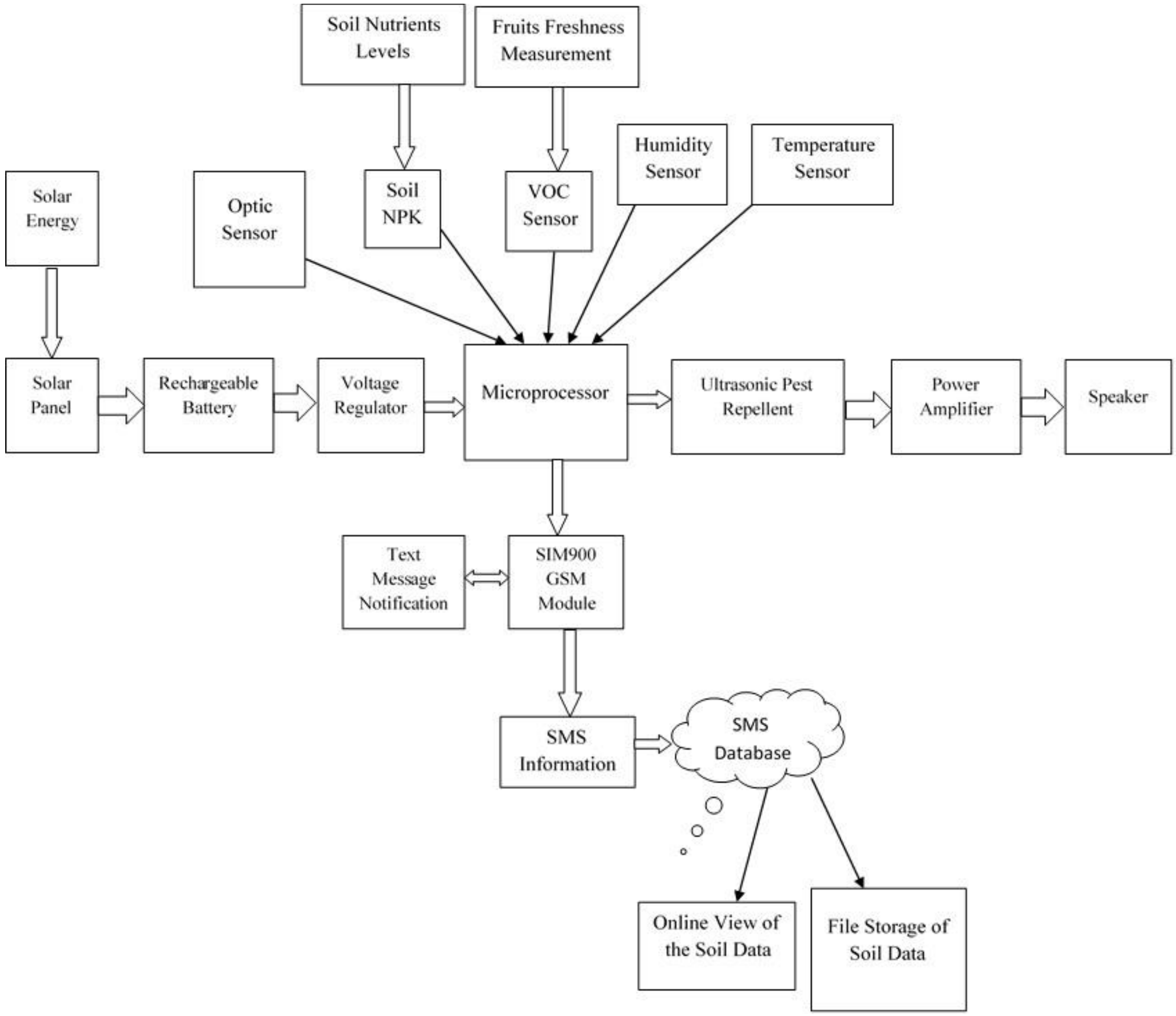

Figure 3. Sample proposed system with IoT

3. DISCUSSION

It takes a long time for manually measure soil nutrients. Many farmers do not conduct soil testing in the laboratory and continue to plant the same crop on the land, causing the soil to lose its fertility. The soil nutrient analysis, which is generally done using laboratory techniques, is required to recommend a proper fertilizer dosage. To attain the aim of Zero Hunger by 2030, an integrated approach and the transformation of food systems will be used to achieve the vision of a world free of hunger, malnutrition, and rural poverty.

4. CONCLUSION

In general, the IoT for monitoring system will assist farmers in gathering real-time information about diverse soils, their fertility levels, and recommending crops and fertilizers via texts or e-mails at their convenience. According to the results of a number of experiments, the built IoT system is shown to be beneficial to farmers in terms of increasing crop yields. Finally, this project effort will assist farmers in making the best decision possible, resulting in increased yield and economic benefit.

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Conflicts of interests

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Masrie, M., et al. Detection of nitrogen, phosphorus, and potassium (NPK) nutrients of soil using optical transducer. in 2017 IEEE 4th International Conference on Smart Instrumentation, Measurement and Application (ICSIMA). 2017. IEEE.
2. Ghanshala, K.K., R. Chauhan, and R. Joshi. A novel framework for smart crop monitoring using Internet of Things (IoT). in 2018 First International Conference on Secure Cyber Computing and Communication (ICSCCC). 2018. IEEE.
3. Zhang, X., et al., Monitoring citrus soil moisture and nutrients using an IoT based system. Sensors, 2017. 17(3): p. 447.
4. Masrie, M., et al. Integrated optical sensor for NPK Nutrient of Soil detection. in 2018 IEEE 5th International Conference on Smart Instrumentation, Measurement and Application (ICSIMA). 2018. IEEE.
5. Ramane, D.V., S.S. Patil, and A. Shaligram. Detection of NPK nutrients of soil using Fiber Optic Sensor. in International Journal of Research in Advent Technology Special Issue National Conference ACGT 2015. 2015.
6. Burton, L., K. Jayachandran, and S. Bhansali, The "Real-Time" revolution for in situ soil nutrient sensing. Journal of The Electrochemical Society, 2020. 167(3): p. 037569.
7. Rahman, S.S.B., I. Ahmed, and F. Ahmed. An IoT Based Model of a Nitrogen Detection System for Soil Samples. in Proceedings of the International Conference on Computing Advancements. 2020.
8. Amrutha, A., R. Lekha, and A. Sreedevi. Automatic soil nutrient detection and fertilizer dispensary system. in 2016 International Conference on Robotics: Current Trends and Future Challenges (RCTFC). 2016. IEEE.
9. Hart, M.R., B.F. Quin, and M.L. Nguyen, Phosphorus runoff from agricultural land and direct fertilizer effects: A review. Journal of environmental quality, 2004. 33(6): p. 1954-1972.
10. Cook, R.L. and A. Trlica, Tillage and fertilizer effects on crop yield and soil properties over 45 years in southern Illinois. Agronomy Journal, 2016. 108(1): p. 415-426.
11. Singh, V., S. Sankhwar, and D.J.G.J.o.M.S. Pandey, The role of information communication technology (ICT) in agriculture. 2015. 3(4): p. 2.
12. Burton, L., et al., Smart gardening IoT soil sheets for real-time nutrient analysis. Journal of The Electrochemical Society, 2018. 165(8): p. B3157.
13. Na, A., et al. An IoT based system for remote monitoring of soil characteristics. in 2016 International conference on information technology (InCITe)-the next generation IT summit on the theme-internet of things: Connect your Worlds. 2016. IEEE.
14. Dorji, U., T. Pobkrut, and T. Kerdcharoen. Electronic nose based wireless sensor network for soil monitoring in precision farming system. in 2017 9th International Conference on Knowledge and Smart Technology (KST). 2017. IEEE.
15. Reshma, R., et al. IoT based classification techniques for soil content analysis and crop yield prediction. in 2020 Fourth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC). 2020. IEEE.
16. Badhe, A., et al., IOT based smart agriculture and soil nutrient detection system. 2018. 4(4): p. 774-777.
17. Mishra, P., et al., Testing/monitoring of soil chemical level using wireless sensor network technology. 2015. 4(11).
18. Lavanya, G., C. Rani, and P. GaneshKumar, An automated low cost IoT based Fertilizer Intimation System for smart agriculture. Sustainable Computing: Informatics and Systems, 2020. 28: p. 100300.
19. Kapse, S., et al., IOT Enable Soil Testing NPK Nutrient Detection. 9. 2020.
20. Shylaja, S. and M. Veena. Real-time monitoring of soil nutrient analysis using WSN. in 2017 International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS). 2017. IEEE.
21. Thilagavathi, G. Online farming based on embedded systems and wireless sensor networks in 2013, International Conference on Computation of Power, Energy, Information and Communication (ICCPEIC). 2013. IEEE.

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