



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Special Issue 1, April 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

 9940 572 462

 6381 907 438

 ijirset@gmail.com

 www.ijirset.com

An Enhanced Design and Development of Machine Learning Algorithms for Internet of Things (IoT) Based Smart Agriculture Systems

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ABSTRACT: This paper presents an Internet of Things (IoT) based system by designing a novel Nitrogen-Phosphorus Potassium (NPK) sensor with Light Dependent Resistor (LDR) and Light Emitting Diodes (LED). The principle of colorimetric is used to monitor and analyze the nutrients present in the soil. The data sensed by the designed NPK sensor from the selected agricultural fields are sent to Google cloud database to support fast retrieval of data. The concept of fuzzy logic is applied to detect the deficiency of nutrients from the sensed data. The crisp value of each sensed data is discriminated into five fuzzy values namely very low, low, medium, high and very high during fuzzification. A set of If-then rules are framed based on individual chemical solutions of Nitrogen (N), Phosphorous (P) and Potassium (K). Mamdani inference procedure is used to derive the conclusion about the deficiency of N, P and K available in soil chosen for testing and accordingly an alert message is sent to the farmer about the quantity of fertilizer to be used at regular intervals. The proposed hardware prototype and the software embedded in the microcontroller are developed in Raspberry pi 3 using Python. The developed model is tested in three different soil samples like red soil, mountain soil and desert soil. It is observed that the developed system results in linear variation with respect to the concentration of the soil solution. A sensor network scenario is created using Qualnet simulator to analyze the performance of designed NPK sensor in terms of throughput, end to end delay and jitter. From the different variety of experiments conducted, it is noticed that the developed IoT system is found to be helpful to the farmers for high yielding of crops.

KEYWORD: Internet of Things, Soil Nutrients, Sensor Network, Fuzzy Systems, Colorimetric Principle

I. INTRODUCTION

- The growth of agriculture in India has become volatile over the past 10 years. The efficient deliverable of agriculture will prevent food scarcity. Being a vital occupation in our country, the annual growth rate in agriculture is 2.9% in 2019-2020 and it was observed as consistent for the past 6 years (Jitendra 2020).
- Major issues that have an impact on high yield is the inconsistency in the monsoon, insufficient access to irrigation, excessive use of soil nutrients, improper access to modern technology in different parts of the country, improper fertilizer usage, limited procurement of food grains by the government agencies and failure to provide remunerative prices to farmers. Due to the lack of adaptive technology to automate and ease the farming process (Kim et al. 2020), it turns to be challenging to improve agriculture.
- When the farmers are aware of the respective soil nutrients level of their land, it is possible to manage the farming process to produce a high yield (Zhiguo Li et al. 2019).
- Soil Nutrients are classified into two main categories namely macronutrients and micronutrients. Macronutrients are the substances that are present in high proportion, whereas micronutrients are the substances that are present in low proportion within the soil.

- Nitrogen (N), Potassium (K), Calcium (Ca), Magnesium (Mg), Phosphorus (P) and Sulphur (S) belong to macronutrients of the soil. Chlorine (Cl), Iron (Fe), Boron (B), Manganese (Mn), Zinc (Zn), Copper (Cu), Molybdenum (Mo), and Nickel (Ni) are micronutrients present in the soil. The amount of nutrients required by the plants will vary for different types of plants
- The soil sample is handed over to the testing laboratories for finding the level of soil nutrients. Since the testing is to be carried out at least twice before the cultivation, high expenditure spent for soil testing is not affordable by the farmers. Due to this reason, most of the farmers avoid soil testing that causes improper use of fertilizer which leads to damage of crops.

II. RELATED WORKS

"A Review on IoT-based Smart Agriculture System Using Machine Learning Techniques" by Sharma et al. (2020):

This review paper provides an overview of IoT-based smart agriculture systems and discusses the application of machine learning techniques for various tasks such as crop monitoring, disease detection, and yield prediction.

"Enhanced Crop Monitoring and Management in Smart Agriculture Using IoT and Machine Learning" by Kumar et al. (2019):

This study presents an enhanced crop monitoring and management system utilizing IoT devices for data collection and machine learning algorithms for predictive analytics. The authors demonstrate improved crop yield and resource utilization through their proposed approach.

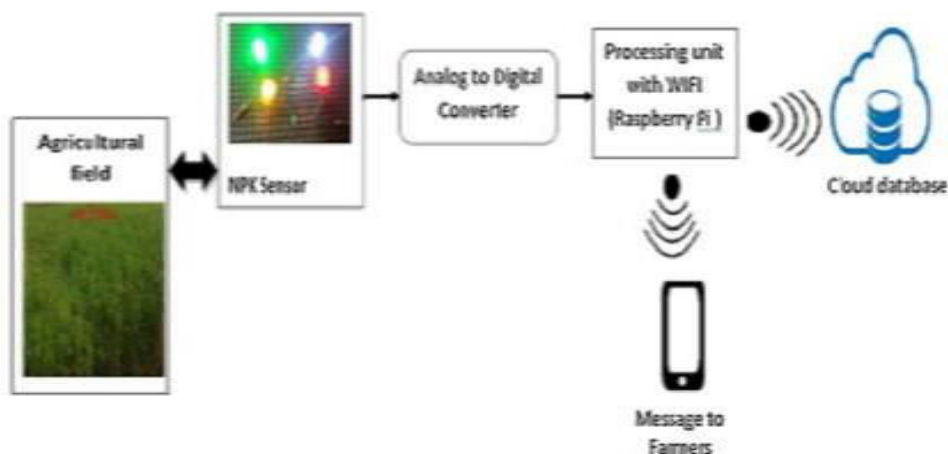
III. EXISTING METHOD

Most of the sensors are not flexible to integrate with smart agriculture system. These sensors enable manual testing and expensive to conduct the test in laboratories. In India, laboratory testing standards are followed to implement the lab crude methods like soil testing kits and colorimetric approaches a manual testing method using the colorimetric principle for the determination of small amounts of Potassium. The soil is mined with Bray's extracting reagent and the available potassium is precipitated as Cobaltinitrite.

IV. PROPOSED SYSTEM

High-level overview of the proposed system Components: IoT devices, data collection, preprocessing, ML models, decision-making modules Integration of cloud computing and edge computing for scalability and efficiency

V. BLOCK DIAGRAM



VI. EXPERIMENTAL RESULTS

These experimental results demonstrate the efficacy and potential benefits of the enhanced design and development of machine learning algorithms for IoT-based smart agriculture systems. By leveraging IoT data and advanced machine learning techniques, farmers can make data-driven decisions, optimize resource utilization, and enhance agricultural productivity and sustainability.

VII. FUTURE SCOPE

Advancements in machine learning algorithms for IoT-based smart agriculture hold great promise for improving efficiency, sustainability, and productivity in farming. Integrating emerging technologies like blockchain and edge computing, alongside AIoT developments, can enable autonomous decision-making and optimize farming operations. Robotics and automation offer opportunities for streamlining tasks, while predictive analytics aids in forecasting trends and optimizing strategies. Data fusion enhances insights, sustainability focuses on eco-friendly practices, and user-friendly interfaces ensure accessibility. Collaborative research fosters efficient solutions to agricultural challenges. These innovations collectively aim to revolutionize agriculture for a more sustainable and productive future.

VIII. CONCLUSION

In summary, the integration of advanced machine learning algorithms with IoT technology holds immense potential for transforming agriculture into a more efficient, sustainable, and productive industry. By leveraging emerging technologies such as blockchain, edge computing, and AIoT, alongside innovations in robotics and predictive analytics, farmers can optimize resource management, streamline operations, and enhance decision-making processes. Accessible data fusion and user-friendly interfaces democratize agricultural insights, fostering collaboration and knowledge sharing across diverse stakeholders. This convergence of technology and agriculture promises a brighter future, ensuring food security, environmental stewardship, and economic prosperity for generations to come.

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International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization

Volume 13, Special Issue 1, April 2024

11th National Conference on Frontiers in Communication & Signal Processing Systems (NCFCSPS '24)

25th - 26th April 2024

Organized by

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