International Journal of Modern Science and Research Technology
ISSN NO-2584-2706

A Study on IoT for Precision Agriculture

Junaid Khan Pathan; Chetan Bawankule; Dr. Sandhya Dahake
Dept. Master in Computer Application, GHRIET, Nagpur, India

Abstract: Precision Agriculture is one of the most promising strategies for solving problems of resource optimization, environmental sustainability and food security in modern agricultural practice. In this paper, author explores whether automation, data-driven decision-making and real-time monitoring offered by the Internet of Things (IoT) can help in precision agriculture. To monitor various aspects of agricultural applications such as soil moisture, temperature, humidity and crop health, Author studies an Internet of Things based framework that combines sensors, cloud computing and machine learning algorithms. This technology improves crop productivity and resource efficiency dramatically with automation of insect control, fertilization and irrigation.

I. Introduction

The agricultural sector is finding more and more constraints, climate change and population growth. Basically, conventional agricultural practices often misuse resources and degrade the environment. Consequently, they suffer from a lower profit point. Precision farming techniques that maximize resource allocation and improve crop productivity are possible with the Internet of Things' (IoT)' radical integration into agriculture [1]. Farmers are able to make well-informed decisions due to real-time data on crop health, weather, and soil conditions provided by IoT devices such as sensors and drones [14]. The contribution of IoT in improving sustainability, productivity, and cost-effectiveness is the main topic of this paper's discussion of the role of the technology in precision agriculture [11]. We propose an Internet of Things (IoT)-based system for automation and real-time monitoring and underpinned by machine learning for insights[18].

Agriculture has been the backbone of human society for thousands of years; food security as well as economic stability. Present day agricultural land management techniques, however, are insufficient to meet the world's food requirements in a resource-limited environment, climate change, and rising population. According to the United Nations Food and Agriculture Organization (FAO), by 2050 there will be 9.7 billion people on Earth, requiring an increase in agricultural production of 70% to ensure sufficient food supply [10].

2. Background

Internet of things(IoT) is an infrastructure of connected devices that exchange information and communicate with each other to perform one of a set of functions[6]. This technology is a game changer in agriculture, allowing farmers to monitor and control their fields at unprecedented levels of precision[9].

A farmer may receive real-time data on a crucial trait affecting plant health, such as crop growth, temperature, humidity and soil moisture through IoT sensors, drones and actuators[15]. With data

DOI: https://doi.org/10.5281/zenodo.15619556

collected from the devices, a crop can be more productive and resource waste reduced by optimizing pest management, fertilization and irrigation techniques[7] Therefore, IoT is a key technology to implement precision agriculture, which aims to increase productivity while mitigating the impact of agriculture on the environment[11].

2.1 Code Review

Code review ensures that reliability and effectiveness of software systems that process sensor information and derive useful insights from it in IoT-enabled precision agriculture[8]. Code reviews of algorithms for pest detection or soil moisture predictions for instance could help identify limitations in these algorithms and improve accuracy[1].

Also code reviews are crucial for ensuring system security, especially in the connection protocols of IoT that transmit private agricultural data[14]. Code reviews also help to incrementally improve IoT applications in agriculture by promoting developer involvement[17].

2.2.Presentation of Review Results

With the review of IoT systems in precision agriculture one of the first things we need to address is that we present the review findings. We can identify inefficiencies such as poorly optimized algorithms for predicting soil moisture or incorrect insect detection models that are discovered during code reviews and system evaluations[1]. For example, there may be an issue with a machine learning model that does not generalize into that setting, leading to changes in the algorithm or training data[7]. Developers and stakeholders are better placed to address any perceived problems if the results are presented in a way that prioritizes and provides context for understanding. The iterative review process ensures predictive models used in IoT-enabled precision farming are adapted to real farming scenarios[11]. Software developers can enhance the accuracy and utility of IoT systems by improving algorithms for crop health monitoring, fertilizer application, and irrigation scheduling[9]. Another benefit of IoT devices is that farmers can better understand the insights generated by the devices when data is accessible through easy-to-understand dashboards or visualizations[17]. This openness drives adoption and builds trust in a system. Displaying review findings ultimately fosters the continuation of IoT applications ensuring they meet the unique needs of precision farming and provide farmers with tangible benefits[6].

2.3.Trust on AI

An important component of efficient distribution of IoT units in accurate agriculture is the belief in artificial intelligence (AI)[10]. To win on farmers, AI-driven recommendations such as insect control, fertilizer application or irrigation program should be related to and understandable[7]. For example, an AI model that predicts the best time for planting based on meteorological data, for example, farmers must provide clear details about the recommendations so that they can compare them with their own experiences[18].

Decisions Three- and rule-based systems are examples of clear AI strategies that can help reduce the difference between end users and complex algorithms[10]. Addressing uncertainties, such as how models react to noise or lack of sensor input, is another aspect of openness in the AI system[17]. IoT solutions are more likely to be adopted by farmers when they result in high crop or low consumption[13].

DOI: https://doi.org/10.5281/zenodo.15619556

In addition to technical sound, good communication between developers and farmers is necessary to promote trust in AI[17]. IoT solutions can enable farmers to create knowledge by creating self - confidence, which will eventually increase agricultural stability and productivity[10].

2.4 Challenges in AI-Powered Code Review

When considering the competent agricultural software system, there are many benefits to AI-trained code assessment units, but they also have deficiencies[6]. Disability of AI model is an important problem for understanding references because it can be difficult to understand domain-specific practice, such as the best ways to manage pests or plants[8]. For example, an AI tool can mark part of the code as useless, without realizing how relevant it is for agricultural activities[10]. Code assessments are made more difficult for security errors in IoT units, as the hacked system can lead to data violations or misinformation[14].

2.4.1 Contextual Understanding and Best Practices:

IoT- One of the biggest obstacles to AI-operated code assessment for competent accurate agriculture is the relevant consciousness[6]. Domain-specific competence required to assess best practices, including crop rotation, method of soil conservation or insect control strategy, is often absent from AI models[8]. For example, an AI unit may recommend excessive watering without taking into account long -lasting effects on soil health or water shortages[15].

2.4.2 Security and Ethical Concerns:

One of the biggest obstacles to the use of IoT technologies for accurate agriculture is security and moral issues[4]. IoT equipment that sends sensitive agricultural data on wireless networks, such sensors and drones are receptive to cyber attacks[15]. For example, unauthorized access to irrigation systems can be agricultural damage or water waste[17].

2.4.3.Human-AI Collaboration and Trust:

The efficiency of the IoT system in accurate agriculture depends on people-AI cooperation[6]. Farmers are often dependent on their experiences and intuition to make final decisions, although the AI sensor is able to analyze and make recommendations of data[9].
To develop a user -friendly interface that clearly explains recommendations and enables farmers to verify against their knowledge, required to promote trust in AI systems[13].

3. Literature Survey

In recent years, due to the inclusion of IoT, there has been a great emphasis on accurate agriculture[6]. Several applications have been investigated by researchers, including smart irrigation systems that adapt the use of water using weather figures and soil moisture sensors[7]. Research has also shown how drones and satellite photography can be used to track crop health and to create very accurate production conditions[2]. Decisions are two examples of three- and nervous networking machine learning algorithms used for disease control and insect identification, demonstrating their ability to damage crop damage[8].
However, research in publishing emphasizes is lacking in addressing security errors in IoT units, resulting in system errors or data violations[14]. Despite the ability of AI-operated solutions, nothing is known about how farmers will use them because of economic and technical obstacles[17].
The requirement for IoT system that is scalable, safe and easy to use in different types of agricultural applications is highlighted by this study[11].

DOI: https://doi.org/10.5281/zenodo.15619556

4. Approaches

A systematic approach involving data aggregation, model construction and system integration is crucial to the successful use of IoT for accurate agriculture[10]. First, it is important to collect and prepare agricultural data. It forces the sensors to collect data on temperature, moisture, soil moisture and crop health in real time[15].

Drone -based photography and satellite data are also used to increase this data[2]. Normalization and external elimination data are examples of traffic techniques that guarantee the quality and dependence of the data set for further analysis[11]. Agriculture has been the backbone of human society for thousands of years; food security as well as economic stability[9].

4.1. Gathering and Preparing Data

Based on the Internet of Things, the presidential agricultural data is designed to collect data[6]. While drones and satellites provide air fantasy for monitoring crops, the sensors held in fields consider variables including soil moisture, temperature, humidity and light intensity[1].Pre-treatment techniques such as normalization, filtration and external elimination are necessary to ensure accuracy, as this raw data is often noisy and deficiency[11].

4.2. Model Training and Development

Artificial intelligence (AI) models are designed to analyze agricultural data and provide useful insights[10]. In order to predict agricultural exchanges, identify diseases and improve irrigation schemes, machine learning algorithms such as regression, decision trees and nervous networks are trained using historical records[18]. Drone -contacted photographs are analyzed using innovative methods such as detecting deep learning to detect crop stress[14].

4.3. Metrics for Evaluation

In order to guarantee effective operations, norms at the system level, including energy use, response time and scalability, are investigated[5].

4.4. Integration with Development Workflow

Dealer services can be enabled by application of the IoT system to the work process[6]. Instruments such as MQTT, Node-RED and REST APIs simplify channel establishment not only between sensors and cloud platforms but also edge devices[5]. The system can be updated and properly maintained with the help of DevOps procedures[13]. Mean while edge computing provides faster response time and better real-time decision-making capabilities by reducing the delay to the minimum[15]. it helps in getting more of the fields work to be done.

5. Methodology

A method, multi-step process is used in accurate IoT implementation to guarantee the construction of a scalable and effective solution[6]. Designing IoT architecture, covering cloud integration, communication protocols and sensors, is the first stage[5]. To collect real -time data and provide low energy use, the sensor is strategically distributed in agricultural areas to monitor parameters such as soil moisture and protocols such as Lorwan or MQT [1].

The data collected is then prepared to eliminate noise and irregularities[11]. After cleaning the data, the machine learning model is trained using methods such as recession for prognosis for thingssuchasnervous networks, decision trees and production estimates, pest infections[18].

Both technical and user centered calculations are used to evaluate the system: Technical matrix involves response time, energy efficiency and prediction accuracy, while user -centric matrix focuses on usability and focus on using prices[5].

DOI: https://doi.org/10.5281/zenodo.15619556

Finally, the IoT solution is integrated into workflows with agriculture using devices such as NOD red and edge Computer processing equipment to enable the solution to make real-time decisions[17]. A user - friendly interface, such as a web dashboard or mobile app, is designed to present action -rich insights to farmers, secure access and purpose[13]. This feature guarantees a reliable, scalable and peasant-focused IoT system for accurate agriculture[9].

6. Future Scope

IoT has a huge future in presentation agriculture, which has many rooms for development and innovation[10]. Integration of condition -Art -art techniques such as age calculation and 5G networks are a possible opportunity[17]. These technologies can improve real -time data processing and low delay, so that quick decisions can be made in contexts with dynamic agriculture [15]. In addition, more complex forecast models such as hyperlocal weather forecasting and adapted crop management plans will be made possible by development in AI and machine learning, depending on the status of farm[18].

The construction of cheap IoT units is another expansion area, which opens these solutions on a small scale and resource transactions[13]. Implementation of blockchain technology can lead to concerns about data security and openness by guaranteeing safe exchange of agricultural data among stakeholders [4]. In addition, by increasing stability and efficiency, IoT can completely change these industries by expanding the applications to aquaculture, greenhouse management and monitoring of animals[14].

When it comes to politics, partnerships between governments, educational institutions and technical companies can encourage the standardization of the Internet of Things protocol and encourage the implementation of smart agricultural techniques[9]. To stop digital differences, future research should also focus on dealing with questions such as IoT units, energy efficient sensordesign and interoperability of peasant training[17]. By taking advantage of these opportunities, IoT can make agriculture a more flexible, productive and durable area that can handle global food safety problems in the coming decades[10].

.

7. Conclusion

Precision agriculture, which incorporates IoT, is a revolutionary approach to modern agriculture dealing with important issues, including food security, environmental, sustainability, and resource optimization[6]. The IoT system provides surveillance of real-time and data-driven decision-making through the use of system sensors, drones and AI-operated analysis, which increases the crops and reduces operating expenses [2].

To guarantee scalability and benefit from IoT solutions, this article has emphasized the importance of methods such as collecting data, even integration into model construction and agricultural operations[11]. The study also emphasizes the need to deal with the relevant problems, such as digital differences, high implementation costs and safety problems between farmers[13]. The efficiency and access to the IoT system in agriculture can be further enhanced by using condition -of -art technologies such as age calculation, 5G and blockchain after future development[5]. The versatility and extensive effects of IoT are performed not only with crop control, but also with the ability to change house deputy monitoring and aquaculture[14].

DOI: https://doi.org/10.5281/zenodo.15619556

8. References

[1] Smith, J., and Brown, R. (2021). "IoT-based soil moisture monitoring for sustainable agriculture." Agricultural Technology Journal, 15 (3), 123–135.

[2] Johnson, A., and Lee, K. (2022). "Drone-assisted IoT system for evaluation of crops." IEEE Transaction on Smart Agriculture, 8 (2), 45-58.

[3] Kumar, S., et al. (2023). "Cloud-ECCCLESTED
IOT platform for accurate agriculture." International Journal of IoT Applications, 12 (4), 67–80.

[4] Zhang, L., et al. (2022). "Blockchain to share secure data in IoT-activated agriculture." Journal of Cybercity and Privacy, 7 (1), 89–102.

[5] Brown, T., et al. (2023). "Edge computing for real -time decision -making of agriculture." Sensors and actuators, 25 (2), 34–48.

[6] Gupta, R., and Singh, P. (2021). "IoT in agriculture: a comprehensive review." Progress in intelligent systems and data processing, 10 (5), 12–25.

[7] Patel,M. and Kumar, V. (2022). "Smart irrigation systems using IoT and machine learning." Water Resources Management Journal, 14 (6), 56-70.

[8] wang, x., Et al. (2021)."IoT-based insect detection and control in accurate agriculture." Agricultural Engineering International, 9 (3), 89–102.

[9] Rajput, S., and Sharma, N. (2022). "IoT role in increasing crop and stability." Sustainable Agricultural Research, 11 (4), 112–125.

[10] Rajput, S., and Sharma, N. (2022). "IoT role in increasing crop and stability." Sustainable Agricultural Research, 11 (4), 112–125.

[11] Liu, Y., et al. (2023). "AI-driven future model for accurate agriculture." Artificial intelligence in agriculture, 15 (1), 34–47.

[12] Chen, H., et al. (2022). "Integration of IoT and Big Data Analytics into agriculture." Big Data Research Journal, 8 (2), 78-92.

[13] Ahmed, F., and Ali, M. (2021). "IoT-competent greenhouse automation for efficient resource management." Renewable energy and environment, 10 (3), 45-58.

[14] Singh, R., et al. (2023). "Low -cost IoT solution for small -scale farmers." Journal of Rural Development and Technology, 12 (5), 67–80.

[15] Davis, M., and Thompson, K. (2022). "Drone in IoT and agriculture: a synnetic approach." Drone in Agricultural Journal, 7 (1), 23–36.

[16] Wilson, J., et al. (2021). "Real -time monitoring using IoT sensor." Environmental monitoring and evaluation, 13 (4), 89–102.

[14] Martinez, C., and Lopez, A. (2022). "IoT for house deputy monitoring and health control." Livestock Science and Technology, 9 (2), 45-58.

[17 Taylor, R., et al. (2023). "Energy efficient IoT equipment for distant agricultural monitoring." Energy Efficiency Journal, 14 (3), 78-92.

[18] Kim, H., et al. (2022). "IoT and machine learning to predict crop disease." Plant Pathology Journal,11(4),112–125.

DOI: https://doi.org/10.5281/zenodo.15619556

[19] Anderson, P., and Roberts, J. (2021). "IoT security challenges in smart agriculture." Cyber security in agriculture, 10(5),34

DOI: https://doi.org/10.5281/zenodo.15619556