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A REVIEW ON THE ADVANCEMENTS IN AGRICULTURE SYSTEM **USING INTERNET OF THINGS**

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ABSTRACT

The agricultural sector faces significant challenges, including climate change, resource scarcity, and the need for sustainable food production to meet growing global demands.Smart Agriculture Systems leveraging the Internet of Things (IoT) have emerged as a transformative solution to address these challenges. This review paper explores the state-of-the-art advancements in IoT-driven smart agriculture, highlighting the integration of sensors, actuators, and real-time analytics to optimize farming practices. Key applications such as precision farming, automated irrigation, pest control, and crop health monitoring are examined. The paper also discusses the role of cloud computing, big data, and artificial intelligence in enhancing IoT capabilities. Additionally, challenges related to security, data privacy, and system scalability are addressed. The agricultural sector faces significant challenges, including climate change, resource scarcity, and the need for sustainable food production to meet growing global demands. Smart Agriculture Systems leveraging the Internet of Things (IoT) have emerged as a transformative solution to address these challenges. This review paper explores the state-of-the-art advancements in IoT-driven smart agriculture, highlighting the integration of sensors, actuators, and real-time analytics to optimize farming practices. Key applications such as precision farming, automated irrigation, pest control, and crop health monitoring are examined. The paper also discusses the role of cloud computing, big data, and artificial intelligence in enhancing IoT capabilities. Additionally, challenges related to security, data privacy, and system scalability are addressed. By providing a comprehensive overview of recent innovations and future trends, this review aims to serve as a valuable resource for researchers, practitioners, and policymakers striving to revolutionize agriculture through IoT-enabled technologies.

1. INTRODUCTION

Agriculture has been the backbone of human civilization, providing food, raw materials, and livelihoods for billions of people worldwide. However, the modern agricultural sector faces an array of unprecedented challenges, including population growth, climate change, resource limitations, and the demand for sustainable and efficient farming practices. As the global population is projected to reach 9.7 billion by 2050, food production must increase by an estimated 70% to meet the rising demand. These pressures necessitate innovative approaches to revolutionize traditional farming methods and ensure sustainable agricultural development.

The integration of technology into agriculture, often referred to as "Agriculture 4.0," marks a significant paradigm shift. Among these technological advancements, the Internet of Things (IoT) has emerged as a key enabler in creating smart agriculture systems. IoT refers to a network of interconnected devices capable of collecting, transmitting, and analyzing data in real time. By harnessing IoT technologies, farmers can achieve precision farming, optimize resource utilization, and make data-driven decisions to enhance productivity and sustainability.

This review paper delves into the transformative potential of IoT in agriculture, focusing on its ability to address critical challenges and redefine conventional farming practices. Smart agriculture systems utilize a combination of sensors, actuators, communication networks, and computational tools to monitor and control various aspects of the agricultural ecosystem.

These systems enable real-time insights into soil conditions, crop health, weather patterns, and resource availability, empowering farmers to make informed decisions and automate key processes.

Precision farming, for instance, leverages IoT-enabled sensors and devices to monitor soil moisture, temperature, nutrient levels, and other parameters, allowing farmers to apply fertilizers and irrigation more accurately. This targeted approach minimizes waste, reduces environmental impact, and maximizes crop yield.

2. LITERATURE REVIEW

The integration of the Internet of Things (IoT) in agriculture has been extensively studied over the past decade, with researchers exploring its potential to address challenges in modern farming. This section reviews the existing literature on IoT applications in agriculture, focusing on key areas such as precision farming, crop monitoring, irrigation

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management, and supply chain optimization. Additionally, the role of complementary technologies such as artificial intelligence (AI), machine learning (ML), and big data analytics is discussed to provide a comprehensive understanding of the IoT-driven smart agriculture ecosystem.

Precision Farming

Precision farming is one of the most researched areas in IoT-driven agriculture. Studies highlight the use of IoTenabled sensors to monitor soil properties, including moisture, pH levels, and nutrient content. For example, research by Jones et al. (2019) demonstrated the effectiveness of IoT based soil sensors in improving fertilizer application accuracy, leading to enhanced crop yields and reduced environmental impact. Similarly, Kumar and Singh (2021) investigated the integration of IoT with drone technologies to map soil variability and optimize seeding practices.

In addition to soil monitoring, IoT devices have been utilized for crop health assessment. A study by Zhao et al. (2020) employed multispectral sensors to detect early signs of plant diseases, enabling timely interventions and minimizing yield losses. The integration of AI in IoT systems further enhances precision farming by enabling predictive analytics for pest control and yield forecasting.

Efficient water management is critical in agriculture, particularly in regions facing water scarcity. IoTbased smart irrigation systems have been widely studied for their potential to optimize water usage.

Research by Ahmed et al. (2018) highlighted the role of IoT-enabled sensors in measuring soil moisture and weather conditions to automate irrigation schedules. Their findings showed a 30% reduction in water consumption without compromising crop health.

Advances in wireless communication technologies, such as LoRaWAN and NB-IoT, have further facilitated the deployment of smart irrigation systems. Studies by Sharma et al. (2020) demonstrated the scalability of these technologies in large-scale farming operations. Additionally, IoTintegrated irrigation systems have been combined with renewable energy sources, such as solar power, to enhance sustainability.

The field of smart agriculture has witnesse significant advancements, with the integration of the Internet of Things (IoT) playing a pivotal role. This literature review provides an in-depth analysis of IoT applications in agriculture, organized under the following topics: precision farming, smart irrigation, crop monitoring and disease detection, livestock management, supply chain optimization, and challenges.

Precision farming leverages IoT to optimize agricultural practices by providing real-time data on soil and crop conditions. Studies have emphasized the importance of IoT sensors in monitoring soil parameters such as moisture, temperature, and nutrient levels. For example, Patel et al. (2021) highlighted the efficacy of IoT-enabled soil monitoring systems in improving fertilizer application efficiency. The integration of drone technology with IoT has also shown potential in mapping fields and identifying areas requiring specific attention.

AI and machine learning (ML) further enhance precision farming by enabling predictive analytics. Research by Zhao et al. (2022) demonstrated how AIdriven algorithms, integrated with IoT devices, predict pest outbreaks and suggest targeted interventions, thereby reducing pesticide usage and enhancing crop yields.

Smart Irrigation Systems Water scarcity and inefficient irrigation methods have been longstanding challenges in agriculture. IoTbased smart irrigation systems offer a solution by automating water delivery based on real-time data.

Ahmed et al. (2020) studied the implementation of IoT sensors to monitor soil moisture and weather conditions, showing a 25% improvement in water efficiency.

The rapid advancement of technology has profoundly influenced agriculture, with the Internet of Things (IoT) emerging as a transformative force. This literature review focuses on the following topics: IoT in precision agriculture, sustainable water management, crop health and disease analytics, post-harvest and supply chain management, the role of emerging technologies, and challenges in adoption.

IoT in Precision Agriculture Precision agriculture utilizes IoT technologies to enhance farming practices by collecting and analyzing data in real-time. Sensors embedded in the soil measure parameters like moisture, pH levels, and nutrient content, providing farmers with actionable insights. A study by Smith et al. (2020) demonstrated that IoTenabled systems could improve fertilizer efficiency by up to 40%, reducing costs and environmental impact. Dronebased IoT systems have also gained attention for their ability to map fields and detect variability. Kumar et al. (2021) showcased a framework where drones equipped with IoT sensors monitored crop conditions, optimizing planting and fertilization strategies. The integration of AI with IoT enhances these systems, allowing for predictive analytics, as observed in studies addressing pest management and yield forecasting.

Water scarcity poses a significant challenge to agriculture, necessitating efficient water management solutions. IoTbased irrigation systems automate water delivery based on soil moisture and weather data, minimizing wastage.



Research by Ahmed et al. (2019) highlighted a 30 %reduction in water use with IoT-driven irrigation. Innovative communication technologies like LoRaWAN and Zigbee have made IoT systems scalable for large agricultural setups. Coupling these systems with renewable energy sources such as solar panels has further improved sustainability, as reported by Sharma et al. (2020) Smart agriculture, empowered by the Internet of Things (IoT), has emerged as a pivotal domain in addressing modern agricultural challenges. This literature review examines IoT's role under these core themes: environmental monitoring, resource optimization, farmer empowerment through data analytics, advancements in agri-tech innovation, and barriers to effective implementation. Environmental factors heavily influence agricultural productivity. IoT-enabled environmental monitoring systems utilize advanced sensors to track parameters like soil quality, air humidity, and weather patterns in real-time. A study by Brown et al. (2021) emphasized how IoT-based weather stations equipped with AI can predict climatic conditions and mitigate risks of crop failure.

Satellite imagery integrated with IoT platforms offers macro-level insights, while ground-level sensors provide microlevel accuracy. Examples include weather-adaptive planting calendars that notify farmers about optimal sowing times, reducing the environmental impact of incorrect timing.

3. METHODOLOGIES

1. Literature Survey

1.1. Criteria for Selection

Conduct a search for relevant research papers based on the following:

Keywords: CNN, IOT conference papers, and technical reports.

Timeframe: Focus on recent works for, for example, from the last 5-10 years.1.2. Categorization of Studies

1.2. Classification of Studies

Classification of studies into:

Internet Of Things: Graphs, IOT based Data.

Classical Machine Learning Methods:

KNN, SVM, K-means clustering.

Deep Learning Methods: CNN,

DenseNet, ResNet..

2. Comparison of Methods

2.1. Metrics used in comparison between studies

- Accuracy
- Precision and recall
- F1-score
- Processing speed and model size
- Computational efficiency

2.2. Data Sources

Datasets utilized in the respective studies:

- Private datasets, images from the field, or farms.
- Characteristics of datasets: size, diversity, and annotation quality.
- 2.3. Feature Extraction Techniques
- Compare traditional methods (Manual feature extraction) with automated approaches (Hierarchical feature learning in CNN).

3. Proposed Framework

3.1. Hybrid Methodology

CNN based feature extraction plus the addition of:

- SVM: This will improve the classification accuracy of the system.
- CBAM: This will help a focus on the critical regions inside the image.
- Advantage of the hybrid technique over individual techniques.
- 3.2. Optimized Lightweight Models
- Discuss the advantages of light models, such as YOLOv5, for real-time applications.

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- Use the following techniques:
- GhostNet: to simplify the model
- BiFPN: for better feature features
- 3.3. Benchmarking
- Devise testing against classical and state-of-the-art solutions to determine performance improvements.

4. Challenges and Gaps

Identify the unsolved challenges

- Large and varied datasets with annotations are needed.
- High computational demands.

4. CONCLUSION

The methodologies outlined above highlight the multifaceted approach required for successful IoT adoption in agriculture. IoT systems offer transformative potential to address pressing challenges such as resource optimization, environmental monitoring, and yield enhancement. By harnessing advanced technologies like AI, edge computing, and blockchain, the agricultural sector can achieve greater efficiency, sustainability, and resilience. Moreover, the importance of contextual customization, farmer training, and robust evaluation metrics cannot be overstated. These elements ensure that IoT solutions are not only technologically sound but also economically and socially viable. Looking ahead, continued innovation and collaboration among stakeholders will be pivotal in overcoming barriers and scaling solutions. By doing so, IoT can fully realize its promise of revolutionizing agriculture and contributing to global food security. The review of smart agriculture systems powered by IoT highlights the immense potential to revolutionize traditional farming practices. IoT enabled technologies provide precise and efficient solutions to some of the most critical challenges in agriculture, including resource optimization, pest management, and climate adaptation. By integrating advanced sensing systems, real-time data analytics, and AI-driven decision-making,smart agriculture fosters increased productivity while ensuring environmental sustainability. However, widespread adoption necessitates addressing key barriers, such as high implementation costs, technical complexity, and limited digital literacy among farmers.

5. REFERENCES

- [1] Zhang , Y., et al. (2015). Internet of Things for Smart Agriculture: Technology and Applications. Agricultural Systems.
- [2] Khan, M. A., et al. (2016). Smart Agriculture and Precision Farming: The Role of IoT. Sensors.
- [3] Hossain, M. S., et al. (2017). Smart Agriculture using IoT-based Systems: A Review. Journal of Computer and Communications.
- [4] Bhat , P. V., et al. (2018). Applications of IoT in Agricultural Decision-Making: A Comprehensive Review. IEEE Access.
- [5] Rashid, M. A., et al. (2019). Advancements in Smart Agriculture with IoT and Cloud Computing. Future Generation Computer Systems.
- [6] 6.Ali, S. Z., et al. (2020).Irrigation System using IoT: Technology and Field Implementations . Journal of Agricultural Engineering Research.
- [7] Patel, P. R., et al. (2021). Blockchain Integration for Enhanced Traceability in Smart Agriculture. Agriculture.
- [8] Wang, H., et al. (2022). Edge Computing in IoT-based Smart Agriculture Systems: A Review. IEEE Transactions on Industrial Informatics.
- [9] Chaudhary, R., et al. (2023). IoT-Driven Smart Farming for Sustainable Agriculture: Challenges and Solutions. Environmental Sustainability.
- [10] Tan, S., et al. (2024). Advances in IoT and AI for Smart Agriculture: Future Prospects. International Journal of Agricultural Technology.