

Farm Management for Sustainable AI and IOT Based Agriculture

Ashwini S.S.^{1*}, Tejashwini N.², Sumadhwa H.M.³, Bopanna M.U.⁴, Chandan Dixit⁵, Aditya S. Kanchi⁶

Abstract

The sector of agriculture has undergone a transformation thanks to the integration of synthetic Artificial intelligence (AI) and The Internet of Things. This has made it conceivable to move towards smart agriculture and promote the evolution of sustainable farming methods. In-depth study of the uses, approaches, difficulties, and potential applications IoT and AI in intelligent agriculture and sustainable farming is offered in this survey report. We examine the several AI approaches that are being used to optimise crop management, resource utilisation, pest control, and environmental condition monitoring. These approaches include machine learning, deep learning, and data analytics, in addition to IoT devices and sensors. We also go over how AI and IoT are helping to make precision agriculture, yield optimization through predictive analytics, and farmer decision support systems possible. We also explore the socio-economic and environmental implications of these technologies, emphasising How they could enhance the quality of meals security, lessen the consequences of climate change, and encourage sustainable farming methods. We also discuss the issues that prevent the mainstream application of AI and IoT technologies in agriculture, such as adoption obstacles, interoperability, scalability, and data privacy concerns. Lastly, we list the future directions for research and the technological developments that is going to be required to fully utilise AI and IoT for smart agriculture and sustainable farming, opening the door to a more resilient and fruitful agricultural ecosystem.

Keywords: Intelligent automation (AI), The Internet of Things (IoT), Environmentally friendly farming, Deep learning, Machine learning, Smart agriculture Analytics of data crop administration, Use of Resources

INTRODUCTION

The domains in which smart agriculture additionally environmentally friendly farming have witnessed a revolution thanks to the advancement of artificial intelligence (AI) and the Things Network (IoT). There has never been more demand on agriculture to produce more food sustainably and effectively as the world's population grows. In this regard, data-driven decision-making, precision farming methods, and resource optimization are being made possible by AI and IoT, which are completely changing the agricultural scene. durability.

*Author for Correspondence

Ashwini S.S.

E-mail: ashwini.ss@saividya.ac.in

¹Assistant Professor, Department of CSE, Sai Vidya Institute of Technology Bengaluru, India

²Associate Professor, Department of CSE, Sai Vidya Institute of Technology Bengaluru, India

³⁻⁶Student, Department of CSE, Sai Vidya Institute of Technology, Bengaluru, India

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SCOPE OF THE PROJECT

Exploration of AI Techniques

Looking at the utilization of various AI techniques, such as data analytics, machine learning, and deep learning [10], in agriculture to improve agricultural yields, decision-making processes, and resource allocation.

Applications in Sustainable Farming

Talking about how AI and IoT solutions may become accustomed to support sustainable agricultural practices, such as organic farming, water conservation, managing soil health, and biodiversity preservation.

Integration of Precision Agriculture

Investigating how AI and IoT technology able can be applied to precision agriculture practices including crop monitoring, variable rate fertilization, and precision irrigation in order to be capable of increasing productivity and reduce resource waste.

Predictive Analytics and Decision Support Systems

Examining the contribution of AI and IoT to the creation of predictive analytics models, farmer decision support systems, proactive management techniques, early agricultural disease diagnosis, and efficient input use.

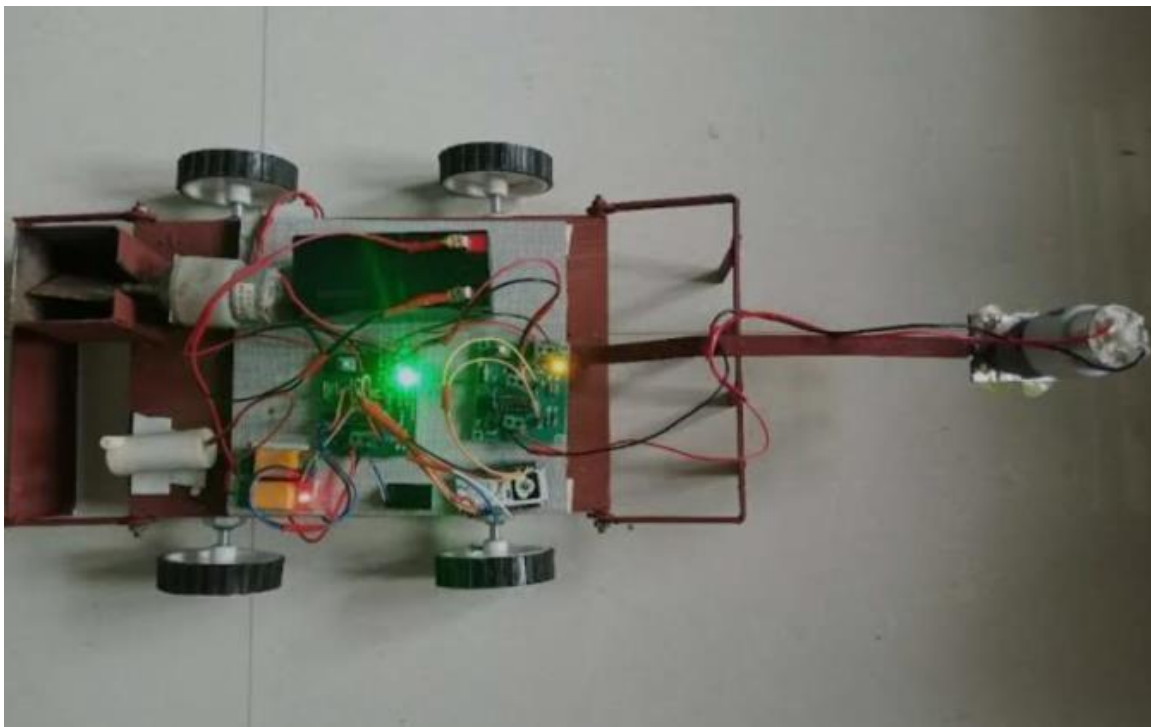


Figure 1. Model of IOT for smart agriculture.

LITERATURE REVIEW

Shabinar Abd Hamid, Nor Adni MatLeh, Zakiah Mohd Yusoff, Muhammad Azri Asyraf Mohd Hafez, and Zuraida Muhammad [1]

Developing a network of objects-connected The intelligent farming system is the project's goal. An irrigation system is combined with the technology to address Malaysia's unpredictable weather. Model B Raspberry Pi 4 is the microcontroller used in this system. With the DHT22's assistance and soil moisture sensor, the surrounding area's temperature, humidity, and soil moisture content are all measured.

Divya J., Divya M., Janani V. [2]

Agriculture plays a major role in the economic and population survival of India. This endeavor seeks to create an soil monitoring and watering system with inbuilt technology that does not require field observations by humans and delivers data through a mobile device application. The method's objective is to help farmers produce more agricultural goods. A pH sensor, a temperature sensor, and a humidity

sensor are a few of the tools used to assess the soil. Based on the results, farmers may plant the crop that is best suited for the land.

J.V. Wijayakulasooriya, H.A.C. Dharmagunawardhana, and H.G.C.R. Laksiri [3]

Creating an efficient smart irrigation system based on the Internet of Things is another essential requirement for farmers in the agricultural sector. This study creates a weather-based, low-cost intelligent irrigation system. The first step is to design an efficient drip irrigation system that can automatically adjust the amount of water applied to plants according to the moisture content of the soil.

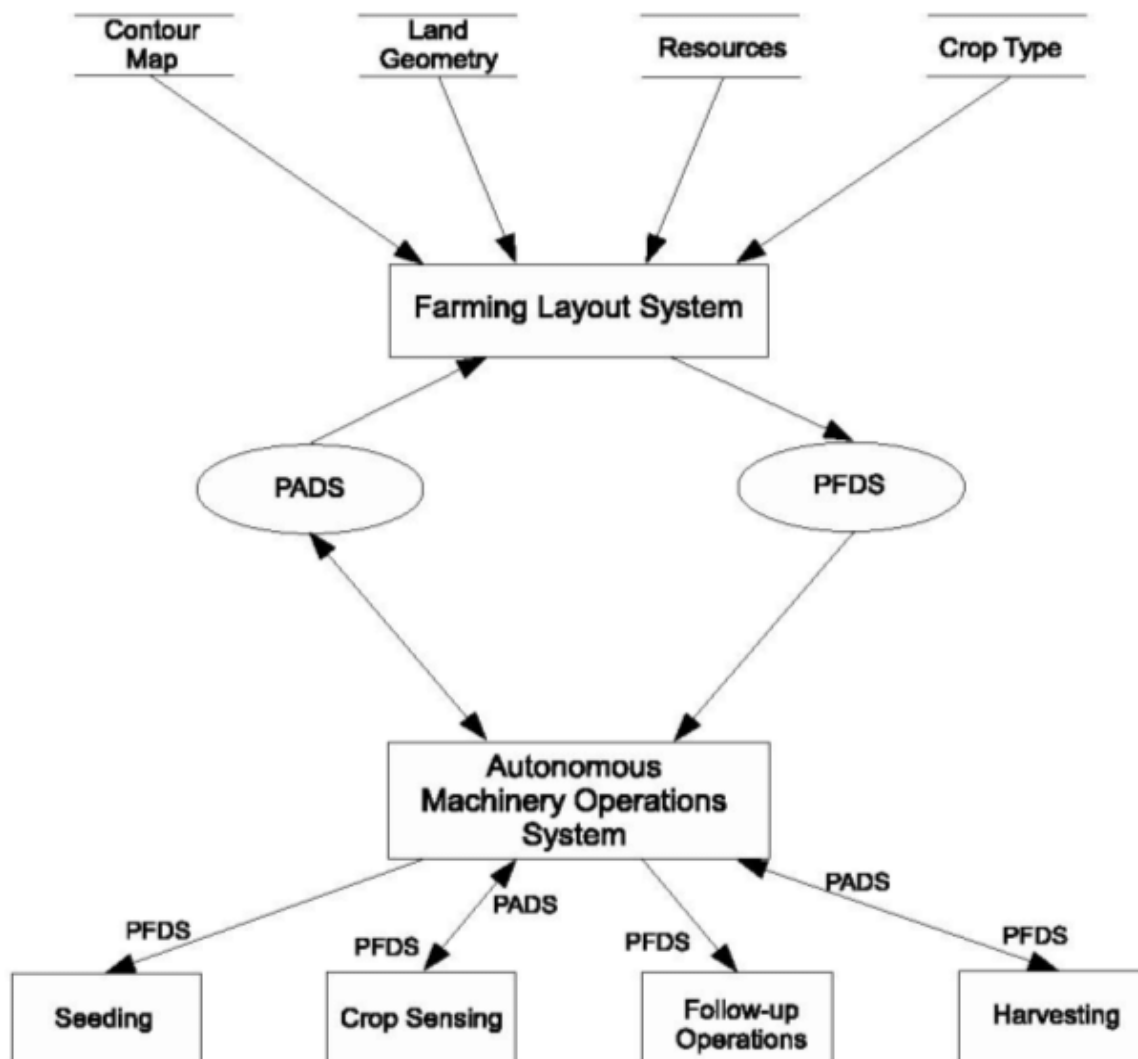


Figure 2. System Architecture.

Pruthviraj U., Layak Ali, and Anushree Math [4]

India is a nation where agriculture is extremely important. Therefore, it's essential to water the plants sensibly to maximum yield per unit space and produce high-quality results. The practice of giving plants a certain amount of water at a specific time is known as irrigation. This project aims to provide smart drip irrigation for the plants on the National Institute of Technology Karnataka campus.

SYSTEM DESIGN

System Architecture

A tiered approach is employed in the system architecture shown in Figure 2, for combining Internet

of Things, Cloud computing [7] and artificialintelligence (AI) technologies in intelligent farming [56] and sustainable farming. This permits the effective collection, processing, analysis, and application of agricultural data. An outline of the main elements and how they work together is provided.

Sensors and IoT Devices

Dispersed all around the agriculture ecosystem, sensors and IoTdevices form the cornerstone of the architecture. These gadgets gather information on a wide range of factors, including crop health, weather, humidity, temperature, and equipment quality. Aerial drones with cameras, temperature, humidity, soil moisture sensors [8], and weather stations sensors, and equipment sensors are a few examples of sensors.

Data Collection and Transmission

A central data collection system receives the information that isgathered by sensors as well the Internet of Things devices. The components of this system could include gateways, edge computing devices, and wireless communication protocols (such Wi-Fi, LoRa, and Zigbee) that preprocess data before sending it to an centralised server or the cloud. Reliable and low-latency connection between devices and the data acquisition system is ensured by data transmission protocols.

Use Case Diagram

Use case consists of client and server, with the client serving as the source of the input to the system and server is used to process the input information and provide output. The flow isdisplayed in the below Figure 3.

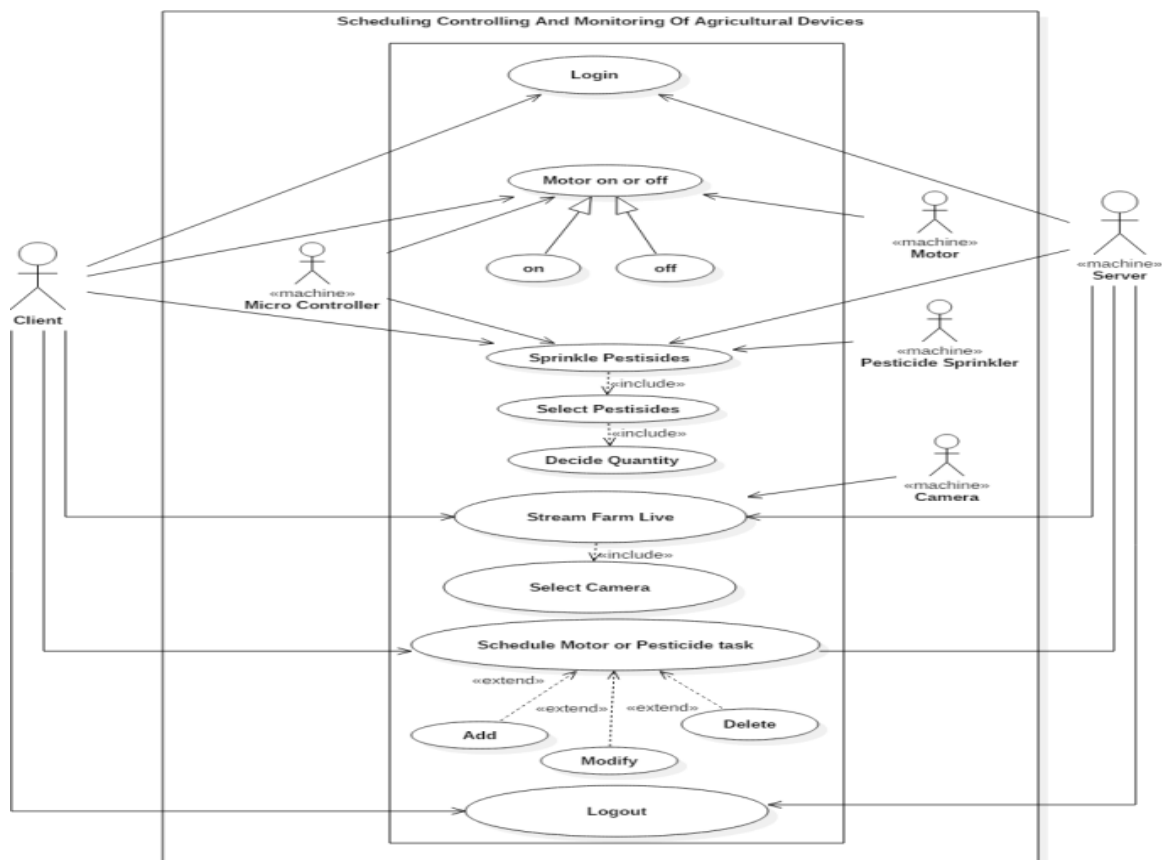


Figure 3. Use Case Diagram.

Sequence Diagram

The farming block gathers information gathered via sensors and other sources to start the sequence

of interactions in the IOT and AI architecture for shrewd farming and sustainable farming. After processing, this data is transferred to the acquisition system for additional preparation and storage. The big data services component then retrieves this information that has been saved and uses sophisticated analytics methods to extract insights. In the meantime, the user application converses with the big data services to deliver alarms, recommendations, and visualizations based on the analyzed data to farmers and stakeholders. After that, users can offer input via the application, completing the circle and assisting in the improvement of the analytical models within the systems as shown in Figure 4.

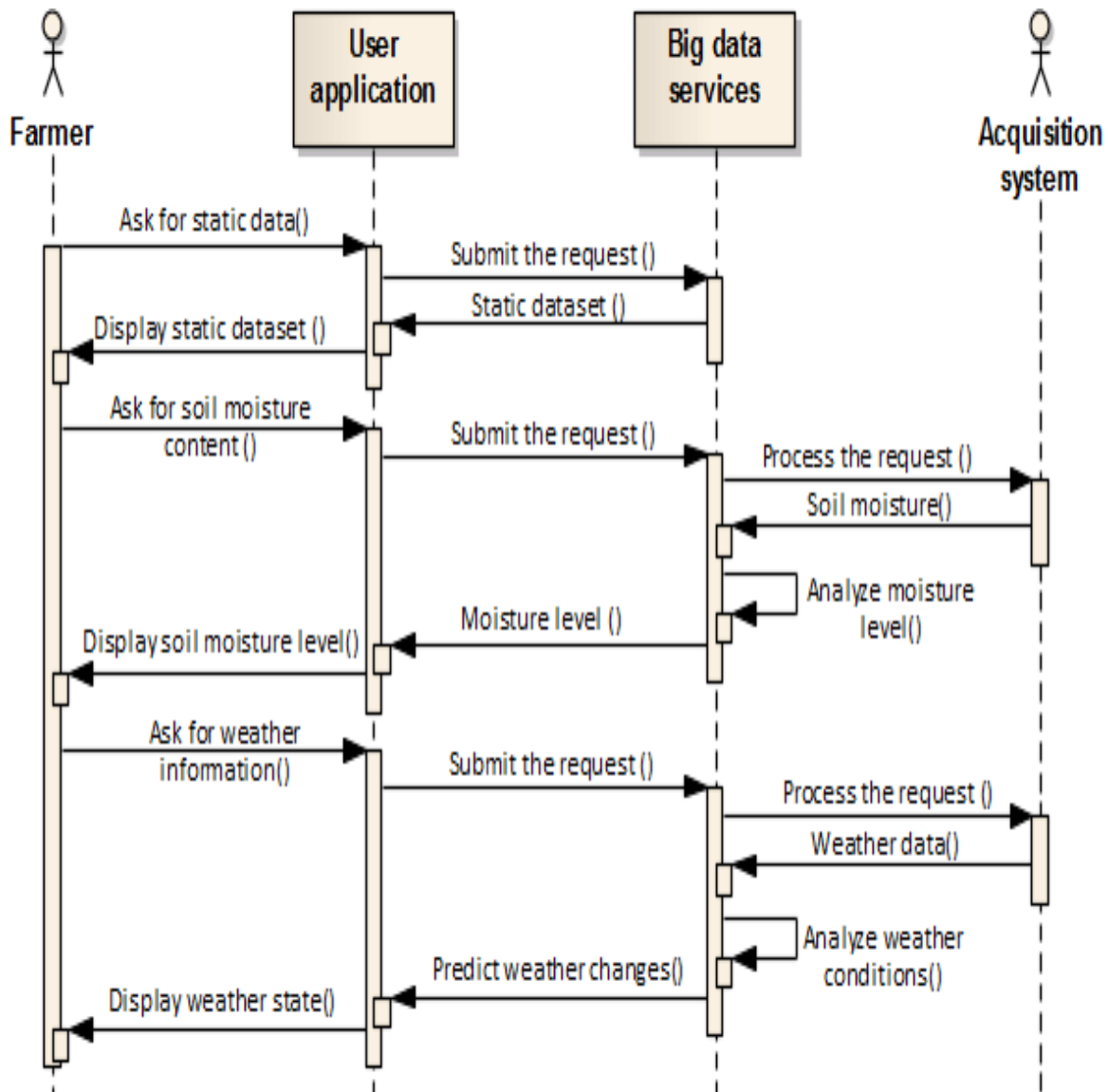


Figure 4. Sequence Diagram

SYSTEM DESIGN

Sensors and IoT Devices

- As shown in Figure 1, The system comprises a range of sensors and IoT gadgets positioned with purpose all around the agriculture environment.
- These detectors are able to be weather stations, equipment sensors, aerial drones with cameras, soil moisture sensors, temperature and humidity sensors, and more.
- The placement and choice of sensors are crucial to be able to be capable to guarantee thorough data

collection across various aspects of farming operations.

Data Acquisition and Transmission

- To effectively gather and send information from sensors [9] to the hub for processing unit, a reliable data acquisition system is required.
- To preprocess data before transmission, this system can incorporate gateways, edge computing devices, and communication protocols including Wi-Fi, LoRa, and Zigbee.
- Reliable and low-latency connection between devices and the central processing unit is ensured via data transmission protocols.

Centralized Data Storage and Processing

- Large volumes of data can be processed through cloud-based systems, which provide scalability, accessibility, and computational resources.
- Sensor data is saved and processed in a centralised database or data lake.
- Databases, data lakes, and processing modules in charge of data analytics, machine learning algorithms, and decision support systems are housed in the central processing unit.

Limitations and Future Directions

- Ensuring the accessibility and caliber of agricultural data is a serious issue. The effectiveness of AI and IoT applications is hampered by limited access to high-quality data, especially in remote or rural locations.
- Subsequent research should concentrate on creating strategies for improving data sharing, cleansing, and collection processes to be able to raise the dependability and accessibility of agricultural data.
- Data breaches or privacy concerns may make farmers and other stakeholders hesitant to contribute data. In order to get around these challenges, more research should create strong access control, authentication, and encryption systems that will safeguard agricultural data at every stage of its life.

CONCLUSION

In conclusion, there is a lot of potential for the agricultural sector to change in the direction of sustainability and intelligence through the integration of artificial intelligence (AI) and the Internet of Things (IoT) technologies. AI and IoT empower farmers to reduce environmental impact, increase productivity, and guarantee food security for an expanding global population by optimizing resource utilization, improving decision-making abilities, and proactively managing farming operations not withstanding current constraints like interoperability problems and worries about data privacy, continued innovation and research initiatives are well-positioned to get over these barriers and realise the full promise of AI and IoT in agriculture. Going forward, harnessing the revolutionary power of AI and IoT to create a more resilient, productive, and sustainable agricultural [5] sector will require cooperative efforts among researchers, policymakers, industry stakeholders, and farmers.

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