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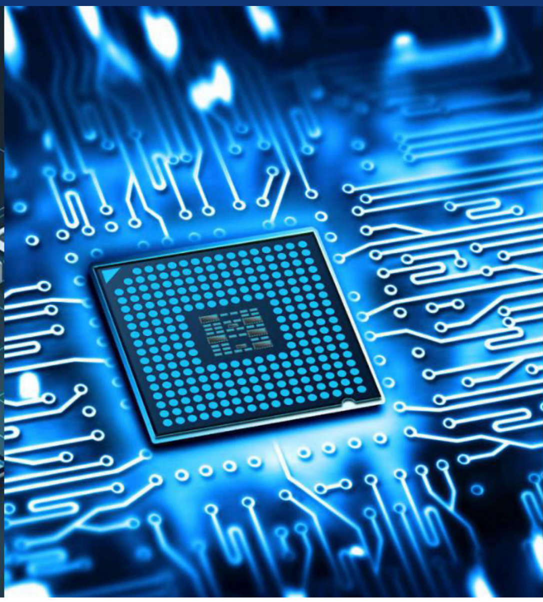


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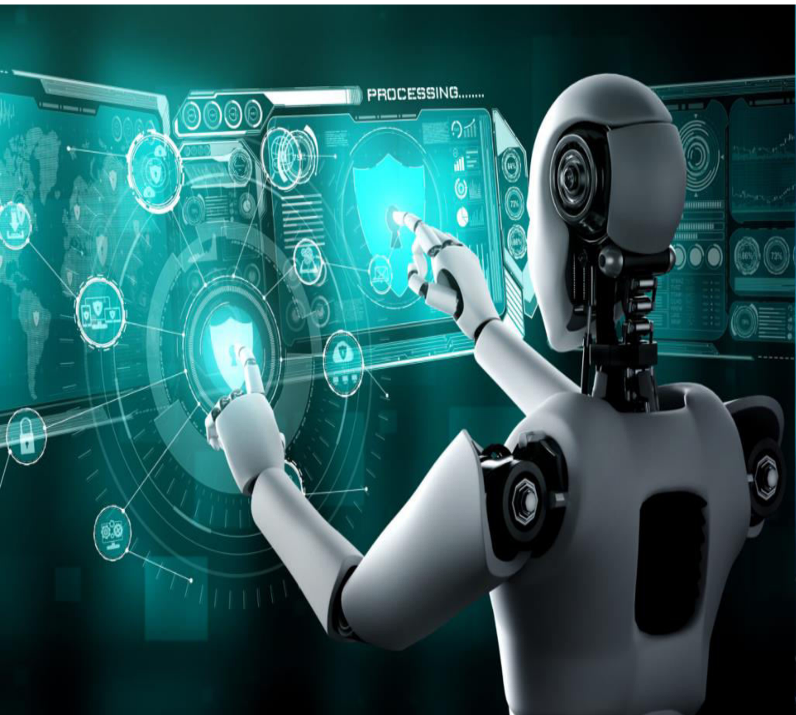

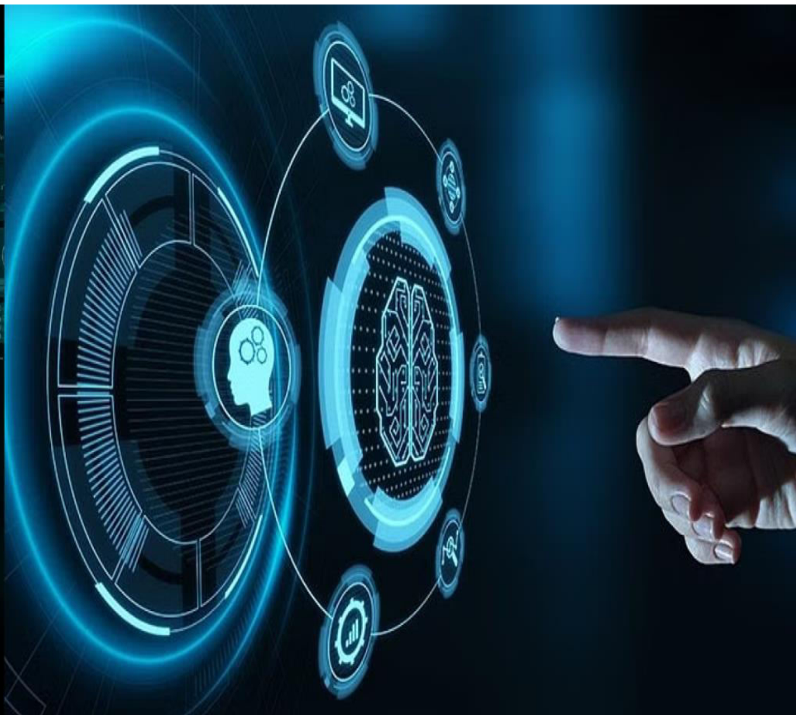

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Comparative Study on Crop Yield Monitoring System in Smart Agriculture

Prof. Sudesh L Farpat, Devdatta Take, Dhruv Sagane, Shankar Barhate, Nikhil Patil

Department of Computer Science and Engineering, Padmashri Dr. V. B. Kolte College of Engineering, Malkapur, India

ABSTRACT: This study introduces a Smart Agriculture Crop Yield Growth Monitoring System to address traditional farming challenges, including manual labour inefficiencies, suboptimal irrigation, and the absence of real-time insights. The system employs an Arduino-powered autonomous vehicle with ultrasonic sensors and motors for obstacleavoiding navigation, coupled with real-time soil moisture, temperature, and humidity monitoring. Data is transmitted wirelessly to a mobile interface, enabling farmers to make informed irrigation and crop management decisions. Key innovations include autonomous field traversal, live environmental parameter updates, and obstacle detection, enhancing operational safety and resource efficiency. Initial testing validated the system's ability to optimize irrigation schedules and reduce human intervention, demonstrating improved crop health and yield predictability. Future enhancements could integrate AI for disease prediction and soil analysis, enabling tailored fertilization strategies to maximize productivity. By merging automation, IoT, and data analytics, this solution modernizes agricultural practices, minimizes resource waste, and supports sustainable farming. The findings underscore the potential of smart technologies to revolutionize crop monitoring, bridging the gap between traditional methods and precision agriculture.

KEYWORDS: Smart Agriculture, Crop Yield Monitoring, Autonomous Navigation, Arduino, IoT, Real-Time Monitoring, Precision Farming, Soil Moisture Sensors, Obstacle Avoidance, Sustainable Farming.

I. INTRODUCTION

The rapid advancements in technology have transformed various sectors, with agriculture being no exception. Traditional farming methods, while essential, are increasingly proving inefficient and unsustainable in meeting the growing demands of global food production .Issues such as excessive manual labour, inefficient irrigation systems, and a lack of real-time data hinder the ability of farmers to make informed decisions, ultimately affecting crop yield and resource management. This has led to the emergence of smart agriculture, a field that integrates modern technologies like the Internet of Things (IoT), sensors, and automation to enhance farming practices and improve productivity.

Current research in smart agriculture emphasizes the potential of autonomous systems, sensor-based monitoring, and data analytics to address these challenges. Studies have demonstrated that integrating real-time environmental data, such as soil moisture, temperature, and humidity, into farming practices can significantly optimize irrigation and crop management. Moreover, autonomous vehicles equipped with sensors for obstacle detection and navigation have shown promise in increasing operational efficiency and reducing manual labour. Research is also expanding into artificial intelligence (AI) applications, such as disease prediction and soil analysis, further enhancing precision farming.

This study focuses on developing a Smart Agriculture Crop Yield Growth Monitoring System that leverages an Arduino-powered autonomous vehicle for real-time monitoring and efficient crop management. By integrating cutting-edge technology into farming, the system aims to reduce resource wastage and improve agricultural productivity.

II. EXISTING TRADITIONAL AGRICULTURAL PRACTICES

Traditional agricultural practices have been the backbone of food production for centuries, relying on manual labour, natural weather patterns, and conventional farming techniques. However, these methods often lead to inefficiencies in resource management and crop yield prediction. The primary challenges in traditional farming include:

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1.Manual Labour Dependency
Farmers rely heavily on manual monitoring and fieldwork, which is time-consuming and labour-intensive. This limits scalability and increases operational costs.

2.Inefficient Irrigation Techniques
Traditional irrigation methods, such as flood and furrow irrigation, often result in excessive water usage, leading to resource wastage and soil degradation. The absence of real-time soil moisture monitoring makes water management less precise.

3. Limited Data Utilization
Decision-making in traditional farming is primarily based on experience and historical trends rather than real-time data. This often results in suboptimal use of fertilizers, pesticides, and water.

4. Lack of Automation
Conventional farming does not integrate automation for tasks like seeding, irrigation, and monitoring. This increases the risk of human error and reduces efficiency in large-scale farming.

5.Unpredictable Yield Estimation
Traditional methods rely on visual inspection and past experiences to predict crop yields, which can lead to inaccuracies due to changing climatic conditions and soil health variations.

Figure 1: Farmer Manually Monitoring Farm

Despite these limitations, traditional farming techniques have played a crucial role in food production. **The integration of modern technologies, such as IoT-based monitoring and automation**, aims to address these inefficiencies while maintaining the fundamental principles of sustainable agriculture.

III. METHODOLOGY

The proposed Smart Agriculture Crop Yield Growth Monitoring System is designed to enhance modern farming by integrating automation, real-time monitoring, and smart decision-making. The system utilizes an Arduino-based autonomous vehicle equipped with ultrasonic sensors, soil moisture sensors, temperature and humidity sensors, and wireless communication to provide live updates to farmers. The primary goal is to address inefficiencies in traditional farming, such as manual labour, resource wastage, and lack of timely insights.

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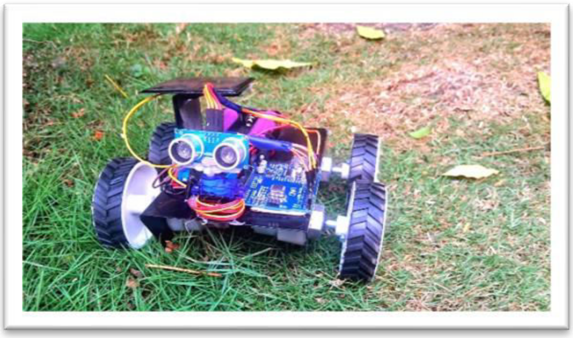

Figure 2: Real-Time Monitoring of Farming Conditions Using Smart Agri Bot

Key Components and Module:

1. Autonomous Navigation

The system features an Arduino-powered vehicle that moves autonomously across the field using ultrasonic sensors and motor drivers. The sensors help detect obstacles and ensure safe movement.

2. Real-time Environmental Monitoring

The vehicle is integrated with multiple sensors to collect critical agricultural data, including:

- Soil Moisture Sensor – Monitors the soil's water content for optimized irrigation.
- Temperature Sensor – Measures ambient temperature to assess crops suitability.
- Humidity Sensor – Determines air moisture levels affecting plant growth.

3. **Wireless Data Transmission**

The collected data is transmitted wirelessly to a mobile application, allowing farmers to monitor real-time field conditions from a remote location. This enables smart decision-making for irrigation, fertilization, and pest control.

4. **Obstacle Detection and Avoidance**

Ultrasonic sensors help the vehicle detect and navigate around obstacles, ensuring uninterrupted movement. This feature prevents collisions and enhances the system's adaptability in different field conditions.

5. **Data Analysis and Smart Recommendations**

The system doesn't just collect data—it also analyse it to help farmers make better decisions. By studying patterns in soil moisture, temperature, and humidity. These recommendations are sent to the farmer's mobile app, where they are displayed in easy-tounderstand charts and alerts. This feature makes farming smarter and more efficient, even for those who aren't tech-savvy. It turns raw data into practical advice, helping farmers grow healthier crops and improve their yields.

This proposed system aims to revolutionize traditional farming by integrating an autonomous vehicle, real-time data monitoring, and wireless communication to enhance crop yield, minimize manual labour, and optimize resource utilization, ensuring a more efficient and sustainable agricultural process.

Comparison between Traditional Agricultural Practices and Modern Smart Agricultural Techniques:

Aspect	Traditional Methods	Modern Smart Techniques
Labour Dependency	High reliance on manual labour for monitoring, seeding, irrigation, and harvesting, leading to increased time and operational costs.	Autonomous Arduino-based vehicle reduces manual effort by automating monitoring, seeding, and irrigation, enhancing scalability and reducing costs.
Irrigation Efficiency	Uses traditional flood and furrow irrigation methods, leading to excessive water usage and soil degradation due to lack of precision.	Soil moisture sensors provide real-time data for optimized irrigation, reducing water wastage and improving soil health.

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Data Utilization	Decisions are based on experience and historical trends rather than real-time data, leading to suboptimal use of resources.	Real-time environmental data (soil moisture, temperature, humidity) is collected and analyzed to provide smart recommendations for irrigation, fertilization, and pest control.
Automation	Minimal automation; manual operations increase the risk of human error and limit large-scale efficiency.	Autonomous navigation with ultrasonic sensors enables automated movement, obstacle detection, and collision avoidance, reducing human intervention.
Yield Prediction	Yield estimation is based on visual inspection and past experience, often leading to inaccuracies.	Data-driven analysis provides accurate yield prediction and insights through a mobile app, allowing better planning and resource allocation.

IV. RESULTS

The system's performance was evaluated through real-time monitoring of key environmental parameters: temperature, humidity and soil moisture. The collected data, visualized in following Figures, illustrates the system's ability to track and respond to changing conditions effectively.

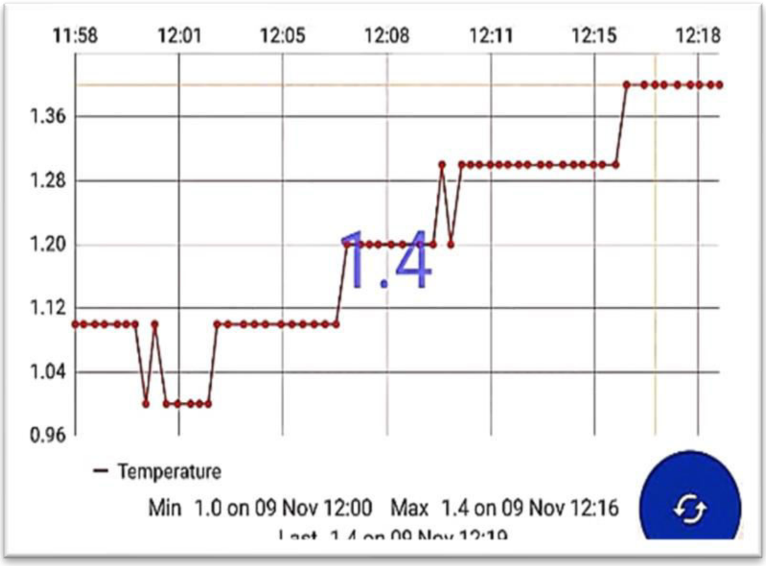

Figure 3: Temperature Monitoring Graph

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Figure 4 : Humidity Monitoring Graph

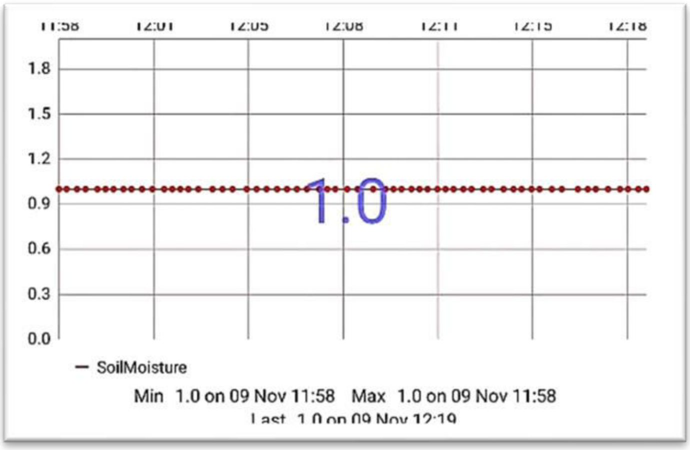

Figure 5 : Soil Moisture Monitoring Graph

V. CONCLUSION

The **Smart Agriculture Crop Yield Growth Monitoring System** is a practical solution to the challenges faced in traditional farming. It uses an Arduino-powered self-driving vehicle equipped with sensors to monitor soil moisture, temperature, and humidity while avoiding obstacles. The data collected is sent to a mobile app, giving farmers realtime updates and helpful advice for better irrigation. This system saves time and resources, promotes sustainable farming, and improves crop yields. Its user-friendly design makes it accessible to all farmers, even those without technical expertise, and its low cost ensures affordability. With future upgrades like AI for disease prediction, this system has the potential to revolutionize farming, making it more efficient and sustainable for the future.

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