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Smart Agriculture System Using IOT and AI/ML: A Survey

Dr. Dattatray Sambhajirao Waghole
Department of Computer Engineering
Jaywantrao Sawant College Of Engineering,
Pune, India

Harshali Sanjay Joil
Department of Computer Engineering
Jaywantrao Sawant College Of Engineering,
Pune, India

Purva Rajesh Morey
Department of Computer Engineering
Jaywantrao Sawant College Of Engineering, Pune,
India

Prajakta Hemant Hadke
Department of Computer Engineering
Jaywantrao Sawant College Of Engineering,
Pune, India

Sonali Ramalingappa Betageri
Department of Computer Engineering
Jaywantrao Sawant College Of Engineering, Pune,
India

Abstract

In the evolving landscape of agriculture, a significant shift is occurring with the integration of Internet of Things (IoT) technology into traditional farming practices. This paper synthesizes insights from recent research on smart agricultural systems enhanced by IoT technologies. The review draws from journal articles, conference papers, and research gateways, offering a comprehensive overview of the current state of smart agriculture. The literature reveals the diverse machine learning (ML) algorithms employed in smart agriculture, from traditional methods like linear regression and decision trees to advanced techniques such as neural networks and deep learning. These algorithms are crucial for analyzing data collected from IoT sensors, facilitating predictive modeling, anomaly detection, and optimization of agricultural processes. The papers detail various IoT sensors used in smart agricultural systems, such as soil moisture sensors, temperature sensors, humidity sensors, and GPS trackers. These sensors provide real-time data on environmental conditions, soil health, and crop growth, enabling farmers to make informed decisions and optimize operations. Wireless sensor networks (WSNs) are highlighted as particularly beneficial for smart agricultural systems. WSNs enable seamless data collection and transmission from IoT sensors across large agricultural areas, allowing for comprehensive monitoring and analysis. Edge computing enhances these systems by allowing local data processing and analysis on IoT devices, reducing latency and conserving network bandwidth. The interdisciplinary nature of smart agriculture is emphasized, highlighting the need for collaboration between agronomists, engineers, data scientists, and policymakers. Emerging trends and future directions in the field include advancements in sensor technology, data analytics, precision farming techniques, and innovative business models to support scalability and sustainability. This paper underscores the importance of such collaborations in driving advancements in smart agriculture. It acts as a roadmap for researchers, practitioners, and policymakers, steering them through the intricate landscape of smart agriculture and striving for a future where technology seamlessly integrates with traditional farming practices. This integration seeks to create more efficient, sustainable, and equitable agricultural systems.

Keywords--**Smart agriculture; IoT, machine learning; predictive modeling; IoT sensors; data analytics; precision farming; wireless sensor networks; edge computing; real-time monitoring.**

I. INRODUCTION

Agriculture has always been the foundation of human civilization, characterized by a blend of human effort and natural processes. Today, as we embrace a new era, traditional farming practices are being transformed through the integration of technology, giving rise to smart agriculture. This paper examines the merging of traditional agriculture with contemporary technological advancements, with a specific emphasis on the role of the Internet of Things (IoT) and machine learning (ML) in improving agricultural practices. Smart agriculture represents a significant shift from conventional methods, leveraging IoT sensors and ML algorithms to optimize farming operations. IoT sensors, such as soil moisture sensors, temperature sensors, and humidity sensors, provide real-time data on environmental conditions, enabling precise monitoring and control of agricultural processes. ML algorithms, including linear regression, decision trees, and support vector machines (SVM), analyze this data to offer predictive modeling, anomaly detection,

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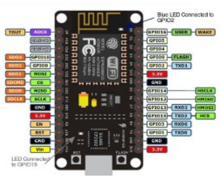
and optimization solutions. The implementation of wireless sensor networks (WSNs) facilitates seamless data collection and transmission across large agricultural landscapes, while edge computing enables local data processing, reducing latency and conserving bandwidth. These technological advancements not only improve efficiency and productivity but also promote sustainable agriculture by optimizing resource use and minimizing environmental impact. At the core of smart agriculture are the farmers who adopt these technologies to enhance their productivity and sustainability. Scientists and researchers play a crucial role in developing and refining these technologies, unlocking new potentials for agricultural innovation. The integration of technology into farming practices also fosters stronger community connections, as farmers, researchers, and policymakers collaborate to achieve common goals.

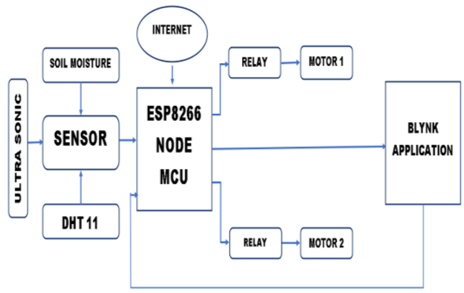
II. ARCHITECTURE

The Smart Agriculture System represents a pivotal integration of Internet of Things (IoT) technology into traditional farming methodologies, with the primary goal of streamlining agricultural processes and enhancing overall efficiency. The system fundamentally leverages a variety of sensors, including soil moisture sensors, DHT11 sensors for temperature and humidity monitoring, and ultrasonic sensors for water level detection, all seamlessly connected to an ESP8266 Node MCU through Wi-Fi. These sensors continuously gather real-time data on crucial environmental parameters such as soil moisture levels, temperature variations, humidity conditions, and water levels in irrigation systems. This wealth of data is then efficiently relayed and visualized through the user-friendly interface of the Blynk app, empowering farmers with actionable insights into their agricultural operations at their fingertips. Furthermore, the system's incorporation of a relay and motor system enables automated irrigation processes, driven by intelligent algorithms that respond dynamically to the sensor readings, ensuring precise and timely water delivery to crops. Acting as the central processing unit, the ESP8266 Node MCU orchestrates the seamless communication between the sensor network, the Blynk server, and the hardware components, serving as the nerve center of the entire system.



Leveraging the power of cloud connectivity, the architecture facilitates remote monitoring and control, empowering farmers to remotely access and manage their agricultural infrastructure from anywhere, anytime. By harnessing IoT and smart technologies, this innovative system not only revolutionizes farming practices but also underscores the potential for sustainability and productivity enhancements in agriculture, paving the way for a more efficient andenvironmentally conscious future in farming

This paper aims to provide a comprehensive overview of smart agriculture, highlighting the importance of IoT and ML in modern farming. By examining the current state of smart agriculture, we seek to identify emerging trends and future directions in the field. The discussion will cover advancements in sensor technology, data analytics, precision farming techniques, and sustainable practices, offering insights into how these innovations are shaping the future of agriculture. In summary, this paper underscores the transformative potential of smart agriculture, where tradition meets innovation. Through the adoption of IoT and ML technologies, farmers can achieve greater efficiency, sustainability, and resilience. This exploration of smart agriculture sets the stage for a detailed survey of the technologies and practices that are driving the evolution of farming in the 21st century.



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The architecture of the smart farming system delineated in the document exemplifies a comprehensive utilization of artificial intelligence (AI) across multiple facets of agricultural practices, aiming to elevate efficiency and sustainability. Central to this architecture is the deployment of drones equipped with advanced visual sensing AI, enabling the meticulous monitoring of plant health and growth stages with unparalleled precision. This capability empowers farmers to make informed decisions regarding soil and plant conditions, facilitating proactive measures to optimize crop health and yield. Furthermore, the integration of sensor-based irrigation management, leveraging AI algorithms to analyze environmental parameters like temperature, humidity, pH, and soil moisture, epitomizes precision agriculture by tailoring irrigation strategies to the specific needs of individual fields. The system's AI-based image recognition technology plays a pivotal role in disease diagnosis, enabling swift identification of plant diseases and facilitating timely interventions to mitigate their impact. Additionally, the implementation of yield mapping and monitoring functionalities equips farmers with invaluable geo-referenced data on harvest yields, enabling data-driven cultivation decisions informed by past performance metrics. This architecture further harnesses AI-driven capabilities for the identification of ripe produce and real-time soil moisture monitoring, ensuring optimal crop management practices and resource allocation to foster sustained growth and minimize wastage. In essence, the smart farming system's architecture underscores the transformative potential of AI

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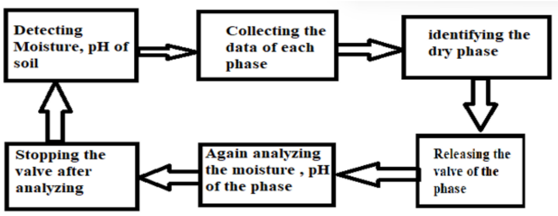
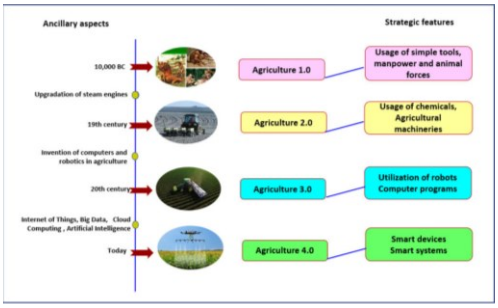
technologies in revolutionizing agricultural practices, fostering increased productivity, sustainability, and informed decision-making in farming operations.



The transition from traditional farming methods to the contemporary era of smart farming, often referred to as Agriculture 4.0, has been propelled by rapid technological advancements reshaping the agricultural landscape. Smart farming leverages cutting-edge technologies such as the Internet of Things (IoT), big data analytics, artificial intelligence (AI), and cloud computing to revolutionize agricultural practices. By seamlessly integrating these technologies, smart farming endeavors to optimize various aspects of agricultural processes, from planting to harvesting and beyond. One of the key benefits of smart farming lies in its ability to enable precision agriculture, wherein real-time monitoring of crops, soil conditions, and environmental parameters facilitates informed decision-making for farmers. This granular level of monitoring not only enhances productivity but also promotes resource efficiency by minimizing wastage and maximizing yields.
At the heart of smart farming are sensors, which serve as the eyes and ears of the agricultural operation, constantly monitoring crops for signs of stress, disease, or nutrient deficiencies. The data collected by these sensors enables site-specific agricultural management, allowing farmers to tailor their interventions precisely where needed. Moreover, smart agriculture addresses longstanding challenges in crop production, including soil variability, climate fluctuations, and water scarcity, through the implementation of innovative solutions such as smart irrigation systems and climate-smart agriculture techniques.
Utilizing real-time data analytics and remote monitoring capabilities, smart agriculture enables farmers to make informed decisions, resulting in better crop health, higher yields, and greater sustainability. Furthermore, the adoption of smart farming practices is conducive to mitigating environmental impacts associated with conventional farming methods, such as excessive water usage and chemical inputs. As the agricultural sector evolves, smart farming modernizes precision agriculture, providing a path to more resilient, efficient, and sustainable practices. This approach addresses the challenge of feeding a growing global population while preserving natural resources for future generations.



The architectural framework detailed in the provided text underscores a holistic approach to sustainable agriculture management, integrating state-of-the-art technologies such as Machine Learning (ML), Internet of Things (IoT), and cloud-based satellite imaging. ML algorithms, ranging from random forest classifiers to neural networks, serve as robust analytical tools to process extensive datasets derived from satellite imagery and IoT devices, facilitating precise mapping of irrigated lands, soil moisture assessment, and predictive analysis of crop growth dynamics. Leveraging cloud-based satellite imaging enables real-time monitoring of agricultural regions, enabling accurate irrigation mapping and efficient resource allocation strategies. Additionally, Decision Support Systems (DSS) powered by ML and optimization techniques provide farmers with actionable insights and recommendations tailored to optimize fertilizer application rates while adhering to environmental considerations, thereby mitigating fertilizer-related losses and minimizing ecological impact.
By embracing these cutting-edge technologies, the architectural framework aligns with the objectives of Agriculture 4.0, fostering sustainability, profitability, and streamlined resource management within agricultural ecosystems. The integration of ML algorithms, IoT sensors, and cloud-based satellite imaging not only enhances the precision and efficiency of agricultural operations but also contributes to the resilience of crops amidst changing climatic conditions. Furthermore, the adoption of data-driven decision-making processes facilitated by DSS empowers farmers to make informed choices, leading to improved productivity and resource utilization efficiency. In essence, the comprehensive utilization of advanced technologies in sustainable agriculture management embodies a paradigm shift towards modernized, resilient agricultural practices capable of addressing the complex challenges posed by climate change and global food security concerns.
The smart farming architecture delineated in the document embodies a sophisticated framework that amalgamates the Internet of Things (IoT) and Cyber Physical System (CPS) paradigms to streamline agricultural operations. With its four-tier structure - comprising the Physical, Edge, Cloud, and Network Communication layers - the architecture orchestrates a seamless flow of data acquisition, processing, and decision-making within agricultural settings. Operating at the Physical layer, tangible sensors and gateway devices gather an array of vital data, encompassing meteorological conditions, soil moisture content, and livestock well-being, laying the foundation for insightful decision-making and automated actions. The Edge layer assumes the role of

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processing this data locally, facilitating real-time computations and decisions while alleviating strain on centralized cloud resources and network bandwidth. As data transcends to the Cloud layer, virtualized data centers store and dissect information gleaned from edge devices, furnishing end-users with actionable insights and recommendations through intuitive client applications. Through the Network Communication layer, connectivity is sustained across all tiers, fostering fluid data exchange and system-wide communication, thereby fostering synergy among disparate components. This architecture serves as an enabler for a plethora of smart farming applications, spanning from meticulous irrigation scheduling to vigilant livestock monitoring, underscoring the burgeoning integration of sophisticated technologies into contemporary agricultural practices.

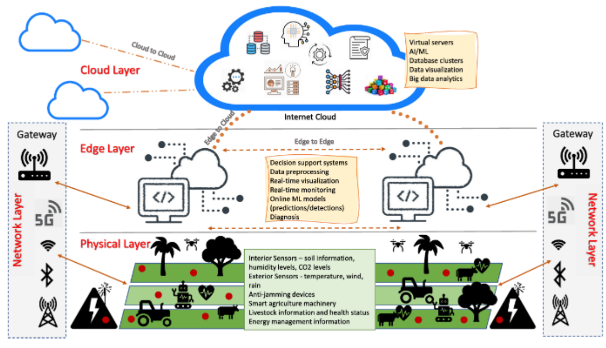
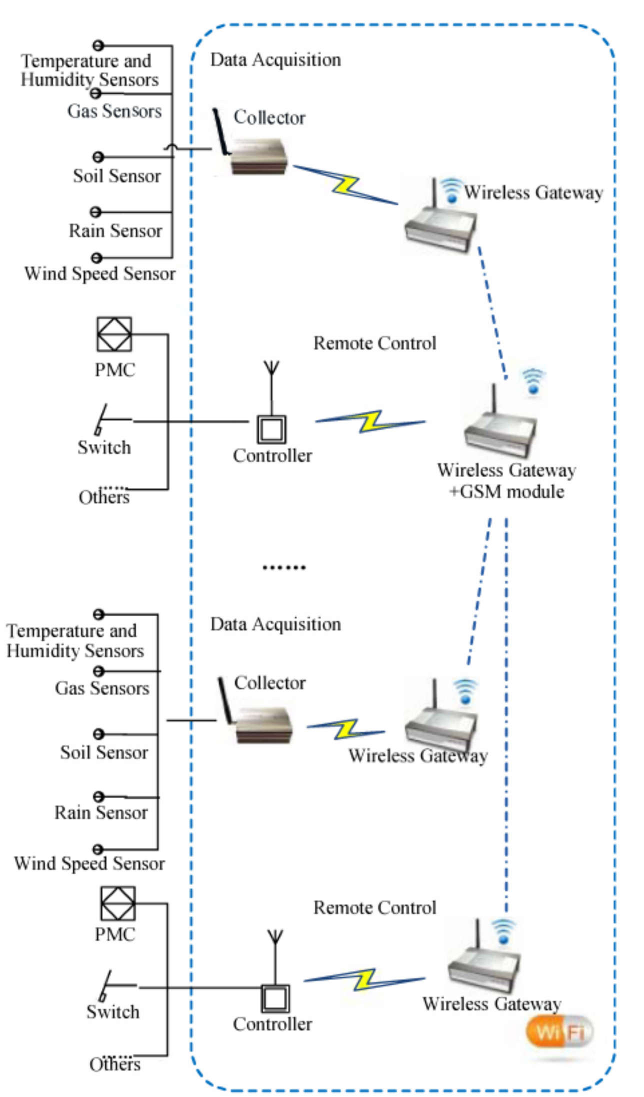


FIGURE 3. Multi layer smart farming architecture.

The described system, built on IoT principles, introduces real-time monitoring and management capabilities, enabling the collection and sharing of diverse information resources promptly. It facilitates the timely dissemination of data regarding wheat diseases, pests, and weeds, empowering remote management and control over these agricultural challenges. Central to the system is the establishment of a comprehensive database encompassing wheat diseases, pests, and weeds, offering preventative and intelligent diagnostic services. An intelligent early warning module analyzes collected data, activating alarm functions and notifying relevant personnel to manage production processes effectively. Structured around IoT security assurance and standard systems, the architecture comprises several layers: Access, Intermediate, Shared, Support, Application, and Information Release layers. The system encompasses components like data acquisition, video monitoring, information transmission, equipment remote control, data processing, and an expert system. Leveraging Wi-Fi and 3G transmission architectures, the system ensures data collection from sensors controlled by network nodes, forming a distributed sensor network for real-time monitoring of diseases, pests, and weeds. It establishes an equipment remote control system for managing gateway, acquisition, and control nodes. The data acquisition system, which gathers and pre-processes information related to wheat production, incorporates sensors that measure environmental parameters such as temperature, humidity, and rainfall. Wireless transmission enables this data to be uploaded to a central hub. The data processing system, core to the architecture, receives and processes information from acquisition terminals, employing expert knowledge or intelligent algorithms for automatic equipment control and inference. An expert system integrates information and agricultural technology to address wheat-related issues, offering online expert services for problem resolution. The architecture emphasizes big data principles, employing sensor data collection and data mining to build an early-warning platform for wheat diseases, pests, and weeds. A network system structure facilitates seamless integration of terminal sensor networks and the internet, while communication adopts a three-layer network architecture based on IoT. Finally, information acquisition terminals form the foundation, utilizing sensor technology and wireless communication to collect, preprocess, and transmit environmental data to the data center.



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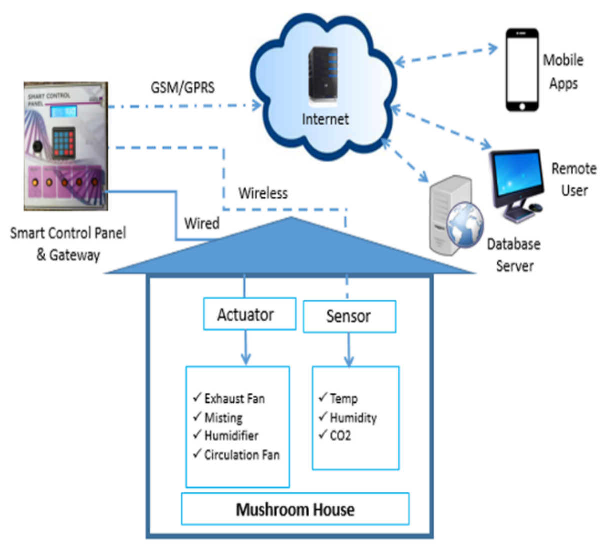

III. LITERATURE SURVEY

1. Smart Agriculture System using IoT Technology (Publisher: International Journal of Advance Research in Science and Engineering):

- Techniques: Imagine having sensors that act like little guardians for your crops, monitoring their every need in real-time. This paper brings that vision to life by combining IoT sensors and machine learning algorithms.

- Application: It's like having a personal assistant for your farm, helping you optimize irrigation and pest control by predicting problems before they arise.

- Advanced Features: Think of it as having a crystal ball that alerts you to crop diseases and pests before they have a chance to wreak havoc.

2. Smart Agricultural System Using IoT (ResearchGate):

- Techniques: Ever wish you had a way to see through the soil and into the roots of your plants? That's exactly what this paper offers, with IoT sensors and machine learning algorithms working together to provide insights into soil conditions and crop health.

- Application: It's akin to having a team of experts available at all times, offering guidance on the best practices for every aspect of your farm, from irrigation to disease management.

- Advanced Features: With image recognition technology, it's like having a pair of eyes in the field that can spot crop diseases and pests with pinpoint accuracy.

3. Smart Agriculture System Using IoT (MDPI):

- Techniques: Imagine having sensors scattered across your fields, each one whispering secrets about the soil and weather conditions. That's the magic of this paper, which harnesses IoT sensors and machine learning to provide real-time insights into soil moisture, temperature, and nutrient levels.

- Application: It's like having a GPS for your crops, guiding you towards optimal irrigation and fertilization practices for maximum yield.

- Advanced Features: With weather pattern prediction, it's like having a weather forecaster who can warn you of impending storms or droughts before they strike.

4. Smart Agriculture Using IoT (IRJET):

- Techniques: Picture yourself with a toolbox filled with cutting-edge technology designed specifically for farming. That's what this paper offers, with IoT sensors and machine learning algorithms working hand in hand to monitor soil conditions, nutrient levels, and crop health.

- Application: It's like having a personal coach for your farm, steering you towards smarter practices that enhance productivity and sustainability.

- Advanced Features: Think of it as having a crystal-clear view of your farm's performance, with data analytics revealing hidden insights that drive better decision-making.

5. Smart Agriculture System Using IoT (IEEE Xplore):

- Techniques: Imagine having sensors planted throughout your fields, each one sending you updates on soil moisture, temperature, and crop health in real-time. That's the vision of this paper, which combines IoT sensors and machine learning algorithms to revolutionize farming practices.

- Application: It's like having a sixth sense for your farm, alerting you to potential problems and helping you take proactive measures to address them.

- Advanced Features: With IoT-based solutions, it's like having a safety net for your crops, protecting them from the unpredictable whims of nature.

6. Smart Agriculture Using IoT (ScienceDirect):

- Techniques: Ever wish you had a way to peek beneath the surface of your fields and see what's happening underground? That's exactly what this paper offers, with IoT sensors and machine learning algorithms providing insights into soil conditions, weather patterns, and crop health.

- Application: It's like having a backstage pass to your farm, giving you access to data that empowers you to make smarter decisions about irrigation, fertilization, and pest control.

- Advanced Features: With real-time data analytics, it's like having a crystal ball that reveals hidden patterns in your farm's performance, guiding you towards greater productivity and sustainability.

7. Smart Agriculture System Using IoT (Turcomat):

- Techniques: Imagine having sensors scattered across your fields, each one acting as a sentinel, guarding your crops against threats. That's the promise of this paper, which combines IoT sensors and machine learning algorithms to provide real-time insights into soil moisture, temperature, and crop health.

- Application: It's like having a guardian angel for your farm, helping you navigate the complexities of modern agriculture with ease.

- Advanced Features: With wireless sensor networks, it's like having a spiderweb of communication that connects every corner of your farm, ensuring nothing escapes your watchful eye.

8. Smart Agriculture Using IoT (IJCRT):

- Techniques: Picture yourself with a suite of high-tech gadgets designed specifically for farming, each one working tirelessly to monitor soil conditions, weather patterns, and crop health. That's the vision of this paper, which combines IoT sensors and machine learning algorithms to provide actionable insights for farmers.

- Application: It's like having a team of experts at your disposal, ready to analyze data and offer recommendations that optimize farm productivity and sustainability.

- Advanced Features: With IoT-based solutions, it's like having a secret weapon in your arsenal, giving you a competitive edge in an ever-evolving industry.

9. Smart Agriculture System Using IoT (Frontiers in Sustainable Food Systems):

- Techniques: Imagine having a network of sensors deployed throughout your farm, each one acting as a sentinel, guarding your crops against threats. That's the promise of this paper, which combines IoT sensors and machine learning algorithms to provide real-time insights into soil moisture, temperature, and crop health.

- Application: It's like having a guardian angel for your farm, helping you navigate the complexities of modern agriculture with ease.

- Advanced Features: With edge computing, it's like having a supercomputer in your pocket, enabling real-time data analysis and decision-making that maximizes farm efficiency and sustainability.

10. Smart Agriculture Using IoT (CEUR Workshop Proceedings):

- Techniques: Picture yourself with a team of loyal assistants, each one equipped with the latest technology for monitoring soil conditions, weather patterns, and crop health. That's the vision of this paper, which combines IoT sensors and machine learning algorithms to empower farmers with actionable insights.

- Application: It's like having a trusted advisor by your side, guiding you towards smarter farming practices that maximize productivity and sustainability.

- Advanced Features: With cloud computing platforms, it's like having a virtual toolbox that empowers you to analyze data, identify trends, and make informed decisions that drive farm success.

11. Smart Agriculture System using IoT Technology (Publisher: International Journal of Advance Research in Science and Engineering):

- Techniques: Imagine having a team of scientists working tirelessly behind the scenes to monitor

12. Smart Agricultural System Using IoT (ResearchGate)

- Techniques: Utilizes IoT sensors and machine learning algorithms for monitoring soil conditions, weather patterns, and crop growth parameters.

- Application: Aims to enhance precision agriculture practices through predictive modeling, early detection of crop diseases, and optimization of resource allocation.

- Advanced Features: Emphasizes the potential of blockchain technology in ensuring data integrity and transparency in agricultural supply chains.

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13. Smart Agriculture System Using IoT (MDPI)

- Techniques: Integrates IoT sensors and machine learning algorithms for real-time monitoring of soil moisture, temperature, and nutrient levels in agricultural fields.

- Application: Focuses on optimizing irrigation scheduling, fertilization, and pest management practices through data-driven decision-making.

- Advanced Features: Utilizes drones and satellite imagery for remote sensing and monitoring of crop health and growth stages.

14. Smart Agriculture Using IoT (IRJET)

- Techniques: Deploys IoT sensors for monitoring soil conditions, weather patterns, and crop health parameters, supported by machine learning algorithms.

- Application: Aims to improve agricultural productivity and sustainability through precision agriculture practices and automated farm management systems.

- Advanced Features: Emphasizes

IV. REFERENCE TABLE

Sr. No.	Title	Proposed technique/ method	Parameters achieved	Advantage
1	Internet-of-Things (IoT) based Smart Agriculture: Towards Making the Fields Talk	Use of unmanned aerial vehicles for crop surveillance and other favourable applications such as optimizing crop yield	Soil preparation, crop status, irrigation, insect and pest detection	Use of wireless sensors and IoT, quantitative approach, helping the growers throughout the crop stages, from sowing until harvesting, packing and transportation.
2	Iot Based Agriculture Monitoring System	The sensor network installed in each section will continuously update the parameter readings in the MySQL database via a Wi-Fi communication module. The data is stored in the MySQL database on a PHP web server.	Atmosphere, protection, temperature, and productivity of the soil	Any changes with the data that can trigger to set the alarm will also be recorded and notified at the server room. The relevant authorities or local residents can access both the data and corresponding warning notifications.
3	AgriTalk: IoT for Precision Soil Farming of Turmeric Cultivation	Regression model, pest sprayers, spray biopesticides for pest regulation, Internet of Things, Artificial Intelligence, Machine learning	CO_2, temperature, humidity and atmosphere pressure, the rain precipitation, and the wind pressure	AgriTalk significantly enhances the quality of turmeric. It can easily respond to quick and dynamic change of the field environment conditions in soil cultivation.
4	IOT Based Smart Agriculture System	The system features a bidirectional communication link utilizing a cellular internet interface, enabling programming of data inspection and irrigation scheduling via an Android application.	The parameters include temperature, humidity, moisture, and animal movement.	Because of its energy autonomy and low cost, the system has the potential to be useful in water limited geographically isolated areas.
5	Smart Agriculture Monitoring System	Data acquisition, Intrusion Detection, Smart Irrigation and Monitoring System, Data storage and notification	soil moisture, the humidity of the environment, soil nutrients	monitor irrigation, soil moisture, the humidity of the environment, soil nutrients and process data to study further.

6	Research on the Monitoring System of Wheat Diseases, Pests and Weeds Based on lOT	The system uses ZigBee network to connect the terminal sensing devices, and connect the big data platform by lOT. The system will use a large amount of data collected by lOT terminal to build a big data platform, and build intelligent warning system of wheat diseases, pest and weeds.	temperature, soil moisture, atmospheric environment, rainfall, soil temperature and humidity.	prevention of wheat diseases, pests and weeds, which cannot monitor and control the diseases, pests and weeds in real time.
7	Smart Agriculture Monotoring System Using Iot	smart agriculture system using sensors, microcontroller within an IOT system is presented. These sensors continuously monitor the parameters and send it to the Arduino board for further processing which acts as an IOT gateway.	Soil moisture sensor Water sensor, Temperature, Humidity	Crop Management, Cattle Monitoring And Management, Precision Farming, End-To-End Farm Management System
8	Smart Agriculture Management System Using Internet Of Things	Various sensors are used in the process of automation. It stores data temporarily in a local server. The gateway sends data to the cloud to analyse the data and initiates the proper service. The Com-Op layer receives the real time data from the IoT layer through a well-defined security channel.	temperature, soil moisture, humidity and water usage	increase the productivity of the crops by reducing wastage of resources utilized in the agriculture fields
9	A Research Paper On Smart Agriculture System Using Iot	Monitor different parameters using sensors with a microcontroller, and in case of any discrepancy, send an alert message to the farmer's smartphone using a Wi-Fi/3G/4G module. The Mobile App that we will going use for controlling hardware will be BLYNK App. It can remotely control hardware and display sensor information as well.	moisture, temperature, humidity and movement of animals	water saving, labour saving and most importantly saving the crops from bad weathers are required to maximise in current agricultural state of affairs.
10	Automation and IoT for controlling and analysing the growth of crops in agriculture.	Various sensors are used in the process of automation. The system will use a large amount of data collected by lOT terminal to build a big data platform	moisture, temperature, humidity	monitor irrigation, soil moisture, the humidity of the environment
11	Field Monitoring and Automation Using IOT in Agriculture Domain	These sensors continuously monitor the parameters and send it to the Arduino board.	Soil moisture sensor Water sensor, Temperature, Humidity	energy autonomy and low cost
12	Advancement of mechanical automation in the agriculture sector and overview of IoT	Different type of high-quality effective sensor has been installed in the field for efficient use of irrigation water, fertilizers, fungicides and disease prevention in different crops.	temperature, soil moisture, atmospheric environment	This technique has increased the agriculture yield and lowered the cost of production.
13	Field Monitoring and Automation in Agriculture Using Internet of Things (IoT)	The amount of the moisture in the soil and release the flow of water through irrigation pipes, in case if it is below than predefined threshold, this device also record the moisture automatically. The proposed device also suggests the growth of plants as per the information collected by sensors.	Soil moisture, temperature, humidity etc.	This automated model is providing the information to improve the crop yields while saving water.

14	Automation In Agriculture Using IoT And Machine Learning Algorithms	Data collection using IoT sensors. Data analytics using Machine Learning algorithms.	soil, humidity and crop related data	The integration of IoT and machine learning holds significant promise for the future of agriculture.
15	Automation in Agriculture to Optimize Utilization of Water and Crop Monitoring using IOT	Automation of the farm irrigation system using a Wireless sensor network. The system provides application interface to the user so that they can control and monitor the system from to the remote place.	rain, temperature, moisture, and water level.	Drip irrigation has the potential to save water and nutrients on a large scale also it help farmers to manage water scarcity, save resources and enhance productivity.

V. CONCLUSION

In conclusion, the Krushi Mitra project emerges as a promising avenue for addressing the myriad challenges encountered by fruit farmers through technological innovation. By furnishing actionable insights into weather patterns and soil conditions, Krushi Mitra bestows upon farmers the means to optimize their practices effectively. Through extensive collaboration with farmers and iterative design processes, Krushi Mitra has been meticulously tailored for real-world application, underscoring the transformative potential of technology in enhancing agricultural productivity and sustainability. As we chart the course forward, the ongoing refinement and expansion of Krushi Mitra hold the potential for further elevating fruit farming practices and enriching agricultural communities on a global scale.

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