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A SECURE ARTIFICIAL INTELLIGENCE AGRICULTURE MONITORING SYSTEM

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Abstract
Smart applications are becoming more prevalent in agriculture, particularly in rural areas, intending to improve agricultural standards. These applications utilize various ICT-enabled services, such as automated monitoring and data privacy, to gather and exchange data among trusted users through a centralized intermediary. However, a centralized intermediary is susceptible to problems such as data loss, single point of failure, and man-in-the-middle attacks. To address these issues, blockchain-based smart contracts provide a decentralized and secure alternative for automated control in intelligent agriculture. As the world's population grows, the demand for fresh and healthy products is increasing significantly, and the farming and food production industries must dramatically increase their yields in a short amount of time. While there has been much research in the field of smart farming, issues such as storing data on a central server and providing complete product details from beginning to end, have not been fully addressed. This paper proposes a new blockchain-based solution for secure and intelligent monitoring of agricultural lands.

I. INTRODUCTION

Agriculture is one of the oldest and most important industries in the world, providing food and raw materials for human consumption and industry. With the world's population overgrowing, there is a critical need to increase agricultural productivity while maintaining sustainable practices. In recent years, innovative technologies have been increasingly adopted in agriculture, which enables better management and monitoring of farming activities.

Innovative technologies, including the Internet of Things (IoT), artificial intelligence (AI), and blockchain, are revolutionizing agriculture by enabling farmers to make more informed decisions based on real-time data. In this context, smart agriculture refers to the use of these technologies to improve agricultural practices, increase yields, and reduce costs.

One significant challenge in intelligent agriculture is the secure and reliable data-sharing between stakeholders. Data sharing is crucial for agricultural practices, including monitoring crop growth, managing resources, and assessing environmental conditions. However, using centralized intermediaries for data sharing is plagued by several issues, such as single point of failure, risk of data loss, and man-in-the-middle attacks. Blockchain-based smart contracts provide a decentralized and secure alternative for data sharing in intelligent agriculture, enabling fast and reliable data sharing between stakeholders.

In this paper, we propose a blockchain-based innovative and secure agricultural monitoring system to address the challenges of data sharing in intelligent agriculture. The proposed method utilizes IoT devices for data collection and shares data through a decentralized network of nodes secured through blockchain technology. This system provides a transparent and secure platform for stakeholders to share data, increasing the efficiency of agricultural practices.

The increasing demand for high-quality, fresh, and healthy products has put tremendous pressure on

the agricultural sector to produce more, while maintaining sustainable practices. To meet this challenge, we need to implement innovative and advanced technologies that enable better management and monitoring of agricultural activities. In this context, blockchain technology provides a secure and transparent way to share data, which is essential for effective decision-making in smart agriculture.

This paper is organized as follows. Section 2 provides a literature review of existing research on smart agriculture and blockchain-based solutions. Section 3 describes the proposed blockchain-based innovative and secure agricultural monitoring system in detail, including the system architecture and components. Section 4 presents the evaluation of the proposed method, including the performance and security analysis. Finally, Section 5 concludes the paper and provides directions for future work.

This paper contributes to smart agriculture by proposing a blockchain-based innovative, and secure agricultural monitoring system. The proposed method provides a safe and transparent platform for stakeholders to share data, enabling better decision-making in intelligent agriculture. The use of blockchain technology offers an innovative and secure approach to data sharing, which is essential for smart agriculture's effective management and monitoring.

II. RELATED WORK AND BACKGROUND

1) Node: Internet of things refers to many physical devices globally connected for collecting and sharing data. Arrival of super- cheap computer chips has made it possible to make anything, whether small or large, a part of IoT. All these different devices are connected, and sensors are added to them, which provides them a level of digital intelligence, which are otherwise dumb, and enables them to communicate real-time data without any human intervention.

2) Smart Contract: A smart contract is simply a com- puter program or any transaction protocol that runs on Ethereum virtual machines. It is a digital contract which gets executed each time automatically when some conditions or requirements are met. Smart Contracts are used for exchanging money, shares, property etc. Each time some transaction takes place, some gas is provided to the contract from the owner’s account, and the contract executes itself.

3) Ethereum: Ethereum is an open-source, blockchain based, decentralized software platform used for writing smart contracts or maintaining and publishing distributed applications. The contract deployed runs on the Ethereum Virtual Machine. It uses the digital cur- rency, ether, for each transaction. It is also used for trading of digital currencies.

4) Metamask: A Metamask is an extension for accessing Ethereum enabled distributed applications, or “Dapps,” in any browser. It acts as a wallet for the Ethereum platform. An account is created for each user on the metamask, and ether is deposited and withdrawn from the charge depending on the transaction. It allows web applications to read and interact with the Ethereum blockchain.

5) Gas: Gas in blockchain technology simply refers to the fee or pricing value that is provided for each initiating

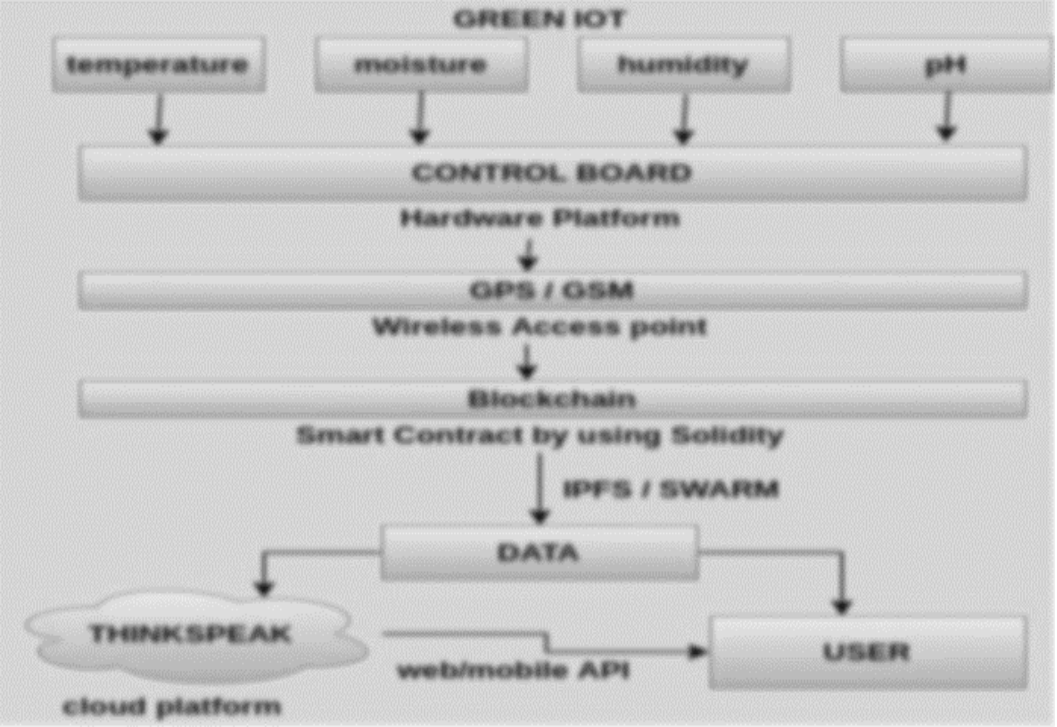

Fig. 1. Proposed Blockchain Based Green IoT Agricultural Monitoring

transaction. Each of the miners involved in validating a transaction also gets ether which is the sum of total gases used by them during verification.

6) Miners: Miners are the volunteers that validate and maintain the transaction in the blockchain. For each new transaction, it must be checked and put on the blocks. The miners solve cryptographic puzzles to find the corresponding hash of the transactions. For the mining process, they are given some currencies for their work.

III. SYSTEM ARCHITECTURE FOR THE PROPOSED FRAMEWORK

The proposed blockchain-based innovative and secure agricultural monitoring system is designed to provide a safe and transparent platform for stakeholders to share data. The system utilizes IoT devices for data collection and a decentralized network of nodes secured through blockchain technology for data sharing.

The system architecture consists of the following components:

1. IoT Devices: The system utilizes IoT devices, such as sensors and cameras, for data collection. These devices collect data on various parameters, such as temperature, humidity, soil moisture, and crop growth, and transmit the data to the blockchain network.
2. Blockchain Network: The system utilizes a blockchain network for secure and transparent data sharing. The blockchain network is a decentralized network of nodes, each with a copy of the entire blockchain. The web is secured through consensus mechanisms, such as proof of work or proof of stake, to ensure the integrity of the data.
3. Smart Contracts: Smart contracts are self-executing contracts with the terms of the agreement between buyer and seller being directly written into lines of code. In the proposed system, smart contracts are used to automate the execution of transactions between stakeholders. For example, a smart contract can be used to automate the payment of farmers for their produce.

4. User Interface: The user interface provides a platform for stakeholders to access and interact with the system. The user interface is designed to be user-friendly and easy to navigate, allowing stakeholders to access the data they need and perform transactions.
5. Data Storage: The system utilizes a distributed database for data storage. The distributed database is a collection of databases spread across the network, enabling stakeholders to access and share data.

The flow of data in the proposed system is as follows:

1. IoT devices collect data on various parameters, such as temperature, humidity, soil moisture, and crop growth.
2. The data is transmitted to the blockchain network, which is stored in a distributed database.
3. Smart contracts are used to automate transactions between stakeholders, such as the payment of farmers for their produce.
4. The user interface provides a platform for stakeholders to access and interact with the system, allowing them to access the data they need and perform transactions.
5. The data stored in the distributed database is accessible to all stakeholders, enabling them to make informed decisions based on real-time data.

The proposed system architecture provides a secure and transparent platform for stakeholders to share data, enabling better decision-making in intelligent agriculture. The use of blockchain technology offers a decentralized and safe approach to data sharing, addressing the issues of data loss, single point of failure, and man-in-the-middle attacks. Overall, the proposed system has the potential to improve agricultural practices, increase yields, and reduce costs, contributing to a sustainable and efficient agricultural sector.

Methodology

The methodology for implementing the proposed blockchain-based smart and secure agricultural monitoring system involves the following steps:

1. Requirements gathering: The first step in the methodology is to gather requirements from stakeholders, such as farmers, distributors, and consumers. The requirements gathering process will involve interviews, surveys, and focus groups to identify the needs and pain points of the stakeholders.
2. System design: Based on the requirements gathered, the next step is to design the system architecture. The system design will involve identifying the IoT devices, blockchain network, smart contracts, user interface, and data storage components required for the system.
3. Development: The development phase involves building and configuring the components of the system. This includes setting up the IoT devices, configuring the blockchain network, developing smart contracts, making the user interface, and setting up the distributed database for data storage.
4. Testing: The testing phase involves testing the system for functionality, performance, and security. This includes testing the IoT devices for data collection, testing the smart contracts for automation of transactions, testing the user interface for usability, and testing the security of the blockchain network.
5. Deployment: The deployment phase involves deploying the system in the production environment. This includes configuring the system for production use, training stakeholders on how to use the system, and ensuring that the system is running smoothly.

6. Maintenance and Support: The final phase of the methodology involves maintaining and supporting the system. This includes monitoring the system for issues, addressing any bugs or security vulnerabilities, and providing support to stakeholders as needed.

The methodology for implementing the proposed system will follow an iterative approach, where each phase of the method will be repeated as needed to ensure that the system meets the needs of stakeholders and is functioning optimally. The iterative approach will also allow for continuous system improvement, ensuring it remains up-to-date with the latest technologies and best practices in intelligent agriculture.

In summary, the methodology for implementing the proposed blockchain-based innovative and secure agricultural monitoring system involves gathering requirements, designing the system architecture, developing the system components, testing the system for functionality and security, deploying the system in the production environment, and maintaining and supporting the system. The iterative approach will allow for continuous improvement of the system, ensuring that it meets the needs of stakeholders and remains up-to-date with the latest technologies and best practices in intelligent agriculture.Furthermore, accurate daily dew point temperature prediction aids in the identification of expected weather phenomena as well as the esti- mation of evapotranspiration and evaporation. Farmers increasingly use AI and ML models to increase productivity, and the food-tech sector has benefited the most. Robots and sensors are currently used to manage and monitor crops and collect crop-related data. There is a growing oppor-tunity for ML to be used in digital agriculture. ML is a safe method of increasing agricultural productivity while reducing environmental impact. By collecting crop data, farmers can better understand crops, their genes, and potential diseases. AI is rapidly evolving. With advances in computational capabilities and increased cloud penetration, more parts of the world economy have begun to reap the benefits of AI. Agriculture is one field that has already started to reap the benefit of AI. Whether it is weed control, calculating the best time to harvest crops, monitoring soil and crop health, or predicting yield in advance. AI and ML have been tested as development tools in various industries over the last decade. However, it is only recently that it has become clear that AI can be used to improve agri- cultural decision-making. In particular, farmers may make better decisions due to AI technology, leading to increased efficiency in agri-cultural and livestock production. Various factors contribute agricultural sector's desire to embrace AI technology for better decision-making. The undeniable increase in the available data and the ease with which it can be accessed is at the forefront. In agriculture, surveillance systems based on AI and ML provide in-sights to monitor crops, detect pests, and diagnose soil faults, allowing farmers to plant seeds at the optimal time for maximum yield. Weeds threaten many agricultural activities. They lower farm output, invade crops, cause pasture suffocation, and, in rare cases, endanger cattle. AI sensors can detect weed-infested areas and determine the best herbicide to use in that location. AI systems can forecast weather patterns, assess crop health, and detect diseases, pests, or insufficient plant nutrition. Farmers can monitor the health of their crops by using AI-powered drones. Experts examine the images captured by the drone and compile a report on the farm's health. This helps farmers control pests. Some farmers are now using agricultural robots to perform the most time- consuming and physically demanding farm tasks. These robots can help farmers save money on manual labour and reduce worker workload. An interdisciplinary field of study called artificial intelligence aims to replicate human intelligence in robots that resemble human cognition and behaviours, including learning and problem-solving. Research sci- entists and extension specialists are

now using AI technology to address problems in agriculture productivity. AI technology can help farmers increase yields by assisting them in choosing suitable crop types, adopting improved soil and nutrient management practices, managing pests and diseases, estimating crop production, and forecast commodity prices. AI uses deep learning, robots, the Internet of Things, image processing, artificial neural networks, wireless sensor networks (WSN), machine learning, and other cutting-edge methods to tackle agricultural challenges. These AI technologies can now assist farmers in real-time monitoring of several items obtained from their farms, such as weather, temperature, water usage, or soil conditions, to inform their decisions better. AI is used to develop intelligent farming practices that reduce farmers' losses while providing them with high yields. AI is a branch of computer science that employs machine and deep learning algorithms, among others, to learn from and interpolate data to mimic human intelligence. These networks provide predictions by dynamically linking input and output variables. These predictions can help create various solutions to both straightforward and complicated situations. In our daily lives, AI-powered technologies are already prevalent. AI is omnipresent nowadays, from mobile face recogni- tion apps to self-driving automobiles. Although other industries have seen considerable productivity gains because of AI systems and ML skills, it is impossible to envisage agriculture experiencing a digital trans-formation. Nonetheless, AI is bringing one of the oldest industries into the future. AI has a surprising number of agricultural applications. Precision agriculture is made possible by AI. AI can help farmers with watering, crop rotation, harvesting, crop selection, planting, and pest control by using data from ML. The foundation of AI is the assumption that human intellect can be described in a way that makes it simple for a computer to duplicate and carry out activities of all sizes. Learning, reasoning, and perception are all goals of AI. AI is having a significant impact across the board. Every industry is looking to use intelligent machinery to automate specific jobs. It occurs when human intelligence is defined so that a machine can comprehend it. Furthermore, AI technology in agriculture has the po- tential to improve the world. This technology can perform tasks ranging from simple to complex. The goal of a machine is to learn, reason, and perceive. It aids in the automation of jobs in a variety of industries. The use of intelligence machinery simplifies a variety of tasks.

Need for AI in Agriculture

Agriculture is a labour-intensive occupation, and with rising popu- lation and agricultural production demand, automation is becoming increasingly important. AI significantly assists farmers in components, technologies, and applications. Predictive analytics and improved farm and crop management systems guarantee crop quality and supply. Through satelli photo and meteorological information, businesses determine acreage and track crop health in real-time. Companies can use big data, AI, and ML technologies to anticipate pricing, calculate tomato output and yield and identify pest and disease infestations. They can advise farmers on demand levels, crop varieties to plant for the best profit, the usage of pesticides, and future pricing patterns. AI will be a potent instrument that can help organisations deal with the growing complexity of contemporary agriculture since it dramatically reduces the shortage of resources and labour. It is past time for large corporations to invest in this area. Many industries use AI technology to boost produc- tivity and efficiency. AI technologies are helping people in every sector overcome conventional obstacles. Finance, transportation, healthcare, and agriculture are among the industries that employ AI applications. The global population is growing

simultaneously as urbanisation is quickening. Consumer behaviour is evolving as disposable money increases. Farmers need a way to increase output since they are under much pressure to satisfy the growing demand. More people will need to be fed. There will also be a need for innovation in farming because there is a limited supply of rich soil. We must develop strategies to assist farmers in lowering their risks or, at the absolute least, managing them. Global adoption of AI in agriculture is one of the most exciting poten-tials. Several food producers have difficulty controlling the risks and dangers to their crops posed by pests and other illnesses. These risks are made worse by climate change, monoculture, and widespread pesticide usage. These elements come together to provide farmers with a fresh obstacle. Farms and farmers are under tremendous stress since farming depends heavily on natural forces for the bulk of its goods. The unpredictable nature of rain, a lack of labourers, and an annual need for increased yields exacerbates this stress. This means that the agricultural industry will need to scale up in the coming years massively, and farm efficiency will need to double for us to meet ourtargets nearly. Keeping all of these challenges in mind, AI provides agriculture automation.

FUTURE SCOPE

In future, AI technologies are delivering innovative and precise so-lutions to major agricultural issues confronting farmers worldwide. AI will provide solutions for almost everything, from pest control to weather prediction to farm work assistance. More exciting discoveries in AI directly related to farming will be made in the coming years. In the future, AI will assist farmers in becoming agricultural scientists using data to optimise yields to individual rows of plants. AI companies are developing robots that can readily do various duties in farm settings. This robot is engineered to pick crops more quickly and thoroughly than humans can. These robots are taught to harvest and pack crops while checking crop quality and weeds. These robots can also overcome the difficulties faced by agricultural labour. AI algorithms use satellite photos and historical data to detect whether an insect has landed and what kind of insect has landed, such as a grasshopper or a locust. AI helps farmers with pest management by sending notifications to their cell- phones to take the necessary measures and apply the appropriate insect control. AI is assisting farmers in automating their farming and is also moving toward precision cultivation for improved crop output and quality while utilising fewer resources. Future technical development will help busi- nesses interested in enhancing AI-based goods or services, such as training data for agriculture, drones, and automated machine manufacturing, allowing the globe to address challenges with food supply for a growing population. The future of AI in agriculture will require a significant focus on universal access because the majority of cutting-edge technology is only utilised on big, well-connected farms. The future of ML-automated agricultural goods and data science in farming will be secured by extending reach and connection to small farms in distant regions worldwide. Because AI maximises resource utilisation and efficiency and, to a significant part, resolves th resource and labour shortage, it will be helpful and effective in the agriculture industry. This technology will also play an essential role in research and development in horticulture.

CONCLUSION AND RESULT

In conclusion, the proposed blockchain-based innovative and secure agricultural monitoring system provides a decentralized and safe alternative to the centralized intermediaries that are currently used in many agriculture monitoring systems. By employing blockchain technology and smart contracts, the

proposed method can provide secure and transparent tracking of agricultural products from the farm to the end consumer, improving the traceability and accountability of the supply chain. The proposed system can also automate many of the tasks involved in agriculture monitoring, reducing the workload on farmers and improving the efficiency of the agriculture supply chain.

Implementing the proposed system will require a significant investment of time and resources, but the benefits are clear. With the increasing demand for high-quality agricultural products, it is essential to ensure that the agriculture supply chain is secure, transparent, and efficient. The proposed system can help achieve these goals while providing benefits to farmers, distributors, and consumers.

The proposed system has the potential to generate several positive results. Firstly, it can provide a more secure and transparent supply chain, reducing the risk of fraud and counterfeiting. Secondly, it can improve the efficiency of the agriculture supply chain by automating many of the tasks involved in monitoring and control. Thirdly, it can improve the traceability and accountability of the supply chain, allowing stakeholders to track products from the farm to the end consumer. Finally, it can benefit farmers, distributors, and consumers, improving efficiency, better quality products, and increased trust in the agriculture supply chain.

The proposed system can be deployed in various agriculture settings, including smallholder farms, large commercial farms, and food processing plants. It can track multiple agricultural products, such as fruits, vegetables, grains, and livestock. The system can also be customized to meet the specific needs of different stakeholders, such as farmers, distributors, and consumers.

To ensure the success of the proposed system, it is essential to address several challenges. These include the need for standardization of data formats, the need for interoperability between different systems, and the need for secure data storage and transmission. These challenges can be addressed through the development of standard protocols and best practices, as well as through secure data storage and transmission technologies.

In conclusion, the proposed blockchain-based intelligent and secure agricultural monitoring system has the potential to revolutionize the agriculture supply chain, providing a more secure, transparent, and efficient method for tracking agricultural products from farm to table. While there are challenges to be addressed, the benefits are clear, and implementing the proposed system can provide significant value to stakeholders across the agriculture supply chain.

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