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Irrigation in Precision Agriculture Using Blockchain Ethereum Based on IoT †

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Abstract: The primary objective of this project is to develop a robust and secure system that uses blockchain technology as well as Ethereum and IoT sensors to create a transparent and automated irrigation management solution for farmers. The key components of this innovative system include IoT sensors for real-time data collection, smart contracts on the Ethereum blockchain for transparent and immutable record keeping, and a user-friendly interface for farmers to monitor and control their irrigation systems remotely. The blockchain will provide data security to avoid the problem of data manipulation; because the IoT components will produce large volumes of data, the data must be securely maintained.

Keywords: MQTT protocol; blockchain; Ethereum; data integrity; smart contracts; accuracy; efficiency; machine learning; precision agriculture

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1. Introduction

The Internet of Things (IoT) is a trending technology, where things defines the physical objects like sensors, activators, etc., and these physical objects communicate autonomously with the help of the Internet, without any human intervention. The Internet of Things (IoT) is a game-changing technology that has brought about an era of connectivity and informed decision making. It involves integrating objects and devices, with sensors and internet connectivity enabling them to gather, exchange and analyse data in real-time. IoT holds the potential to transform industries by boosting efficiency cutting costs and enhancing user experiences [1]. However, it also raises concerns regarding data security, privacy protection and the need for standards to ensure smooth communication among the wide array of IoT devices. Blockchain technology uses several computers, or nodes, to securely record transactions in a distributed and decentralised ledger system. Although it was first developed to support cryptocurrencies like Bitcoin, it is now used in a variety of non-financial industries [2]. Blockchain is mainly used for storing the data securely, with the help of a decentralised system where there are multiple nodes, and these nodes are interconnected with a chain so that each transaction made in the chain will be known to all the nodes connected in the system. Ethereum, a blockchain platform, has gained recognition for its groundbreaking smart contract technology [3]. In contrast to blockchains like Bitcoin, Ethereum empowers developers to create and implement contracts that can execute themselves on its network. These contracts are designed to verify and enforce themselves, enabling an array of decentralised applications (Dapps) to be built on the

Ethereum platform [4]. Precision agriculture is the way of undertaking farming in a smart way by using the trending technologies in the process of farming. The main objective is to increase the efficiency as well as to improve crop yield, and it can reduce the farming costs. MQTT, an acronym for Message Queuing Telemetry Transport, is a messaging protocol that was specifically created to cater to networks with high latency or unstable connections [5].

2. Related Work

In recent years, Mr. Chao Xie, from the paper Secured Data Storage Scheme based on Blockchain for Agricultural Products Tracking, said that a secure system for storing data using technology has been developed to improve the transparency, traceability and security of tracking products [6]. This system utilises blockchain, an unchangeable ledger system to store details about the production, processing and distribution of goods. In 2017, Mr. Seong-eun Yoo from the paper Automated Agriculture System based on WSN said that an advanced farming system that relies on Wireless Sensor Networks (WSN) is a cutting-edge technology that combines sensors, actuators and communication tools to oversee and manage elements of farming activities [7]. These setups use WSN to gather data from the fields, process it, and make choices to enhance crop yield while conserving resources. On 25 July, Mr. Oscar Bermeo-Almeida, from the paper Food supply chain's processing, said that the food supply chain goes through stages to turn agricultural products into items ready for consumers. These stages usually consist of harvesting, sorting, cleaning, processing, packaging and distributing [8]. According to Mr. William Bazian-vera of the paper Monitoring and Openness in the Agricultural Trade, streamlining the tasks of all parties involved in the "Agri-chain" and enhancing transaction transparency can be achieved by monitoring commerce and providing assurances in the processes for certifying the origin or quality of the goods [9].

3. Methodology

- The IoT sensors are specifically placed throughout the field for monitoring the moisture and several atmospheric aspects. These sensors will generate large volumes of data regarding the conditions in the field every minute; this data will be continuously sent to blockchain using a secure method [10].
- Blockchain, along with Ethereum, has the specification called smart contract. These smart contracts contain predefined algorithms based on the work that what we want to carry out in the field for irrigation. It has the capability of taking irrigative actions immediately based on the data and algorithms given [11].
- Each transaction that had occurred over the blockchain will be noted in an immutable ledger that will be used as a proof of work [12].
- Through using machine learning algorithms, we can make predictions about irrigation needs based on data and real-time sensor readings. Decision trees, forests or neural networks are examples of algorithms that can be used for this purpose. Another approach is to employ optimisation algorithms to determine the irrigation schedule and how water resources should be allocated. Genetic algorithms, linear programming or reinforcement learning techniques can help us find the solutions [13].
- To anticipate changes in irrigation requirements due to weather conditions, we can integrate weather forecasting data into the system. Algorithms can then adjust irrigation plans based on weather information. When it comes to ensuring data integrity and security within the blockchain network, it is important to choose a consensus algorithm. Options like Proof of Work (PoW), Proof of Stake (PoS), or practical Byzantine fault tolerance (PBFT) are commonly considered [14].
- For irrigation decisions using contracts we need to define the logic behind them. This may involve setting up IF rules, thresholds and triggers. Lastly, implementing anomaly detection algorithms will help identify irregularities in sensor data that could indicate equipment malfunction or inefficiencies in the irrigation system [15].

4. Useful Methods

- Predictive Analytics and Machine Learning: Utilising machine learning algorithms to anticipate irrigation needs by analysing data and current sensor readings. Algorithms such as decision trees, random forests or neural networks can be applied for this task.
- Blockchain Consensus Algorithms: To ensure data security and integrity, the network should choose a consensus algorithm. Practical Byzantine fault tolerance (PBFT), Proof of Stake (PoS), and Proof of Work (PoW) are popular choices.
- Smart Contract Logic: Designing the logic for contracts that automate irrigation decisions. This could include defining rules using IF THEN conditions setting thresholds and establishing triggers.
- Algorithms for Allocating Resources: Creating algorithms that effectively allocate water resources, taking into account factors such as the type of crops, their growth stage, and the condition of the soil.
- Detecting Anomalies in Data: Applying algorithms for anomaly detection to identify any abnormalities in sensor data. These irregularities might suggest equipment or inefficiencies within the irrigation system.

5. Results and Comparisons

We can create a better system for handling the components and its data, and can make better decisions that improve crop yield; not only that, we can also achieve proper resource utilisation. Data integrity and security is achieved using this implementation because of its immutable nature. Finally, we can improve the agriculture methods and can enhance it in many ways by integrating all these technologies.

6. Conclusions and Future Enhancements

The intersection of IoT, the blockchain Ethereum and precision agriculture has the capacity of making a new generation of farming. This integrated approach has many benefits to increase the efficiency of farming, making accurate decisions, etc. The progress observed in this new approach is mainly the security of data and information, and the ability of Ethereum to perform required actions immediately. Overall, the way of carrying out agriculture will evolve continuously, from Table 1, but the blockchain and its implementations along with precision agriculture will make a huge impact on present farming techniques Figure 1.

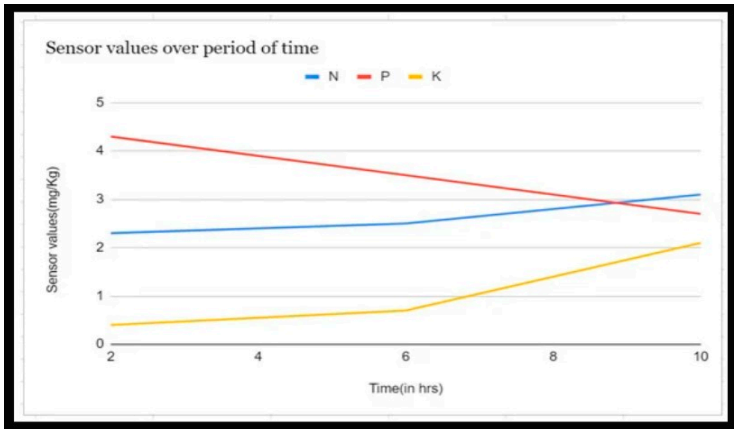

Figure 1. Blockchain-based crop recommendation system for precision farming in IoT environment.

Table 1. Unit testing scenarios.

Scenario	Hypothesis	Testing Result	Conclusion
Sending valid data to predefined MQTT	Data are stored in blockchain	Data are stored in blockchain	Success
Sending invalid data to predefined MQTT	Data are ignored and not stored in blockchain	Data are ignored and not stored in blockchain	Success
Reading data to predefined endpoint	Showing data list in blockchain	Showing data list in blockchain	Success
Adding data to predefined endpoint	Data are stored in blockchain	Data are stored in blockchain	Success

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