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Smart Contract for Decentralized Water Management System using Blockchain Technology

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Abstract: ***There is A finite amount of portable water which is decreasing day by day. Rapid degradation of useful water on earth results in an unkind impact on livelihood. In future, people may have to face (DAY 0) problem therefore, conservation of water is essential. A solution has been proposed to this problem that is "decentralized water management system" using blockchain technology. Blockchain technology can help to use water more efficiently so that every household can lend/borrow the required/extra water from its peer household in the network. In this research work, water ledger architecture has been proposed. This architecture can serve as the basis for Blockchain implementation which can help inbuilding transparency in the water management system with the ultimate goal of Water Conservation. To purpose a system architecture that meets the "demand and supply" of all consumers in a peer-to-peer network so that water can be conserved. A smart contract has been written for transactions (P2P network of 10 household) using Ethereum as a platform. A web interface is created for consumers. Hence, the overall objective is to create a smart water management system for 10 households using blockchain technology to conserve water by medium of sharing water among peer-to-peer as per their needs.***

Keywords: Water Problem, Blockchain Technology, Smart Contract, Decentralized Water Management System, Ethereum.

I. INTRODUCTION

A. Water Problem

Water is a fundamental asset forever, and its administration is a key issue nowadays.[1] Water is a basic product that interfaces each part of the everyday running of urban areas and networks with direct socio-political and monetary ramifications. It is assessed that 70% of all out masses will live in urban networks in water-concentrated on territories continuously [4]. Despite the fact that the absence of water is a worldwide issue, country networks whose economy relies absolutely upon farming, domesticated animals and other essential division exercises endure this issue more than some other social group.[7] Water shortage and water pressure issues have become clear danger to the worldwide populace.

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This makes water the board a basic perspective to guarantee supportable water.[3] Hence, there is need of programmed, keen and shrewd frameworks that can make savvy use of accessible measure of water to take care of plants for greatest time of the cultivating [8]. Proposed security engineering for savvy water the executive's frameworks, the design uses existing security arrangements and configuration designs [3].

B. Blockchain Technology

The blockchain is a peer to peer based scattered data sort out system. Since the blocks are combined to make chains which known as blockchain. In the blockchain, all customers participating in the framework to pass transactions and store history data in form of blocks, which is a great deal of trades. Since each hub has a cryptographic key and an open key, it is possible to play out a propelled mark on the trade using the puzzle key and the hash work. Each center point uses the open key to affirm whether the subject of the electronic mark truly denoted the trade [11][4]. The square containing this exchange has a structure of "chains" that are consistently associated along the time stream subsequent to being made at a particular cycle. Since all clients hold exchange history by checking the record they hold, accordingly exchanges are not approved can't be put away in the square. In this way, blockchain has three attributes: information uprightness, security, and decentralization [11].

C. Smart Contract

According to Scratch Szabo introduced this thought in 1994 and portrayed a clever agreement as "An electronic trade show that executes the points of interest of an understanding" [6]. Scratch proposed offering a translation of definitive expressions into code, and embedding them into property that can self-actualize them [11][7]. Regardless, in blockchain structures, the importance of Smart Contract has progressed. Inside the blockchain setting, Smart Contract are substance recorded on the blockchain. (They can be thought of as commonly undifferentiated from recorded strategies in social database the board frameworks [11][8]. Since they harp on the chain, they have an exceptional area. We trigger a clever agreement by keeping an eye on a trade to it. It by then executes self-ruling and thus in a prescribed manner on every center in the framework, as demonstrated by the data that was associated with the initiating exchange [11][3]. Thusly, we can see this technique through the Virtual Machine can never be deleted [9]. Exchanges infer that transmitting information for writing to the blockchain to broadcasting various hubs.

Each exchange requires a significant advanced mark which can be made with automated keys to be associated with the blockchain.

The usage of cutting-edge advanced mark approval and nonrepudiation of the exchange. Each trade is affirmed by understanding of a predominant piece of the part hubs and

II. LITTERATURE REVIEW

According to Thomas Robles water control management facing interoperability problem. This problem affects water management system activities like water consumption, water distribution. Right now, Martin proposed a water overseeing model consolidating IOT and choice emotionally supportive network. OPC UA utilized as a stage for this engineering and incorporating IOT to better arrangements. A MEGA architecture is also presented based on IOT to achieve a scalable and feasible industrial system. This paper concludes that in future IOT with OCP UA facilitates the performance of test in the water management system [1]. This review study introduces a platform for single water management that is integration of ICT (information and communication network) and SWGs (smart water grids). SWGs gives answer for basic worldwide water issues and ICT fundamentally takes a shot at five prime research regions. schematic procedure for shrewd water lattices (SWGs) for use in water the executive's stages, which coordinates data and correspondence innovation (ICT) into a solitary water the executives conspire. SWG innovation is viewed as a promising answer for settling late basic worldwide water issues. To guarantee the safe future of water amount, wellbeing of water quality, and ICT-based water the executive's arrangements, SWG innovation ought to coordinate five prime research territories. These methods are cost saving, safe and secure for water production and distribution. SWGs in future smart cities use to overcome management limitations and to create a viable water cycle [2]. Nonhlanhla Ntuli proposed a security architectonics for managing water, this architecture leverages secure methods and design for water distribution network. This deals with water scarcity problem and reduces water stress. This foundation sent on continuous perception and control water lattice segments by utilizing sensors/actuators. By coupling functions of cryptographic hash capacities and dispossessed access tokens, approve the personality of the gadget and the uprightness/realness of the substance [3].

According to the implementation work of Boorja BORDEL defines a critical problem of water crisis in rural areas obtained so, requirement of better water management system. By using blockchain network on hardware platform proposed a water irrigation system for irrigation community has been proposed. As conclusion combination of blockchain and voltaic devices is appropriate for the environment. It is a trustworthy system at its first evaluation.[7]

In 2018, Implementation work of Seung Jae Pee interprets the problem of water trade market effects the settlements of transactions which extends for days or months. This results in prevention joining of irrigators hence huge waste of water resources than Jong Ho Nang designed a light weight water trading system which holds a Smart Contract resides on private Blockchain. This guarantees immediate transactions, confirmed delivery of water, immutability and transparency, data integration, authentication.[11]

Nibi Maouriyan discuss about solutions related to IOT in water supply chains but there are some drawbacks and unresolved issues in centralized infrastructure. Later on, blockchain is used as a decentralized system which remove corruption, fault tolerance, immutability, transparency. This review paper decentralized traceability solutions based on blockchain knows as Aqua-chain. In future Hyperledger used as a frame work to enhance performance.[6]

In 2019, EA Ochungo proposed a water tracking system based on blockchain technology to eliminate informal water transactions. This gear up consumers trust and gives a reasonable cost system. In future this also helps in saving ground water level and improves natural ecology.[10]

According to Gheorghe Grigoras review work, innovative solution for water pricing problem is developed. A water supply management system integrated with ICT solutions and blockchain technology. It improves water consumption and distribution to cut down the cost, wastage of water. In future, it results in conservation of water resources and environment.[9]

According to review of M. Safdar Munir explains about the need of smart watering system for medium scale gardens and irrigation field. A mobile application is designed for watering schedule which is integrated with IOT, Blockchain, and Fuzzy logic. Combination of Blockchain and IOT gives security of system and only trusted devices can access. In future this will helps in to conserve water and crops also.[8]

In Beijing China, Manfred Voigt discuss about problems in centralized water system, rain water harvesting. To avoid flooding and fulfil demand of toilets flushing they propose a decentralized approach for sustainable water use. Grey water recycling is the suitable technique for saving water in Beijing China.[5] In this chapter, Eustace M. Dogo explains about how integration of Blockchain Technologies and Internet Of Things makes knowledgeable water management system in Africa. In this chapter they discuss about water scarcity and to conserve water by using blockchain. In future this work impacts on water industry and revolutionize the sanitation. Along with AI and Blockchain water crisis will be eliminated in Cape town.[4] This paper discusses about blockchain based technologies used for sustainable environment. Usman W. Chohan describes about IBM'S water management in California by using blockchain technology.[12] Christian Lazaroiu defines the problem of extinct resources(water) that will
adversely effects globalization. This paper proposed a smart city infrastructure which gives better life and socio-economic improvement. This architecture is designed using blockchain technology.[13]

III. METHODOLOGY

This implementation paper proposed an innovative method for eliminating water stress i.e. Blockchain Technology. Blockchain firstly generates water tokens and then water transactions have been passed as water shared among 10 households.

Smart contract consists of different transactions functions as shown in fig1 and fig2. All transactions were written in solidity and run on Ethereum as platform.

A. Flow Chart Diagram

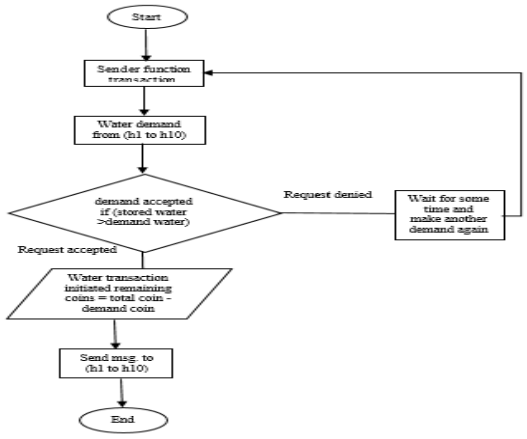

Fig 1- flow chart diagram for sender's side function.

This figure depicts the process of transactions which occurring at sender's side for water demand. This demand is arising from any household, if demand is accepted than transaction has pass otherwise user wait for some time to make another demand again.

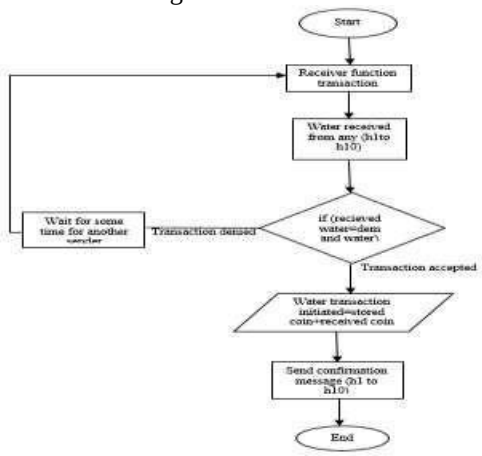

Fig 2- flow chart diagram for receiver's side function.

This figure depicts the process of transactions which occurring at receiver side for acceptance of water demand request. Water received from any household, transaction pass if demand coin equals to received coins otherwise user wait for another some time to make another demand again.

IV.IMPLEMENTATION

This paper proposed a solution for dwindling water resource i.e. Decentralized water management system. There are many techniques were used before for water management system but as innovative solution Blockchain Technology is used. Remix is used to deploy smart contact code and Ganache truffle is used as a platform to compile code version of 0.4.11+. Ether wallet is consisting of water coins and ready to share them. Interfaces were shown in fig 3, fig 4, fig 5 and fig 6 defines implementation process of water transactions.

A. Interfaces

These are the following interfaces of initial and processing of implementation of transaction for selling and buying of coins.

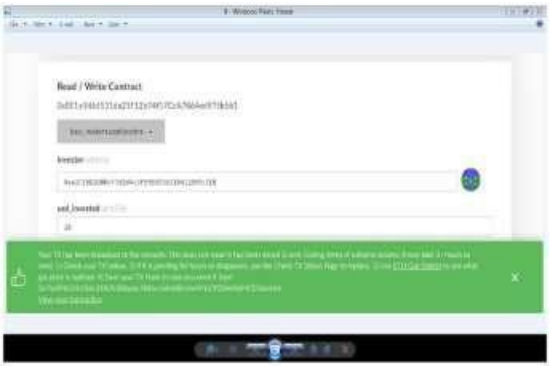

Fig 3- Sending 10-unit coins

Fig 4- Again sending 20 coins

Fig 5- Transaction generated

B. Smart Contract Code

```
function buy_watersupplycoins(address investor, uint usd_invested) external
    can_buy_watersupplycoins(usd_invested) {
    uint watersupplycoins_bought = usd_invested * usd_to_watersupplycoins;
    equity_watersupplycoins[investor] += watersupplycoins_bought;
    equity_usd[investor] = equity_watersupplycoins[investor] / 1000;
    total_watersupplycoins_bought += watersupplycoins_bought;
}
    function sell_watersupplycoins(address investor, uint watersupplycoins_sold) external {
    equity_watersupplycoins[investor] -= watersupplycoins_sold;
    equity_usd[investor] = equity_watersupplycoins[investor] / 1000;
    total_watersupplycoins_bought -= watersupplycoins_sold;
}
```

Fig 6- Code of Smart contracts functions.

V. RESULT

These two figures, fig 7 and fig 8 shows the result of passed transaction and updated balance of coins. Fig 3 shows interface where firstly we have to write senders address, receivers address and amount of coins to be transferred. Fig 7 shows result after transaction completed and coins will be added at receivers' side. fig 4 and fig 5 shows starting of another transaction where same sender sent 20 unit of coins to another receiver address.

Fig 8 shows verified transaction and updated balance of coins at side.

Fig 7-First transaction pass

Fig 8-Second transaction pass

VI. CONCLUSION AND FUTURE SCOPE

This paper, concludes that a decentralized water management system by using blockchain technology and a Smart Contract is giving better solution for saving water in between households. A smart contact has been written in solidity and run on remix compiler (i.e. Ethereum platform). This system is used for water conservation at household level. In future it will be applicable to society level or city level. This system will be implemented on Hyperledger frame work also so that it eliminates previous limitations and more trustworthy architecture is obtained.

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AUTHORS PROFILE

Soniya Tiwari, I am master's scholar. Currently I'm pursuing my Master's degree from CSE Department, JSS Academy of Technical Education NOIDA, U.P., India. My research domain is Blockchain. I'm going to used blockchain on water management to conserve water for future. While Pursuing masters, in 2nd semester, I got an opportunity to write research papers which completely changed my mind and interest. I wrote two research papers as a co-author in "Innovative Learning Methodologies for Enhancing Software Quality in DevOps A Review" and "Authentication Mechanisms for Preventing Cyber Crime and Providing Security in Cloud: A Review (IEEE and Scopus respectively)". That was the moment I realized that I want to pursue my career in the research field with artificial intelligence. I started exploring the problems and took AI as my research field as the subject has the huge potential itself and the scope & possibilities excite me to no end.

Jyoti Gautam Currently working as Associate Professor, CSE Department, JSS Academy of Technical Education NOIDA, U.P., India. Worked as HOD CSE from April, 2015 to May, 2018. Member Executive Committee IWA (International Water Association, India) 2018-20. Appointed as member of the Governing Council at JSS Academy of Technical Education, NOIDA, Uttar Pradesh, India. Coordinator for Signing of MOU between Xinova, Seattle, USA and JSSATE NOIDA. Invited as a speaker from Japan and Taiwan for one of my research papers on Air Pollution. Invited as a session chair by International Water Association, World Water Congress and Exhibition held in Tokyo as session chair for the Category-Disinfection Products in September 2018. Jury for Smart India Hackathon and World Skills Competition. Published papers in reputed International journals and conferences. Reviewer for journals and conferences of Repute. Attended various conferences, fdps and events.

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