

# Blockchain-Based Electronic Voting System

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## ABSTRACT

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Blockchain technology can be used in all areas of our lives because it is a transparent and reliable database. On the other hand, electronic voting systems are becoming an electoral system that has become widespread worldwide. As a result of the combination of electronic voting systems with blockchain technology, it is possible to perform the voting process more reliable and faster. In this study, the advantages of blockchain-based electronic voting systems were examined. A simple electronic voting system has been set up to better understand the voting system, and what is needed here is examined. Blockchain technology is very important to ensure the reliability of systems. This study shows that elections can be made more reliable by using a blockchain-based electronic voting system. As a result, this article allows the use of the new and increasingly popular blockchain technology in the electronic voting system.

Keywords: **Blockchain, smart contracts, electronic voting system, distributed network structure.**

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## I. INTRODUCTION

Countries governed by democracy determine the people who will represent them by voting. In traditional voting systems, a person votes through a ballot in a physically determined institution. This leads to some miscalculations and miscalculations. Electronic voting systems are proposed to reduce errors and slowness in elections. With electronic voting systems, the person can vote remotely and the votes used can be examined by the authorities. These systems increase efficiency by reducing costs. However, the development of technology can also be an advantage for those with bad intentions. The transition to electronic voting systems leads to the start of frauds that can be carried out with cyber attacks. Recently, blockchain technology is being investigated to ensure the security of electronic voting systems and provide a transparent electoral environment to the electorate.

Blockchain is a distributed ledger in which digital transactions are securely stored and shared without a centralized system. Blockchains, also defined as advanced database, is formed by the linking of blocks that store data. Each block is linked together to have the hash value of the previous block. In blockchain technology, the center is eliminated, ensuring that no third approval mechanism is needed in transactions. Satoshi Nakamoto published his most important work on blockchain structure with his work "Bitcoin: Peer-to-peer electronic cash payment system" in 2008 [1]. Nakamoto's work never mentions the concept of blockchain, but after this study, blockchain technology attracted the attention of researchers, and research in this area increased. Prior to Nakamoto's work, blockchain structure was researched and some articles were discussed in this field [2] [3] [4]. However, after these studies, the development of blockchain technology has stagnated. However, Nakamoto published a study that was successful in 2008, and this work is considered a milestone in the development of blockchain technology.

Blockchain technology is being researched in many areas. It has been investigated that blockchain and patent management will reduce transaction costs [5]. Decentralization, transparency, immutability, and data integrity are the most important points in blockchain technology [6]. Blockchain technology is being researched to study and solve current problems. A lot of blockchain-based research has been done for the recently emerged Covid-19 virus. In a study by Sadah Anjum Shanto, monitoring of the Covid 19 vaccine through a blockchain-based system was examined. This study controls and follows the change of the antibody applied using blockchain technology. The antibody applied in the post-vaccination process can be followed with blockchain technology [7]. Blockchain technology is being researched for the solution of many current problems. Blockchain technology is also being researched to prevent DDoS attacks, which is an important issue in mobile vehicle use [8]. Blockchain technology, which we encounter frequently in the field of supply chain management and distribution, was used in a study for pharmaceutical supply and distribution [9] [10] [11]. Blockchain technology has also started to be used in the field of education. In a study by M Ayman et al., a decentralized application using blockchain was developed for E-JUST (Egypt-Japan University of Science and Technology) [12]. The fact that blockchain technology strengthens the user's trust greatly increases the usage area. Another area where security is important is voting systems. Many different voting systems, traditional and electronic, are used around the world. Traditional voting has many disadvantages in terms of time and security. Considering these disadvantages, researchers have started to research blockchain technology for the voting system. Ahmed Ben Ayed proposed a blockchain-based electronic voting system in 2017. According to this study, every voter registered in the system will be able to vote on the internet and the blockchain where the votes are recorded will be distributed in such a way that no one can break it [13]. In a study conducted by X. Yang et al., blockchain technology was used to create an

environment of trust during the storage and public disclosure of election results. This study proposes to use blockchain and Intel Software Guard Extensions together. The researchers' analysis and experiments show that using this proposed system in voting would be more efficient [14]. In another study that emphasizes system security, researchers proposed an online voting system using post-quantum cryptography. This study aims to improve system security by using post-quantum cryptography and blockchain together [15]. The COVID-19 epidemic, which affected the whole world in 2020, attracted the attention of researchers in all fields. Elections have become a major issue, especially for people who want to avoid crowded areas. Divya et al propose a blockchain-based online voting system. In this system, the vote will be securely recorded on the blockchain, and information such as the voter's name, city, and whether he or she voted will be accessible on the website [16]. In one of the studies conducted in this field, the resistance of the blockchain against cyber-attacks was calculated [17]. Ch R. and colleagues propose an e-voting system using the distributed application (DApp) in their study. The security of voter ID is ensured with the DApp they developed using Ganache, MetaMask and specified dagger hashing algorithm [18]. Another study conducted in the field of e-voting used Ethereum. In this study, smart contracts are used to develop the DApp, and a front end is developed for easy access to the DApp. Additionally in this study, the transparency feature of blockchain technology is emphasized [19]. With the beginning of the creation of blockchain-based voting systems, the performance of blockchain-based systems has also been investigated. In a study of the performance of the blockchain-based electronic voting system, the speed at which blocks are created, the speed at which transactions are executed, and the size of blocks were examined [20]. Blockchain technology makes the electoral process more reliable and robust with electronic voting systems. As a result of these positive developments, countries have started to switch to blockchain-based voting systems in elections. In the study conducted by Vladucu and his colleagues, blockchain-based voting systems adopted by countries such as Germany, Russia, Estonia, and Switzerland were examined [21]. With the examination of the research made in this field, this study provides the necessary information for the electronic voting system to be carried out using blockchain technology.

## II. BLOCKCHAIN FUNDAMENTALS

Blockchain technology is defined as a decentralized database in its simplest form. In 1991, a study by Stuart Haber and Scott Stornetta first introduced blockchain. In this study, a cryptographic method was proposed to secure the data. it can be said that in the 90s and early 2000s, research for blockchain stagnated and there were no studies where successful results were achieved. However, with Nakamoto's work in 2009, interest in blockchain technology increased and attracted the attention of researchers.

The development of blockchain technology has passed through different stages and continues to develop. The development of the blockchain consists of 5 phases. The general structure of the development stages of the blockchain is shown in Fig.1 The electronic voting system blockchain is carried out in phase 3.0. These stages are still in development,

allowing new and reliable systems to be created for many areas.

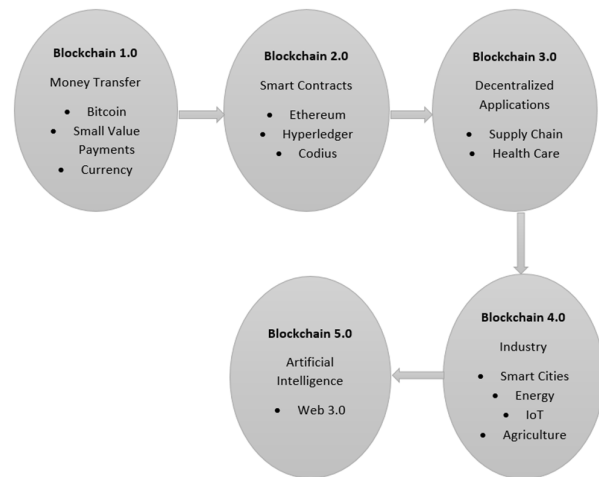


Figure 1: Stages of development of the blockchain

The blockchain is made up of blocks that contain information. A block consists of data, the hash value of that block, and the hash value of the previous block. The first block is called the genesis block, and since it is not the previous block, the previous hash is usually set at 0. Fig. 2 gives the basic structure of the blockchain and how the blocks are linked together by hash.

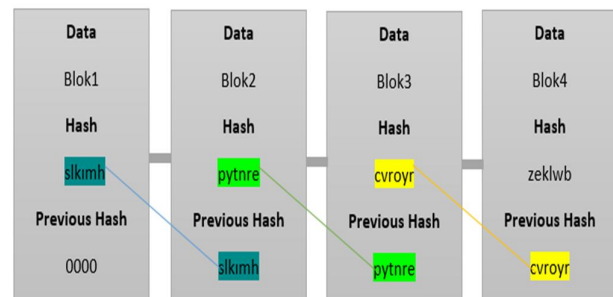


Figure 2: The basic structure of the blockchain

Blockchain is a technology with a distributed network structure. In other words, the data added to the system will not be recorded by a center but by everyone who is included in the system and everyone will be able to follow the process. Any changes to the data chain will be notified to everyone in the system. In the distributed network structure, transactions are carried out without the approval of one or more centers. With a distributed network structure, the processing time is reduced and a transparent environment is also provided to the user.

Smart contracts are an important area of application that uses blockchain technology. Smart contracts are the second phase of the blockchain. It was first described by Nick Szabo in 1993 as "a computer-operated transaction protocol that fulfills the terms of a contract." A secure system without central control that can replace classic contracts is called a smart contract. Smart contracts are prepared after the parties' agreements are signed cryptographically, and uploaded to the blockchain network. For example, when smart contracts are

created for a vehicle title transfer process, the two parties confirm the transaction with a cryptographic signature after the agreement, and if the money transfer is added to the system, automatic money transfer is also carried out through the same system. Agreements created in this way are not lost or modified in the system. Thus, the blockchain provides security and transparency for contracts as well. One of the conveniences of this technology is that it can be performed faster without going to a notary or other institution.

The best and most widely used platform for smart contracts is the Ethereum platform. In 2013, Vitalik Buterin, a student named Ethereum, is one of the most important studies in this field. This study describes the blockchain platform, which allows the execution of applications developed with a general scripting language structure.

Some programming languages, such as solidity, can be created for smart contracts and can be easily coded with existing languages.

Smart contracts use consensus protocols. When transactions such as adding and publishing data on the blockchain began, some disputes also occurred. Reconciliation protocols have been developed to resolve such disputes and prevent security breaches. The proof of work protocol presented by Nakamoto was a protocol based on miners solving complex cryptographic puzzles. Later, protocols such as proof of stake, delegated proof of stake, practical Byzantine fault Tolerance, proof of burn, proof of Elapsed-time and proof of capacity were presented by the researchers.

### III. METHOD

One of the most important innovations that blockchain brings is smart contracts. A smart contract is a process in which the terms of a contract are embedded in the code and data performs transactions transparently by activating the codes. This process ensures that there is no need for approval from an intermediary or a central system. Smart contracts, which can perform transactions faster by replacing classic contracts, constitute the second period of the development phase of the blockchain. It was first described by Nick Szabo in 1993 as “a computer-operated transaction protocol that fulfills the terms of a contract.” Over time, many studies have been conducted in this area and different methods have been proposed. Following the success of Nakamoto’s Bitcoin work, a milestone in the smart contract field was recognized towards the end of 2013 with Vitalik Buterin’s work on Ethereum.

Smart contracts are drafted after the related parties have agreed on the scope, signed cryptographically, and uploaded to the blockchain network. Installed contracts can interact with other components that are on the blockchain network. This interaction can be the initiation of a transaction or the sending/receiving of information. When a contract is drafted, smart contracts automatically execute the terms of the agreement defined in them.

In this study, we examined how a simple voting system is realized by creating a smart contract. The smart contract of the selection application performed is written using the Solidity software language. The smart contract written is distributed by the Ethereum Blockchain.

In the implementation phase of this application, Ganache, which provides the local Ethereum blockchain, was used. The

Ganache application and the Ethereum blockchain are shown in Fig. 3.

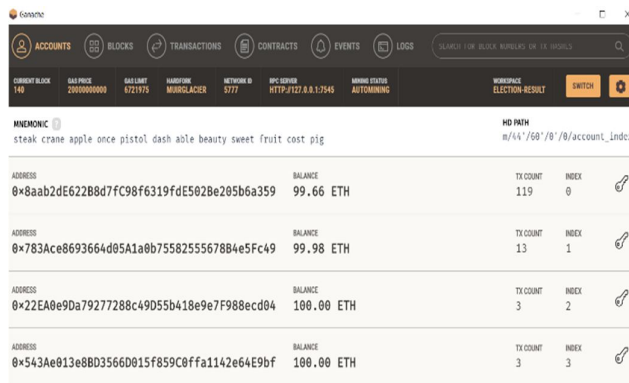


Figure 3: An Ethereum blockchain in Ganache

To connect to the Ethereum blockchain and interact with the smart contract, the Metamask Chrome extension was used. MetaMask is a cryptocurrency wallet used to interact with the Ethereum blockchain. It allows users to interact with decentralized applications and access Ethereum wallets.

In the voting system, all necessary transactions, such as users can vote only once, must be coded in a smart contract. Once the necessary transactions for the contract are determined in a Solidity file, it is ensured that this contract is distributed on the blockchain. Once the necessary transactions for the contract have been defined and distributed on the blockchain, test codes for the smart contract have been written. In these test codes, the procedures that constitute the terms of the contract, such as the number of candidates, the number of votes of candidates, and a user can only vote once, have been tested to ensure their accuracy.

After the smart contract side of the application was realized, a design was performed using HTML, CSS, and JavaScript for the web part. The communication between the website of the application and the blockchain side was established using the web3 library. After these operations were completed, the application was run.

After connecting to the Metamask chrome extension in the application we performed, a screen like in Fig. 4 is seen. Here are the names of the candidates and how many votes they have been shown. Under it, the voting process is carried out by selecting one of the candidates listed.

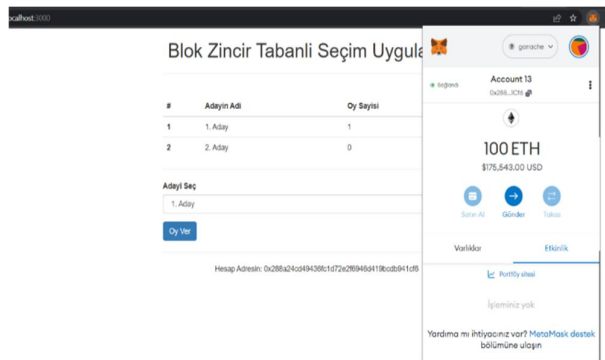


Figure 4: User's selection screen before voting

Once they vote, they vote again on the same account. As shown in Fig. 5, once the user votes, there will be a deduction

from the ETH fee from the wallet and this user will not be able to vote again.

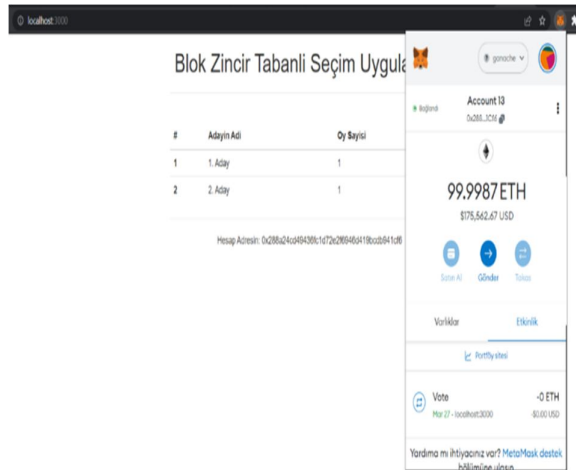


Figure 5: The user's choice screen after voting

This blockchain-based election application is a decentralized distributed system, making it almost impossible to intervene in votes and provide a reliable election platform.

#### IV. CONCLUSION

With this study, the use of blockchain technology in the electronic voting system has been examined in the recent period. With its transparency and reliability, blockchain technology makes it possible for elections to be held securely, away from fraud. The lack of a centralized structure of the blockchain makes the voting process faster. Smart contracts created using the blockchain structure are one of the applications that will make our lives easier. Ethereum is the most effective blockchain platform for smart contracts. This platform, which provides many conveniences, also removes third-party approval and allows transactions to be carried out in a shorter time. We also used smart contracts when we set up an electronic voting system. In the contract we have created, all the necessary conditions for the voting system are determined by coding.

In this study, we examined the blockchain-based e-voting systems in the literature and created our blockchain-based e-voting system. We used the Ethereum Blockchain platform when creating our e-voting system. We observed that there are advantages such as time cost, reliability, and transparency when using the blockchain-based e-voting system. Additionally, the lack of third-party approval has greatly improved the speed at which transactions can be processed. In general, this study examined how to use the electronic voting system by considering the advantages of blockchain technology. With the transfer of the voting process to the internet environment, problems arise regarding the confidentiality and security of the data. With this study, the voting process to be carried out on the internet will be much safer with the effect of blockchain technology. Blockchain technology is a very important technology to ensure security in the internet environment. This study aims to switch countries to blockchain-based electronic voting systems and increase the voters' trust in voting. And in light of the results obtained, it is seen that the blockchain-based electronic

voting system will be faster and more reliable than the traditional voting system.

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