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Research on the sharing platform of college instructional resources based on blockchain technology

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Abstract. The integration of instructional resources in colleges is gradually entering the innovation era from electronic and information technology. A new issue that has emerged is the storage and reading of electronic instructional resources in colleges. Additionally, with the rapid development of blockchain technology, its use in numerous fields has burgeoned. In the information management field, confidential and reliable technologies are still needed to help manage resource storage. Blockchain, which is immutable and untrusted, can be well applied in the establishment of an educational resource sharing platform in universities. The main focus of this paper is as follows: first, to analyze and compare the three educational resource sharing systems proposed by Chinese scholars, enumerate the main contents and functions of each system, compare and analyze the differences of the three systems, and secondly, to put forward the construction framework of a new educational resource sharing platform according to the disadvantages still existing in the three systems. The paper also explores the research on college instructional resource sharing platforms using blockchain. It uses blockchain techniques to build an educational resource sharing system, provides a reliable platform with high security and traceability through intelligent contract technology, and connects user groups through "alliance chain + private chain". Its aim is to facilitate efficient use by users of different levels. The advantages of using blockchain technology to construct a sharing platform for university educational resources have practical significance in further promoting educational informatization.

Keywords: blockchain, sharing platform, information management.

1. Introduction

Archives management is an important task for the storage and maintenance of university resources. In the era of expanding big data, physical paper storage has become outdated, and digital storage has become the mainstream. Digital archives not only reduce labor costs but also facilitate information review. Consequently, digital archives are increasingly being established in colleges. Network technology applications upload all kinds of resources to digital archives, shorten the time of information transmission, efficiently classify and collect a large amount of archival information, and achieve the digitization, interaction, and sharing of instructional resources [1]. However, this type of resource sharing mainly exists within universities, and there are still many questions regarding the interconnection of teaching resources among universities.

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Firstly, a large amount of information needs to be collected and summarized from each school, and the storage of PB, EB, or even ZB levels needs stable and sustainable storage databases [2]. Secondly, teaching resources among colleges are precious cultural property, whose authority, safety, and integrity should be effectively guaranteed. To improve the efficiency and security of resource sharing, blockchain technology is used in the teaching resource sharing system in this paper.

Blockchain technology is immutable, decentralized, and untrusted. Its core is to build distributed ledgers and combine data into a chain structure, which has similarities with information management. Information is securely redacted and stored through blockchain data structure and hash function, asymmetric encryption, and supervisor identity to ensure the reliability of data interconnection. A distributed ledger is used to update information efficiently and conveniently. There is an urgent need to break the independent recycling of instructional resources in colleges, achieve the efficient transfer of instructional resources among universities, improve the utilization rate of various information, and promote win-win cooperation between digital archives.

2. Related works

2.1. Definition of blockchain

Blockchain refers to a peer-to-peer network that constructs a non-counterfeit and non-tamper-resistant distributed ledger through transparency and trust rules. It combines blocks of data in a sequential manner to form a chain data structure in chronological order.

The blockchain is decentralized and immutable, meaning any node on the network can become the center, and the rights and obligations of each node are equal, forming an autonomous ecological chain. Transactions' blocks are continuously added to the end of the chain in chronological order. To amend the data in a block, at least 51% of the nodes in the system need to be controlled, making it extremely difficult to tamper with data.

Blockchain is mainly divided into three types: public chain, alliance chain, and private chain. The public chain refers to the consensus blockchain where everyone can read, send transactions, and obtain valid confirmation. It is suitable for digital currency, e-commerce, Internet finance, intellectual property, and other application scenarios. The alliance chain refers to a network controlled by multiple centers, which is suited to complex intra-organization and inter-organization scenarios. The private chain refers to the blockchain with centralized control, which is controlled by a company or an individual and is applicable to enterprises or specific financial institutions.

2.2. Blockchain system

The blockchain architecture consists of five layers: the data layer, contract layer, consensus layer, network layer, and application layer. The data layer contains the underlying data blocks, basic data, and algorithms. The chain structure is physically manifested through blockchain technology, and each block contains a block random number, time stamp, and public and private key data generated by asymmetric encryption algorithm. The contract layer mainly refers to the smart contract formed by code in the blockchain. The immutable and transparent features of blockchain make the terms in the smart contract real and credible. When the terms of the contract are met, the smart contract will be automatically executed. The consensus layer includes the consensus mechanism of the blockchain network and the corresponding algorithm. The distributed feature of blockchain necessitates the consensus of the entire network nodes for governance. The consensus layer is responsible for effective identification and authentication of peer-to-peer patterns.

The network layer distributes all materials and services in the network to each node, and information transmission is directed between two nodes. On the blockchain network, each node can both generate and obtain messages. Nodes need to jointly maintain the blockchain system. When a node creates a new block, it requires to inform other nodes in the broadcast form, and other nodes receive the information to verify the block and then create a new block based on that block.

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The application layer is mainly for various scenarios of blockchain and is responsible for closely integrating blockchain with real life. Examples include product supply chain traceability, decentralized social networks, distributed data storage, and blockchain games. With its powerful functional advantages, blockchain has a very wide range of application scenarios.s.

2.3. Application of blockchain

Over the past five years, as blockchain technology has gradually developed and improved, scholarly research on its application in information management has surged. Among them, Guo [3] discussed the feasibility of using blockchain technology for archives management informatization and detailed the feasibility path based on the main characteristics of blockchain and the basic steps of information management. In terms of practical application, numerous articles describe how blockchain can be applied to manage public institutions [4], railway projects [5], electronic medical records [6], content auditing [7], and other types of archives management. Building upon existing research, Zhang [8] focused on the feasibility of applying this technology to a shared platform.

In the aforementioned studies, various researchers have concentrated on the application of blockchain technology to various categories of information management. However, due to the rapid expansion of blockchain technology and limited time for studying its application fields, there have been few developments and constructions of educational resource information management systems based on blockchain technology.

3. Systems analysis and comparation

3.1. Construction of high-quality education resource platform framework for colleges and universities based on blockchain

The system is composed of seven layers, namely the resource layer, data layer, network layer, consensus layer, contract layer, service layer, and application layer, which are superimposed from bottom to top. The resource layer focuses on the production, packaging, uploading, auditing, and broadcasting of instructional resources, providing basic sharing services for high-quality instructional resources in colleges. The data layer stores data in the unique block data structure using hash algorithms, time stamps, and inter-block data transmission mechanisms for data transportation. The network layer uses a combination of authentication mechanism, node permissions, and point-to-point distributed network protocols to transmit and store data to each node. Its main function is to transport and store data to block nodes in coordination with the data layer. The consensus layer adopts the certificate of equity mechanism or authorized equity mechanism. The node with accounting rights is the highest authority node with the most resources. Through this mechanism, education departments and universities on the platform are granted higher authority to review the blockchain of educational resources.

At the contract layer, laws and regulations related to copyright of instructional resources, credit programs for academic qualifications, learning process and achievement evaluation standards are included in the smart contracts of the blockchain [9]. This effectively helps the regulatory department conduct audits and improve regulatory efficiency. The service layer establishes a database during platform operation to provide users with basic data management services, personal learning big data analysis services, resource sharing services, course completion verification services, and copyright dispute confirmation services. The application layer provides access to the platform for education departments, universities, employers, teachers, and students. Through page design, it constructs the webpage end of a high-quality education resource platform for colleges and universities to provide services.

3.2. Research on data sharing system based on interplanetary file system

This system consists of four core parts, which are user, IPFS cluster, blockchain cluster and RSA encryption module.

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Users can upload data and have the right to control and modify the data (the operation of uploading data can go through the encryption module, only the object specified by the data owner has the key of the corresponding data, so as to realize the data security) [10]. After a user uploads a file to IPFS, the hash value of the file is returned, and the file sharing system interacts with the IPFS cluster. The system will upload the keywords of file sharing operation to the blockchain cluster (encryption process is added in the middle, RSA encryption algorithm is used to encrypt the file hash value and then upload it to the blockchain cluster), and the corresponding file sharing system will interact with the blockchain cluster. Users can also share data and encrypt it in the process to ensure the privacy of user data.

The blockchain cluster uses Hyperledger Fabric to simulate and test the blockchain network. Six nodes are simulated in this system, one client node, four peer nodes, and one ordering node. The client node is used to propose transactions. The four peer nodes belong to two organizations, which can communicate with each other. The sorting node is used to sort the transactions processed in the peer node. RSA encryption module is used to ensure the security and privacy of data transmission transactions on the chain, and a pair of keys are generated for each user by using ursa module in node.js. When transferring file data, use the receiver's public key to encrypt the hash value of the transmitted file. The receiver uses the private key to decrypt the encrypted file hash, so as to obtain the real hash value of the file. Finally, the public key can be retrieved through the private key.

3.3. Research on key technologies of college digital educational resource sharing based on blockchain

This system is mainly developed for data layer, network layer, contract layer and application layer. The data storage mode of the data layer is that important data and transaction information are stored on the blockchain through the FISCO BCOS platform to ensure the security and authority of the transaction information. The resources upload by college teachers are distributed stored by IPFS to ensure that the data cannot be lost. In order to improve the functions of the platform, other relevant operational information such as forum management and part of personal information is stored in the local MySQL database. The contract layer realizes the automatic linking of user created resources and other resource operations by writing intelligent contract of course information. The incentive mechanism intelligent contract is written to improve the enthusiasm of users to upload resources and learn, and the automatic acquisition of user points [11]. The Web end is designed with Vue framework, which is convenient for users to operate and reduces the difficulty of operation. Finally, the system is tested for function and performance, and the laboratory findings are analyzed. Through the experimental results, it can be concluded that the college digital education resource sharing platform designed in this paper based on block chain basically meets the requirements.

3.4. Comparation and conclusion

The first system builds the overall framework of a high-quality educational resource platform based on an alliance chain. The consensus management mechanism of the alliance chain, which includes authorized and open nodes, guarantees the quality of instructional resources while also ensuring platform security and reliability. The platform is built by expanding and decomposing the blockchain architecture, with detailed descriptions of front-end design and related functions. Employers are connected to this platform, and colleges and universities that provide high-quality education resources can verify and broadcast a student's completion certificate for a certain course, which employers accessing the platform can inquire about and verify.

In the second system, the InterPlanetary File System (IPFS) stores the main body of file data, while the blockchain only stores the encrypted hash value and user public key of the file stored in IPFS. This design effectively avoids the problem of block chain data storage capacity and expansion, with real data stored in IPFS and private keys held by users to reduce privacy disclosure risk and avoid security risks associated with the storage of original data on the chain due to data transparency [12]. The third system is designed to improve digital instructional resource uploading by college teachers and

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students' enthusiasm for active learning, with an incentive mechanism model that distributes credits to uploaders and learners of digital instructional resources in proportion to successful cases. Smart contracts are used to ensure storage of intellectual property rights for college digital education resources and related author information on the chain, with course and integral information smart contracts designed to ensure authenticity and authority of educational resource information on the chain.

4. System design

The characteristics of blockchain technology are utilized to build a distributed and decentralized educational resource sharing system. The system can (1) distribute the instructional resources uploaded by users after the request of smart contract, (2) dynamically manage the data according to the data supervision protocol, (3) update and store the data in real time for users to read, (4) manage and verify various license terms. This system mainly refers to four participants: data provider, data reader, data supervision department, university resource management department.

The system is constructed based on the following assumptions: The sharing of instructional resources in the system refers to the sharing of all resources. partial sharing with certain people is not exist. All resources will be shared with all users identified by the system [13]. The users of this system are limited to internal personnel of universities, external personnel or graduated students have no access to the system. Whether the resource is uploaded or not depends entirely on the personal will of the data provider, and there is no violation of legal provisions.

4.1. University resource management department

Blockchain technology can be segmented into three different forms, namely public chain, private chain and alliance chain. Due to the security and confidentiality of college resources, the alliance chain is adopted to connect colleges and universities for effective college resource management, and the private chain is used to manage the internal user access of colleges and universities.

Each university or individual teachers and students is set as a node, and the resource management department of the university is established to authenticate and review the educational materials uploaded by each university, hence to ensure the authority and professionalism of the materials themselves. The user accesses the system and uploads or browses data under the supervision of the smart contract, which will also expand with the increase of resources. The campus education resource management platform adopts the private chain management mode to ensure users' high-speed browsing and reduce the requirements on hardware facilities.

4.2. Data providers and data readers

Data providers have higher privileges than simple data readers. The data provider can add, delete and modify the uploaded resources to guarantee the copyright of the data provider, but all operations still need to be verified by the data supervision department. The data provider has the following permissions: (1) register to access the system; (2) view the shared instructional resources in the system; (3) add content to the uploaded file, which can directly add text content or video pictures; (4) delete uploaded files, deleting all files or part of text (videos, pictures, etc.); (5) modify the uploaded files which could modify multiple files at a time or only modify part of a file; (6) consult uploaded files anytime and anywhere. Among them, (3), (4) and (5) all need to be supervised by the data supervision department. The data reader has the following permissions: (1) register to access the system; (2) Search and view the shared instructional resources in the system; (3) Maintain personal information and access rights.

4.3. Smart contract

The smart contract consists of two parts. The first part, which cannot be changed after the subsequent operation of the platform, is the mandatory requirements for users to access the system and the way to access the system. The second part is the uploading and sharing of instructional resources by data

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providers and the operation of “adding, deleting, modifying and checking” of resources after uploading. This part will continue to expand with the increase of user operations. In the second part, the smart contract is automatically generated based on the resources uploaded by the user [14]. Its functions are as follows: (1) identify the author who uploads the resource to prove that there will be ownership competition in the future, and record and publicize the source of the resource through hash function; (2) Record the "add, delete, modify and check" information of the data provider and other users' access information, including access path and access duration, and this record cannot be changed; (3) Resource retrieval and viewing can only be carried out through the interaction between intelligent contracts to prevent malicious attacks and guarantee the stability of the system.

4.4. Data supervision department

For the authority and reliability of resources, the system has its own data supervision department. Firstly, users need to record resource information and personal data through smart contracts; Next, the platform will conduct the system preliminary screening and automatically conduct resource audit according to national (international) data standards; Finally, it is sent to all members with resource screening qualification through consensus mechanism. Only more than 51% of users who pass the authentication can upload it to the system [15]. Members with resource screening qualifications must meet the following criteria: (1) at least six months of registration into the system; (2) high quality of resource release; (3) high activity in the system.

5. Conclusion

Blockchain technology can effectively support the back-end construction of a college instructional resource sharing platform. A feasible university education resource sharing system can be built based on blockchain technology. The system primarily includes a data provider, data reader, data supervision department, and university resource management department. The system connects colleges and universities through an alliance chain for effective college resource management and manages the way internal users of colleges and universities read resources through a private chain. Data readers can register to access the system and view system resources. Data providers can also "add, delete, modify and check" resources. Data supervision departments are embedded in the system to ensure the authority and reliability of resources. Smart contracts using blockchain technology can effectively support platform construction credibility, facilitate sustainable development of the shared platform by recording the core operations of users, and provide practical basis for possible problems in the future. Distributed ledger technology and chain data structure by blockchain can update and store information more securely. After university resources are completely uploaded by each independent participant through a series of operations, they can share information with each other. Multi-party storage is carried out on each server to prevent important resource leakage or even loss caused by core server crashes. The design of private chain and alliance chain can restrict users to a certain extent. Since the system is only open to internal staff of universities, it needs to be supervised by alliance chain and private chain to identify users. Partial decentralization can also improve operation efficiency and utilization rate. However, building an educational resource sharing platform requires the support of various technologies, including hardware connection of data storage, front-end design of the platform requiring relevant knowledge of web page design, and consideration of data supervision regulations of different countries. Statistical knowledge and software testing knowledge are necessary for system detection and maintenance. Thus, it is necessary to use multiple knowledge to build the system.

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