Research on Course Sharing Technology Based on IPFS and Blockchain

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Abstract. This paper studies the course sharing project by using IPFS and Ethereum technology. Designed a course sharing project based on IPFS and Ethereum. This project solves the problem of huge course data and single point of failure. First of all, using IPFS as the access medium can effectively reduce storage costs and improve storage efficiency. Second, use Ethereum technology to solve the single point of failure problem. Finally, the Ethereum transaction mechanism is adopted to enhance the enthusiasm of course users to share and improve the liquidity of the course.

Keywords: IPFS; Ethereum; Course sharing; Blockchain; Data storage

1 Introduction

At present, in the field of college online courses, each college has its own characteristics and expertise. The sharing and interoperability of courses in various colleges and universities not only improves the circulation rate of excellent courses, but also provides a good learning platform for students [1]. The sharing of high-quality courses is a prominent problem at present, and it mainly has the following shortcomings: (1) There are many course sharing platforms, and there is a lack of a unified management platform that enables readers to quickly find the courses they need; (2) A specific shared platform is an ordinary centralized platform, which is prone to single point of failure; (3) The premium course platform draws a large amount of commissions as platform management fees, which is a loss for the course owner.

In order to overcome the above shortcomings of the system and realize a truly decentralized, free sharing, and course paid course platform, this project adopts blockchain technology to achieve platform decentralization, data sharing and data immutability, and intelligent Related concepts such as contracts are applied to the course sharing platform. In this way, the construction of a course learning platform of "decentralization, intelligent learning, fairness and justice" is realized. It enables readers to quickly search for the courses they need, and also overcomes the problem of single

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point of failure. At the same time, the necessary blockchain absenteeism fees are deducted [2]. Most of the course fees are paid to the course owner, exempting the course platform from commissions.

2 Introduction to IPFS and ETHEREUM

2.1 IPFS

IPFS (Inter Planetary File System) is a system that combines the existing successful systems Distributed Hash Tables (DHTs), BitTorrent, version control system Git, Self-Certified Filesystems (SFS) with blocks Chain combined file storage and content distribution network protocol [3].

These systems form several important characteristics of IPFS: (1) permanent and decentralized characteristics, which can permanently save files and achieve decentralization, solving the problem of single point of failure; (2) the characteristics of peer-to-peer hypermedia, P2Peye. com saves various forms and types of data; (3) versioning, which can save the modification history, trace the source and reliability of the data; (4) addressable content, which can locate files through the hash value obtained after uploading to save the file locally. Only one file of the same file is saved on IPFS, thereby achieving file uniqueness and saving storage space [4].

Since IPFS has the characteristics of permanent decentralization, addressable content, and uniqueness of files, IPFS is very suitable for storing a large amount of data materials [5]. For this project, it is very suitable for storing course teaching data.

2.2 ETHEREUM

Ethereum is a mature blockchain powered by smart contracts. While Bitcoin's main goal is to establish itself as a payment alternative to regular currencies, Ethereum is more committed to decentralization by giving developers built-in tools and monetary tools to enable them to build and run distributed applications Application (DApp) [6].

A DApp is a two-layer application consisting of two main components: the front-end layer on the user side and the back-end layer (smart contracts) located in the blockchain network [7]. On the front end, we can use any framework we are familiar with to write the user interface [8]. The back-end mainly carries out smart contracts such as user account management and currency transactions [9]. Figure 1 shows the overall framework of DAPP for this project.

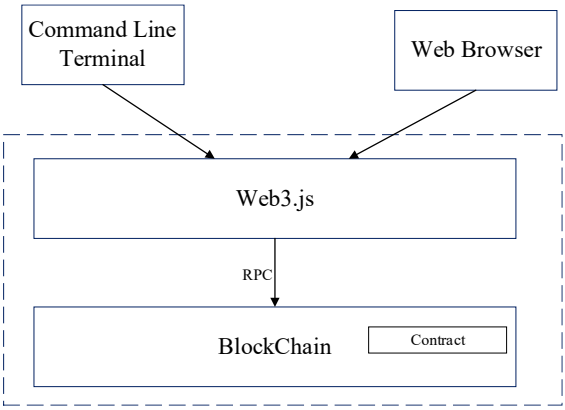

Fig. 1. The overall framework of DAPP for this project

The user interface mainly includes command line and web page display. This project mainly includes: data uploading, sorting, searching and displaying functions, which are realized by writing HTML pages. Web3.js is the interface between the user interface and the Ethereum blockchain. By encapsulating the Ethereum interface, users can interact with the underlying blockchain through the JSON RPC of Web3.js [10]. A peer-to-peer network of nodes with all data and code on the chain. Web3.js allows us to send requests to an Ethereum node to read and write data via JSON RPC [11]. At the same time, the user blockchain smart contract is in the blockchain [12].

A DAPP requires programming in all aspects, which is very cumbersome, so Truffle solves our difficulties. Truffle is a smart contract framework for the convenience of development, debugging and deployment. It integrates many functions and greatly reduces development time [13]. At the same time, in conjunction with the Truffle framework, this project uses the ganache tool to simulate the Ethereum node service, and at the same time creates 10 accounts with a face value of 100 ether for us, which saves us a lot of setup troubles for development [14].

Truffle integrates contract writing, contract deployment, script testing and network construction [15]. Under its framework, developers can quickly implement the deployment of a smart contract. Therefore, this project uses Truffle as the basic framework of the project.

3 Course sharing scheme design based on IPFS and Ethereum

3.1 Overall design

Conduct research on IPFS and Ethereum blockchain technology, and use the combination of IPFS and blockchain to realize the sharing and interoperability of college courses. It enables users to use IPFS to store a large number of files, which can not only ensure the security of the files, but also ensure the uniqueness of the files. At the same

time, the open source technology of the Ethereum blockchain is used to store the paid course transactions, providing legal protection for the transactions, and finally forming a decentralized course sharing platform. The overall plan of the project is shown in Figure 2-3. In Figure 2, the course user uploads the course to IPFS and obtains the Hash value of the course, and then uploads the Hash value packaging smart contract to the Ethereum blockchain. The user needs to obtain the Hash value through the Ethereum transaction, and then download the course to the local through IPFS, that is, a successful course sharing.

The research content of the course sharing platform mainly includes the following aspects: (1) User course materials are collected and uploaded to IPFS to form a course resource pool; (2) The course information Hash value and various specifics are uploaded to the blockchain, which is convenient for users to query; (3) Smart contract design, that is, the transaction relationship between the two parties, either paid or free.

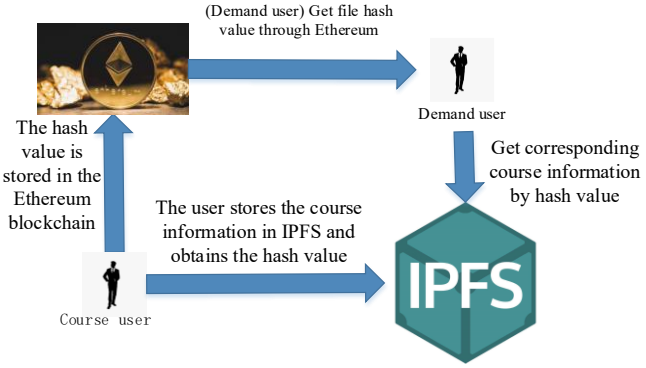

Fig. 2. Overall scheme of course sharing based on IPFS and Ethereum

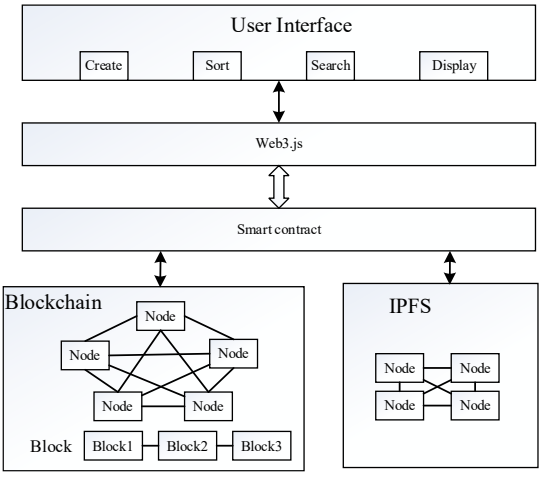

Fig. 3. Overall diagram of course sharing based on IPFS and Ethereum

The user interface provides the user with a visual operation interface, which is the bridge between the user and the system. It mainly realizes the operation of creating courses, searching, sorting and purchasing courses, and realizing user course sharing and payment operations. In turn, the user's operation request is converted into virtual assets and transactions are sent to the underlying Ethereum blockchain, and are permanently stored on the chain. Web3.js acts as a medium between smart contracts and upper-level user interfaces, providing convenience for user interfaces to access smart contracts.

3.2 Detailed design based on Ethereum

The course information contract is used to store the course information hash generated by IPFS. Course users can control whether the hash stored by themselves can be retrieved by the outside world. Therefore, the hash has the following two states:

- Course editing status: When a course user modifies or upgrades the course information, the course user can set the course status to the editing status through the course information contract, that is, the hash information cannot be retrieved by the outside world. In this state, the user's course information is in the editing state, and other users cannot search and share temporarily.
- Course online status: When the course user edits the course information, the course can be run online, and its hash can be retrieved by the outside world, and the hash value can be displayed on the web page.

The course information contract includes the addition of hash value, the update of hash value status, and the query of hash value. The addition of the hash value is used to process when a new course file is stored in IPFS, a new hash value is generated and stored in Ethereum; the update of the hash value status mainly deals with the question of whether the course can be queried, including editing status and Online status; Hash value query is mainly for users who need to obtain the hash value of the current course for query use, and course users can directly obtain the course hash value stored by themselves.

The course data structure is shown in Table 1. Course users upload new course works, upload course information to IPFS, and record the unique hash value in the blockchain to form smart contract transactions.

Table 1. The course data structure

Table Head	Table Column Head				
	Name	***ID***	***Author***	***Hash***	***USER***
TYPE	String	Int	String	String	Mapping

Ordinary users query courses, and query the corresponding course works according to the course ID or course name. The course ID is the unique identification data of the

course, and can accurately locate a specific course information. During the query process, the contract method getCurriculum () is called for the value, and there is no need to modify the data, so no transaction is generated and no gas is consumed.

4 Experimental results and analysis

4.1 IPFS Test

This project uses go-IPFS to access files, first install IPFS, and enable IPFS daemon to monitor, then access operations can be performed. First, upload the course content to IPFS through the IPFS client, and the result is shown in Figure 4.

Fig. 4. IPFS upload and download test results

In Figure 4, by uploading a university physics course to IPFS, the course user gets a Hash value: QmSibQU5yQmrwrgaaiVELhRFYE2k4mXo1avTaT3PZDY9eF.

4.2 Ethereum test

As a programming language, the entire system is built using the truffle framework. First use the Truffle framework to build the entire system, by displaying all shared courses of course users on the platform. At the same time, the course name, price and author are displayed. There is a "I want" button in the lower left corner of each course, through which users can obtain information about the course. Its web page rendering is shown in Figure 5.

Fig. 5. Course sharing platform based on IPFS and Ethereum

In Figure 5, sixteen courses of the platform are shown. In this test, through the process of obtaining the university physics course, by clicking "I want" in the lower left corner of the university physics course, the system will automatically connect to MetaMask and generate a transaction information, the effect is shown in Figure 6, in In Figure 6, the transaction is expected to cost a maximum of 0.000741 ETH, which is about $1.15. The user confirms the transaction by clicking "Confirm".

Fig. 6. MetaMask Trading Order Chart

Figures 7-8 respectively show the results of the entire transaction and the details of the order transaction displayed in the MetaMask wallet after the transaction is successful. Among them, 0xfc2...578F is the course user account, and at the same time, it also shows the details of the entire transaction, using 23281 fuel, the price is 20, so the actual transaction amount is 0.00046562, which is about 0.73 US dollars.

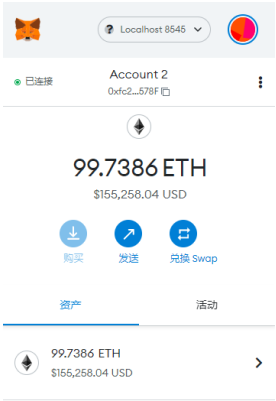

Fig. 7. Transaction Result

Fig. 8. Transaction Result

At the same time, the system automatically returns the hash value of the university physics course to the user and echoes it back. The echo effect diagram is shown in Figure 9. After users obtain the Hash value of the course, they can download the course through IPFS software, and then complete a course sharing.

Fig. 9. Hash returns to the display page

5 Conclusions

The IPFS-based blockchain course sharing technology project mainly solves the following problems: First, the huge amount of course data reduces storage costs. Using IPFS as an access medium can effectively reduce storage costs and improve storage efficiency. Second, use Ethereum technology to solve the single point of failure problem. Finally, the Ethereum transaction mechanism is adopted to enhance the enthusiasm of course users to share and improve the liquidity of the course.

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References

1. Yao L, Xiong X. Design a teaching resource sharing system in colleges based on cloud computing[C]//2013 International Conference on Information Technology and Applications. IEEE, 2013, pp: 374-378.
2. Ethereum. (2016). Solidity Documentation. [Online]. Available: http://ethereum.github.io/solidity/docs/home/.
3. Benet J. IPFS-content addressed, versioned, P2P file system[J]. arXiv preprint arXiv:1470.3561,2014.
4. Chen Y, Li H, Li K, et al. An improved P2P file system scheme based on IPFS and blockchain. In: Proc. of the Int'l Conf. on Big Data. IEEE, 2017. 2652−2657. [doi: 10.1109/BigData.2017.8258226]
5. Experimental features of Go-IPFS. https://github.com/ipfs/go-ipfs/blob/master/docs/experimental-features.md#private-networks
6. IPFS documentation. https://docs.ipfs.io/
7. Hei Yiming, Liu Jianwei, Guan Yewei. Authentication Scheme for Identity Information Sharing Based on Blockchain [J]. Journal of Cryptography, 2019, pp: 605-615.
8. Ding Y, Luo D, Xiang H, et al. Design and implementation of blockchain-based digital advertising media promotion system [J]. Peer-to-Peer Networking and Applications, 2021, pp: 482-496.
9. Hejun Xu, Binkai Jiang. Study on a security intelligence trading platform based on blockchain and IPFS. 2021, pp :1-7.
10. JavaScript API.http://github.com/ethereum/wiki/wiki/JavaScript-API.[EB/OL]. 2018/9.
11. He Peng. Research on the identification method of tokens on Ethereum and its application [D]. University of Electronic Science and Technology of China, 2021.
12. Gu Yan. Design and implementation of identity authentication system based on blockchain [D]. Beijing University of Posts and Telecommunications, 2018.
13. He Honghao. Design and implementation of ownership-based traceability anti-counterfeiting system on blockchain [D]. Zhejiang Technology and Business University, 2019.
14. Zhou Fangming, Zhang Zehua. Welding data storage and sharing system based on IPFS blockchain technology [J]. Journal of Xuzhou Institute of Engineering (Natural Science Edition), 2021, pp: 10-17.
15. Zheng Qiuhong. Design and Implementation of Teacher Title Evaluation System Based on Blockchain [D]. Beijing University of Posts and Telecommunications, 2020.
16. Li Huoqin. Design and research of voting scheme based on smart contract [J]. Changjiang Information Communication, 2021, pp: 121-124.