# Integrating Blockchain and the Interplanetary File System, a resilient platform for storing students' file

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# Integrating Blockchain and the Interplanetary File System, a resilient platform for storing students' file

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**ABSTRACT**

In the current unprecedented time, daily news of the cyber-attack, data breaching is heard, it has raised the question on the central authorities who are in control of handling the database. It has become tough to trust the centralized servers for sharing sensitive details such as transaction information, credit card details for payments, etc. In the proposed model, integration of blockchain and Interplanetary File System (IPFS) has been done to build a decentralized application for students to upload files containing fee transaction details. The proposed model has been designed using the private blockchain for its' striking features like enhanced privacy and transparency. The trust issue for large file storage has been solved by the Interplanetary File System (IPFS) which is a decentralized platform. In the proposed model, the student uploads a file that gets stored in the Interplanetary File System (IPFS) across the peer-to-peer network (P2P). As soon as the file goes into the Interplanetary File System (IPFS) a transaction hash is generated in real-time. This hash is displayed on the browser for the student to keep for future reference of viewing file and another copy of the hash goes into the blockchain. This hash acts like a password. The student needs to keep the hash safely because this password will be the gateway for the student to view the uploaded file, in future. Thus, this paper discusses the proposed model that has used the decentralized, tamper-proof platform for file storage.

***Keywords- Blockchain, Interplanetary File System (IPFS), Hash***

## 1. INTRODUCTION

The proposed model is based on integrating blockchain and Interplanetary File System (IPFS), hence understanding what the terminologies mean is mandatory. Blockchain is a decentralized database that keeps a permanent record of information and stores it in blocks in consecutive, cryptographic pattern linking these blocks to form a chain. It almost nullifies the chances of hacking the database due to the cryptographic encryption technique used in the blockchain. The digital ledger transaction is duplicated and spread across various nodes of the computer which makes it transparent, decentralized, and immune to tampering network.

Here is a simple diagram comparing a conventional database and blockchain database: -

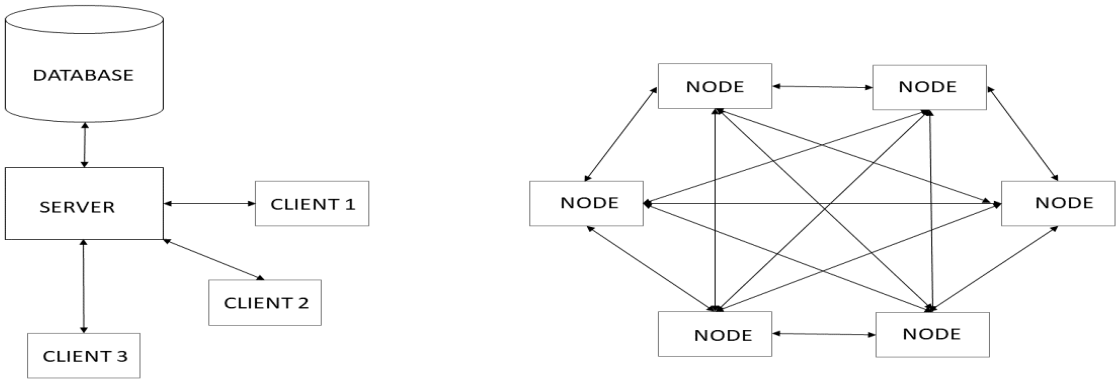


Fig 1. Conventional client-server and blockchain

Since blockchain cannot store large files due to size limitations and high cost, an alternative is necessary to store large file and get the benefits of the decentralized database. This can be achieved by one such distributed file storing system, the Interplanetary File System (IPFS). Interplanetary File System (IPFS) uses content addressing i.e., storing the file by identifying what is in it and sharing it over all the nodes. Thus, Interplanetary File System (IPFS) replicates the file all over the network. Here's a simple diagram comparing traditional file storage system and Interplanetary File System (IPFS).

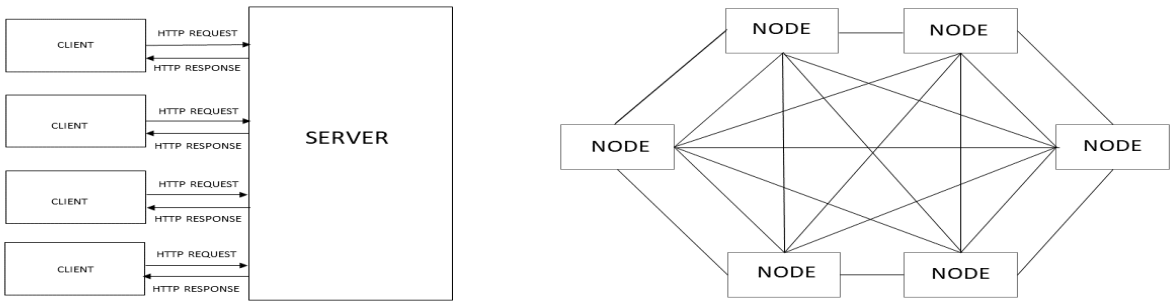


Fig 2. Conventional client-server Hypertext Transfer Protocol (HTTP) and peer-to-peer (P2P) Interplanetary File System (IPFS) network where each client itself acts as a node.

In this conventional diagram if a server gets crashed data can never be retrieved since the system is centralized. In Interplanetary File System (IPFS) all computers are interconnected and everyone on the network has a copy of the uploaded file. Also, the copy of files can only be accessed by the one who has the Interplanetary File System (IPFS) hash. Thus, enabling security as hash acts like a password. Interplanetary File System (IPFS) is rightly quoted as "permanent web" [2] since the file will always be there on a particular address unlike regular Hypertext Transfer Protocol (HTTP), which makes it tamperproof. Here is a diagram to understand file storage in Interplanetary File System (IPFS) in more depth.

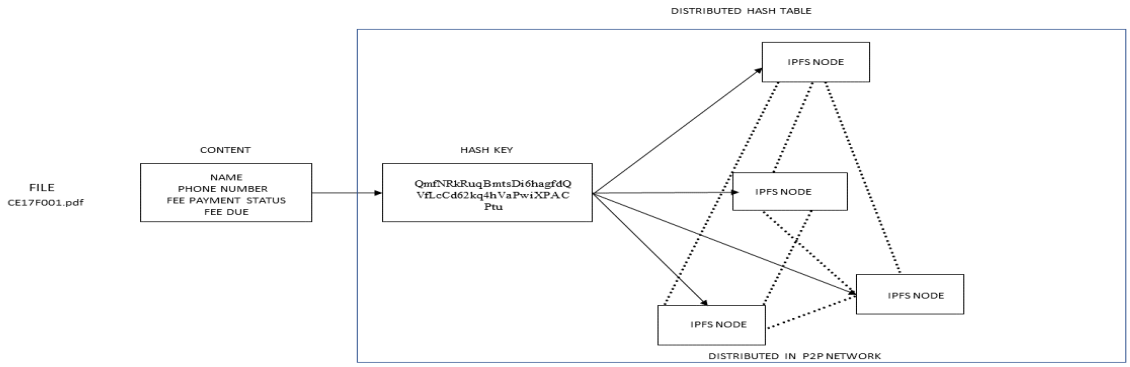


Fig. 3. How the file gets stored in Interplanetary File System (IPFS)

The copy of the file is distributed over the peer-to-peer (P2P) network. Every copy has a cryptographic hash that cannot be decoded. Data will be shared across a network on these peers called nodes. Each node in the network stores the content whose relevancy it finds with the help of additional indexing of information. It helps to find which node is storing what content. To retrieve the full data, there is a need for these cryptographic hashes. The hash gets data from all the other nodes throughout which data was split and combine to form the file, that was uploaded. Here data scrambling is avoided by a distributed hash table (DHT). The blockchain stores hash address in the smart contract. It strengthens the security by hiding the content of the file within a series of letters and digits. Any alteration regardless of the motive changes this series of letters and digits completely which gives proof that there is no consistency between the file requested and the file that is stored in Interplanetary File System (IPFS).

Thus, the proposed model integrates blockchain and the Interplanetary File System (IPFS) to store student's files containing information such as fee transaction details. Connecting the two domain technologies enable large file storage in a decentralized system. Since both technologies exhibit similar features to a good extent, the proposed model enables to leverage of maximum common benefits out of them. Security, transparency through blockchain and untampered, immutable large file storage through Interplanetary File System (IPFS) are the driving features that lead towards using the decentralized technologies. Thus the model has been proposed for storing a students' file containing fee details, securely.

## 2. LITERATURE REVIEW

- The term "Blockchain" was conceptualized back in 2008 by Satoshi Nakamoto. [1] the problem of double-spending was solved using a Peer-to-peer (P2P) network.
- IPFS which stores the large files was created in 2014 by Juan Benet. In [2] a distributed file system for large file storage was introduced. Interplanetary File System (IPFS) is also called a "permanent web" [2]
- [3] integrated the domain technologies by the adoption of Interplanetary File System (IPFS) proxy to share files. The problem was there was no access control mechanism.
- [4] was proposed to share data securely across Electronic Health Record System (EHR).
- [5] proposed a system that uses smart contract to ensure fake transcripts of students' certificates, degrees are not made.
- The rapidly growing technology Blockchain and Interplanetary File System (IPFS) have been integrated and applied in various fields such as research, agriculture, forensic, healthcare field because of their features like decentralization, immutability and security.

## 3. METHODOLOGY

### 3.1 REQUIREMENTS

Requirements of the proposed model for student's file system:

- A device with internet, to run the web browser where student can submit the file to upload.
- Student must upload a pdf file no greater than 10 Megabytes (MB)
- Students must know their respective account details i.e. User Identification (UID) and password provided by the admin of the college.

### 3.2 COMPONENTS

The components that have been used are Interplanetary File System (IPFS) [6], Ganache [7], Remix IDE [8], Metamask [9], Truffle [10], web3.js [11] and React.js [12]. PHP [13] has been used to create a database containing student User Identification (UID) and passwords.

Interplanetary File System (IPFS) [6] is a tool to store student's file across various nodes in a peer-to-peer (P2P) network. Ganache [7] is an Ethereum blockchain that has been used to set up a private blockchain. Ganache securely stores hash in the smart contract.

Remix Integrated Development Environment (IDE) [8] is a web application that is used in the proposed model to write, debug, and deploy ethereum smart contracts. Metamask [9] which is a Google Chrome extension has been used in the model which helps to connect to a private blockchain network. It interacts with Ganache [7] is used to validate transaction and deployment and testing. Truffle [10] is a framework that has been used for building the model, writing a test against Ethereum smart contract and deploy it to the blockchain.

Web3.js [11] is a component used to convert a regular browser into a blockchain browser. React.js [12] has been used to build the user interface.

### 3.3 ARCHITECTURE

Students with verified User Identification (UID) and password can upload their files. Preceding are the steps that have been explained through the diagram:

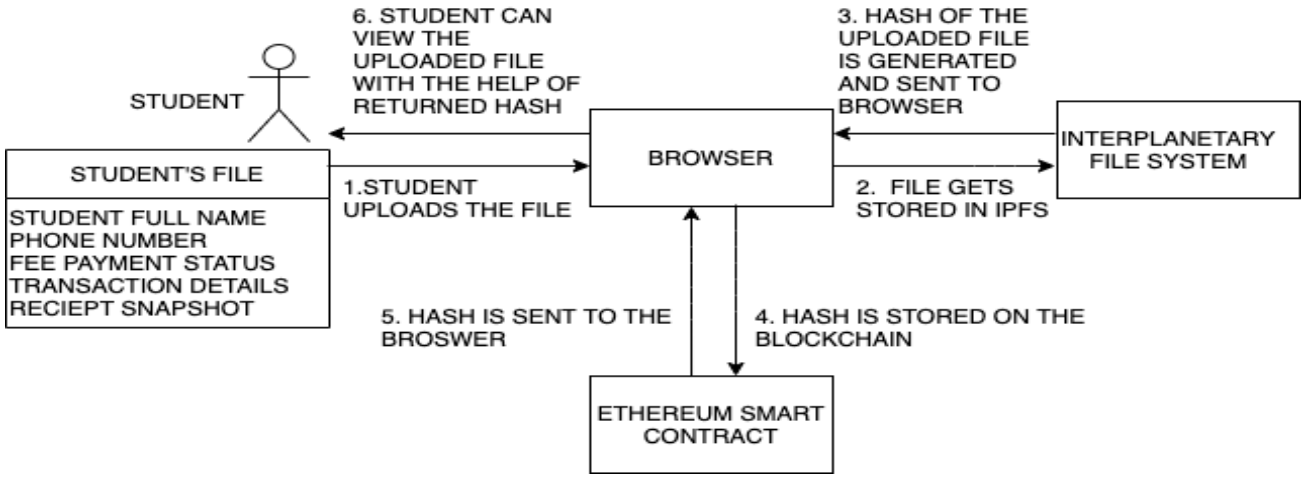


Fig. 4. Working of the integrated platform

In the proposed model student after entering the correct Unique Identification (UID) and password, uploads the pdf file on the browser which goes into the Interplanetary File System (IPFS). It generates a hash which is the key that gets stored in the smart contract of the private blockchain. The same transaction hash is displayed on the browser in real-time. Student must keep the received hash string safely to view the uploaded file in future.

### 3.4 APPROACH

For students to upload their file steps have been given below:

- Student must enter the valid Unique Identification (UID) and password and click on login.
- On successful login, the student is redirected to the file upload page.
- The student must upload the file in pdf format. Student must make sure file size is not greater than 10 Megabytes (MB)
- As soon as the student uploads the file, he/she must click on submit button.
- A pop-up notification of successful file upload is displayed.
- Student receives transaction hash generated in real-time.

## 4. RESULT AND DISCUSSION

### 4.1 SNAPSHOTS OF WORK

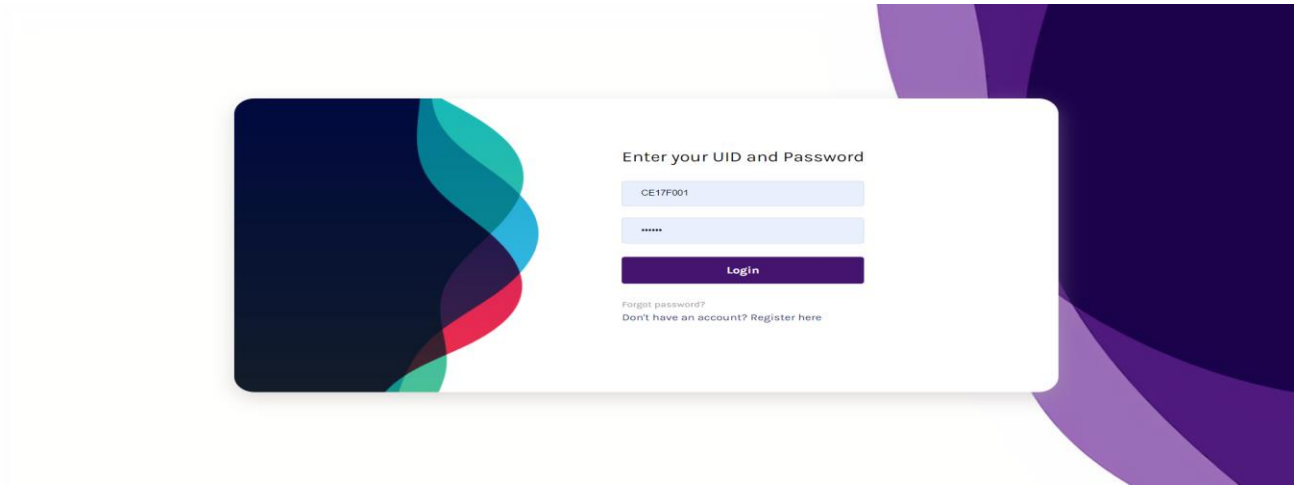


Fig. 5. The student enters the necessary details on the login page.

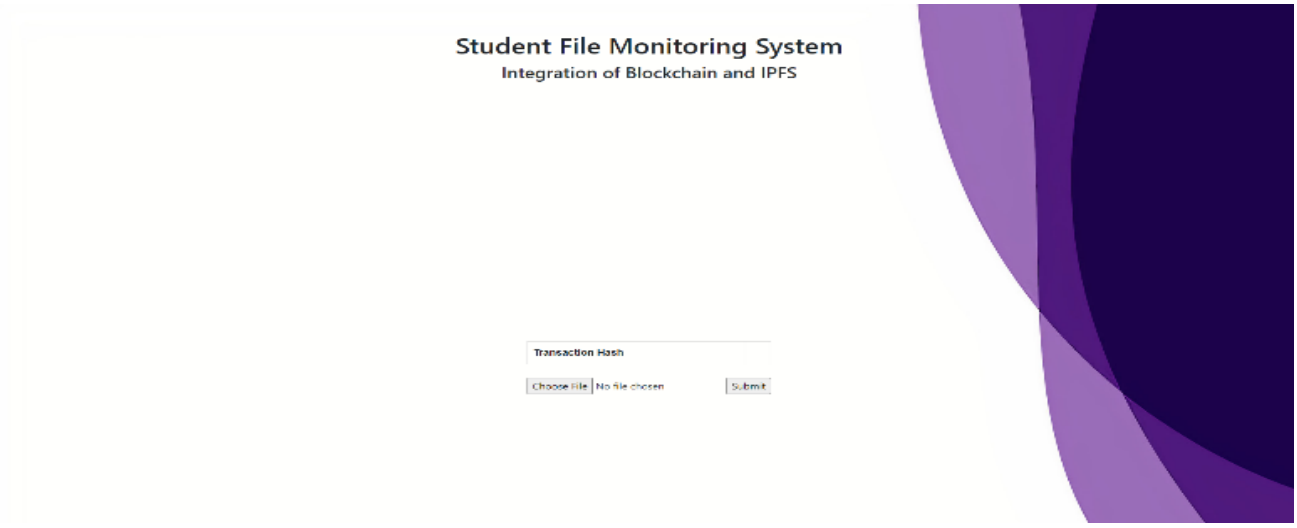


Fig. 6. From the login page, the student is redirected to the file upload page.

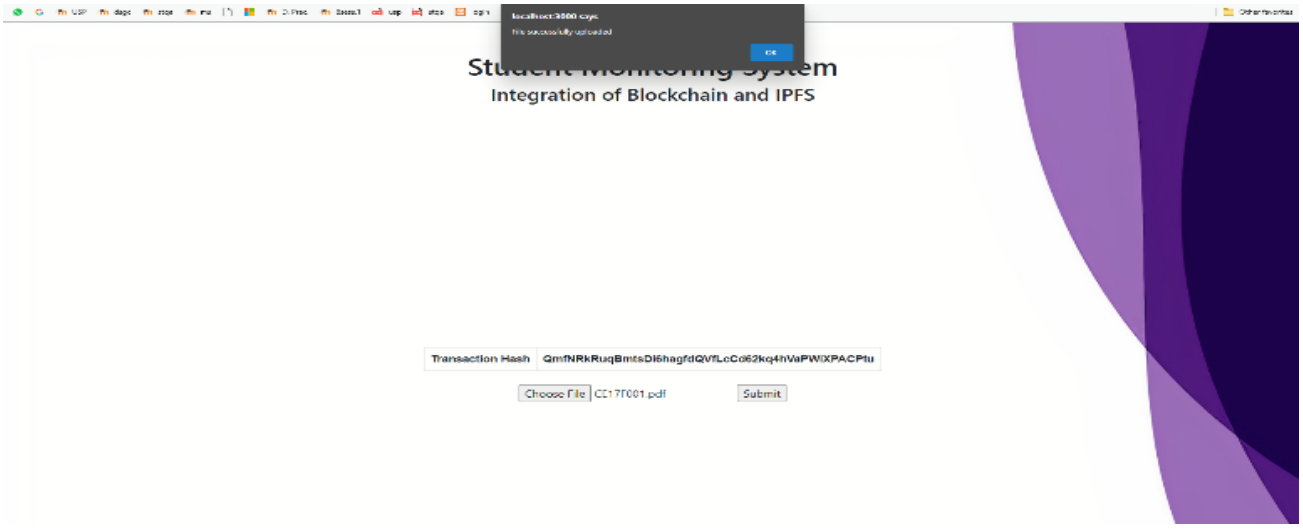


Fig. 7. File upload successful, Interplanetary File System (IPFS) hash is displayed.

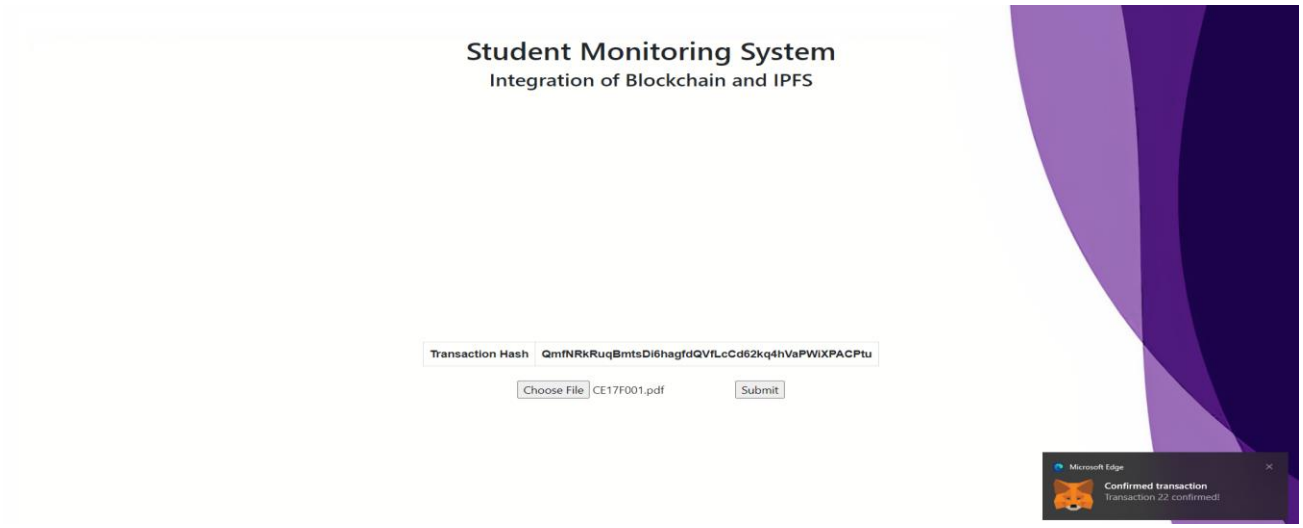


Fig. 8. Metamask [9] confirms the transaction

### 4.2. FEATURES IMPLEMENTED SUCCESSFULLY

- Only students with registered User Identification (UID) are redirected to the file upload page, thus enables authentication.

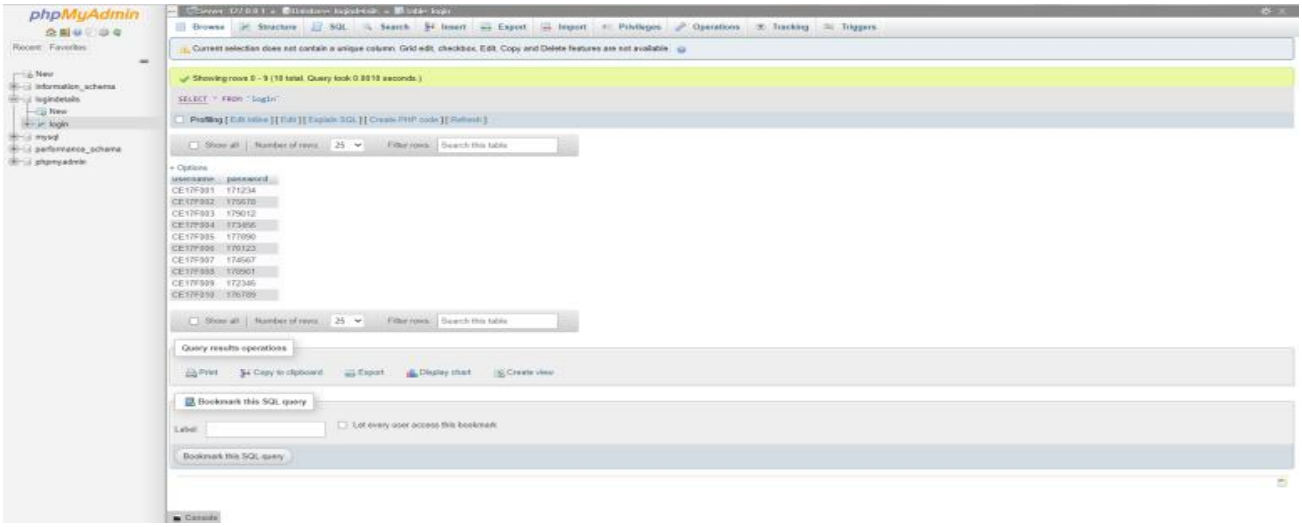


Fig. 9. List of registered students in the database [13]

- Smart Contract securely stores the hash of the blockchain.

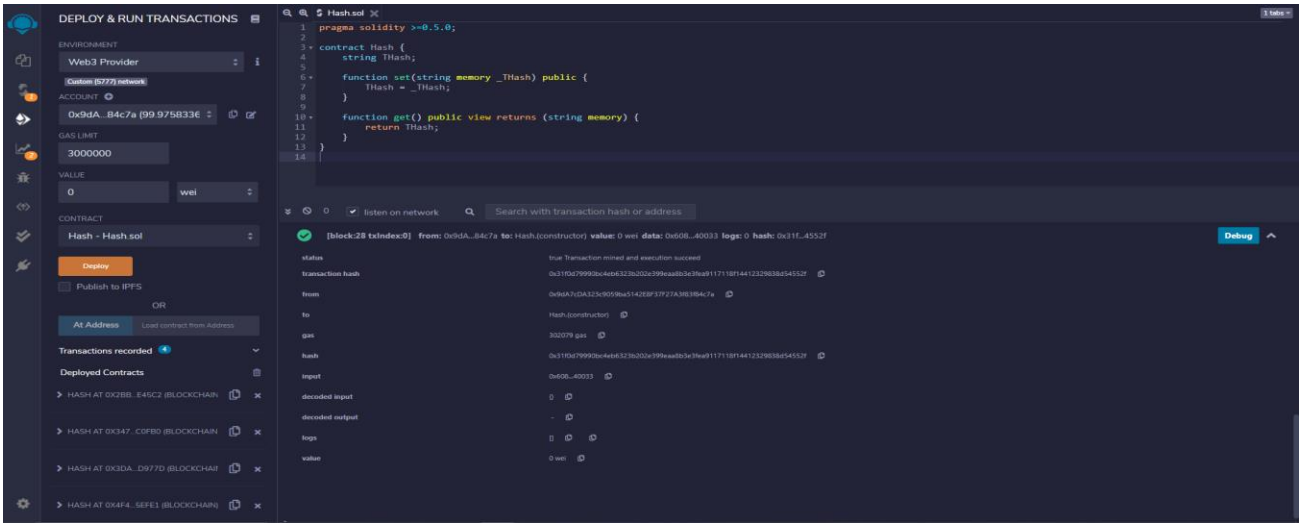


Fig. 10. Compilation in solidity, Remix Integrated Development Environment (IDE)

- Ganache successfully stores the Interplanetary File System (IPFS) hash-QmfNRkRuqBmtsDi6hagfdQVfLcCd62kq4hVaPwiXPACtu

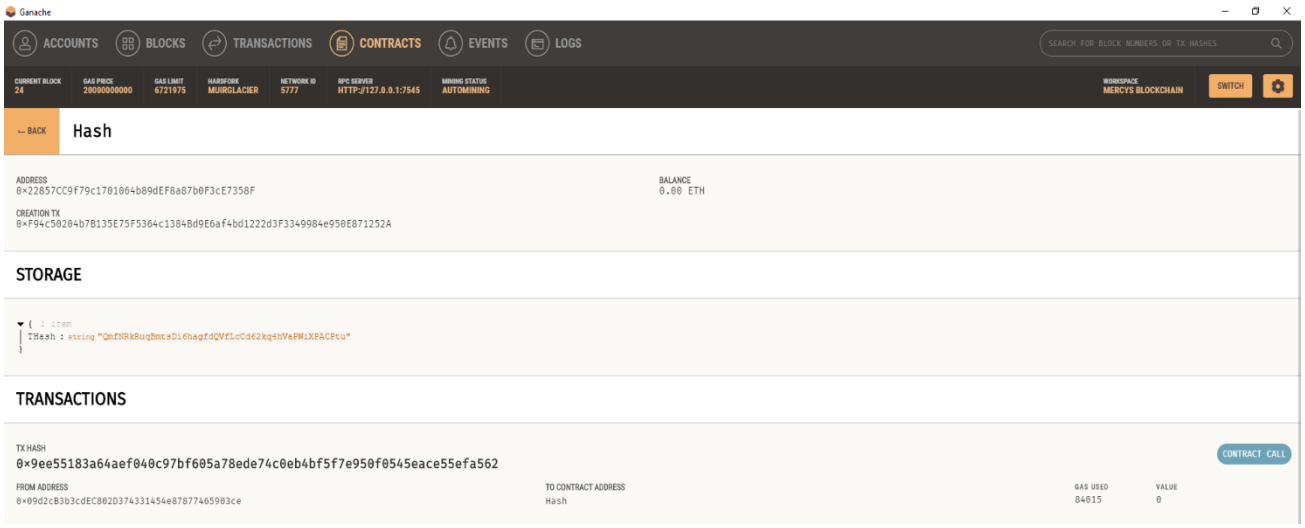


Fig. 11. Interplanetary File System (IPFS) hash string (starting with Qm) has been stored in Ganache [7]

- Displays stored Interplanetary File System (IPFS) hash in real-time so that the student does not have to wait or depend on the third party for accessing his/her uploaded file. This enables trust in a decentralized system.
- Student can access the uploaded file if he/she has the hash. Student file can be accessed through a web browser by entering the string. Here is a sample file that was uploaded a month ago and using the hash string which was generated in real-time, student pdf has been retrieved.

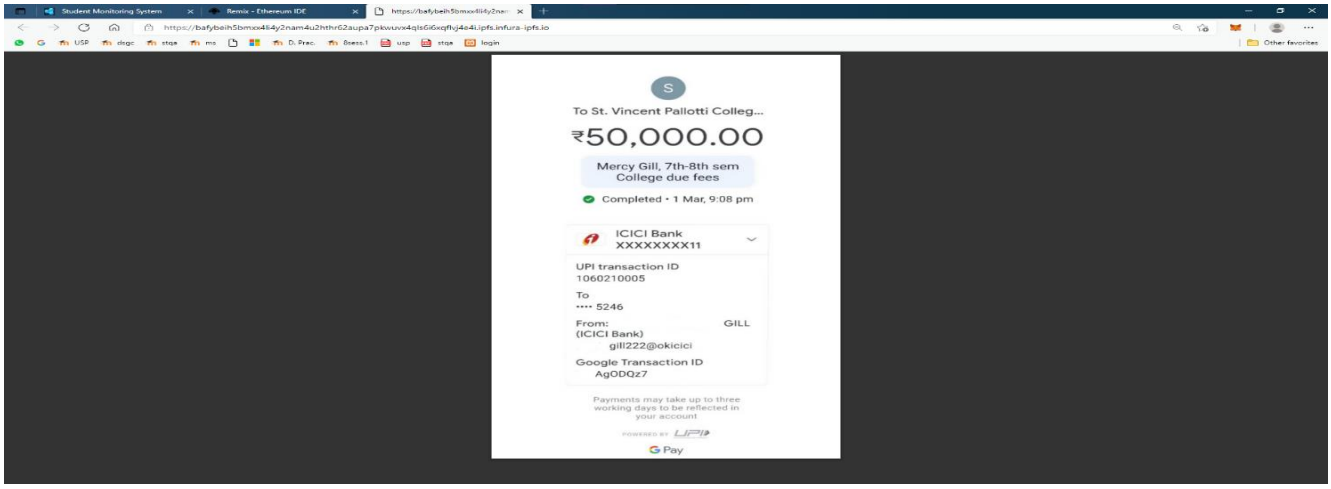


Fig. 12. A sample fee details file stored in the Interplanetary File System (IPFS) which can be viewed in future till the student has the hash string secure, link to view the particular file [14]

- Thus, students' data files are successfully stored in the Interplanetary File System (IPFS).

## 5. CONCLUSION

In this paper, a model has been proposed by integrating Blockchain and Interplanetary File System (IPFS) to store files containing students' information. Blockchain is a rapidly growing technology because of its striking features like decentralization and immutability. There was a need for one such decentralized network that stores large files since there is a scalability issue in the blockchain. Hence the Interplanetary File System (IPFS) has been beneficial in solving that problem. In this model, students who have entered correct login details after authentication are redirected to the file upload page where they can upload their pdf file containing fee detail. As soon as the file gets stored in the Interplanetary File System (IPFS) hash generated is sent to the student and stored in blockchains' smart contract. In the proposed model, blockchain provides security, transparency, and the Interplanetary File System (IPFS) provides decentralized, immutable large file storage, thus making the storage economically feasible. The proposed model in future will be applied to store a large amount of colleges' data such as fee details and to store question papers in the decentralized application. In future, integration of the blockchain and Interplanetary File System (IPFS) technologies can be applied on a larger scale in various fields which can replace the conventional systems with a central point of control.

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