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Novel Approach Towards Academic Module Based on Blockchain

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Abstract: This research paper presents a smart contract-based system for managing academic courses and student results on the Ethereum blockchain. The system allows the creation of courses, subjects, and faculty members, as well as the registration of students and their enrollment in courses. Students can also view their subjects, and faculty members can add marks to a student's subject. The system uses various Solidity data structures such as mappings, arrays, and structs to store and manage the data. The paper provides a detailed description of the smart contract functions and their usage, along with code snippets. The system's reliability and security are enhanced by the use of the Ethereum blockchain and its decentralized nature. Additionally, the use of smart contracts ensures that all transactions are transparent, immutable, and tamper-proof, which reduces the risk of fraud or errors. The system's scalability is also improved by leveraging the Ethereum blockchain's ability to handle a large number of transactions simultaneously. This paper highlights the potential of De-centralized systems in the academic module and provides a room for future development in this area. Overall, this research presents a novel solution for academic management on the blockchain.

Keywords: *Blockchain, IPFS, SHA256, Academic Module, Smart-Contracts, Cryptography, Proof Of Stake, Remix IDE, Node JS, Ethereum Blockchain, Ethereum Wallet MetaMask.*

1. Introduction

Blockchain technology has emerged as a revolutionary technology that offers numerous advantages such as decentralization, transparency, immutability, and security. Blockchain-based systems are being explored in finance, healthcare, and others. In recent years, the education sector has also shown potential for blockchain adoption, which can bring transparency and efficiency in managing academic records and processes. This paper presents a novel approach towards academic management based on blockchain technology, specifically, the Ethereum blockchain. The proposed system leverages smart contracts to manage academic courses, subjects, and student results. The system aims to provide a secure and reliable platform for managing academic data while ensuring transparency and immutability of the data. This paper provides a detailed description of the smart contract-based system, its implementation, and the Solidity data structures used for data management. The proposed system demonstrates the potential of blockchain technology in transforming the education sector and lays the foundation for future development in this area. The traditional academic management systems have several limitations, including lack of transparency, vulnerability to fraud and errors, and the inability to handle a large number of transactions efficiently. This research paper addresses the gap by presenting a novel approach to academic management based on blockchain technology. The system proposed in this paper leverages the Ethereum blockchain to provide a transparent, secure, and efficient platform for managing academic courses and student results. The paper highlights the benefits of using blockchain technology in academic management and provides a framework for implementing similar systems in other educational institutions.

2. Centralized Vs De-Centralized Based Academic Module

The traditional academic management system is centralized, which means that a centralised body controls and manipulates all aspects of it. This centralized approach has its drawbacks, such as the risk of data manipulation and fraud, and the lack of transparency in the system. On the other hand, the proposed blockchain-based academic module is de-centralized, which means that the data is distributed across a network of nodes, and no single entity has control over the system. This de-centralized approach offers several advantages, including transparency, immutability, and security. The use of smart contracts ensures that all transactions are automated, transparent, and tamper-proof, removing the requirement of intermediaries and decreasing the error margin and scams. Furthermore, the use of blockchain technology eliminates the need for intermediaries such as educational institutions or government agencies, allowing for a more efficient and streamlined system. However, the adoption of a decentralized academic module based on blockchain

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requires addressing various challenges such as regulatory compliance, standardization of data, and integration with existing systems. This paper focuses on following discussion of the potential in blockchain based education sector which provides a practical solution for academic management on the blockchain. Therefore, the de-centralized approach presents a more efficient and secure solution for academic module.

3. Technology Used

An overview of the use, adoption, and use of smart contracts in educational organisations is covered in this section. In addition, we give a brief overview of the application development tools for developing a blockchain system which has integrated IPFS using Node JS, smart contract developed using solidity on Ethereum block chain environment using Remix IDE and Metamask to display transaction details.

A. Node JS

Node.js is a JavaScript runtime built on Chrome's V8 JavaScript engine. It is used for developing scalable, server-side applications. Node.js is event-driven, non-blocking I/O model enables developers to build fast, lightweight, and efficient applications that can handle a large number of simultaneous connections with high throughput. It also has a vast ecosystem of packages and libraries available through its package manager, npm. One of the key advantages of Node.JS is its speed in developing and deploying DApps, thanks to its libraries. It is also asynchronous, meaning that its modules and libraries can operate independently without waiting for API data to be returned. Despite being a single-threaded framework, it is highly scalable and can handle a large number of requests compared to traditional servers. Additionally, Node.JS does not buffer data and generates output in chunks.

B. IPFS

Inter Planetary File System (IPFS) is used to store data i.e. being embedded into smart contract that can be accessed by anyone on the internet with specific permission. IPFS is often used in blockchain applications to store data and files, as it allows for efficient and reliable data sharing and distribution. By using IPFS in blockchain, developers can create decentralized applications that are more resilient to network failures and censorship, and provide greater privacy and security to users. Additionally, IPFS can be used to store smart contract code, ensuring that it is available to all nodes in the network.

C. Blockchain

Blockchain is a decentralized, distributed digital ledger technology that records transactions and data in a secure and transparent way. It enables secure and tamper-proof transactions without the need for intermediaries, such as banks or financial institutions. Blockchain is being explored in various industries, including finance, healthcare, logistics, and more. This technology enables transparent, verifiable, and immutable recording and transfer of data through an open distributed ledger system. All nodes on a blockchain network have access to the transaction record, creating a transparent and easily verifiable system. Cryptography ensures the immutability of all data on the blockchain, making it tamper-proof.

D. Ethereum

Ethereum is a platform where the developer can deploy their smart contract in a blockchain enabled environment which helps them in developing a d-Apps. Developers can create and implement smart contracts and decentralised apps (dApps) using Ethereum, an open-source, blockchain-based decentralised platform. The Ethereum platform operates on its cryptocurrency called Ether (ETH) and is designed to be more flexible than Bitcoin, allowing developers to create their own custom applications and tokens. Ethereum also introduced the concept of "gas," a payment mechanism for transactions and smart contracts, which prevents spam and incentivizes miners to process transactions. Its potential uses range from decentralized finance (DeFi) and supply chain management to voting systems and identity verification.

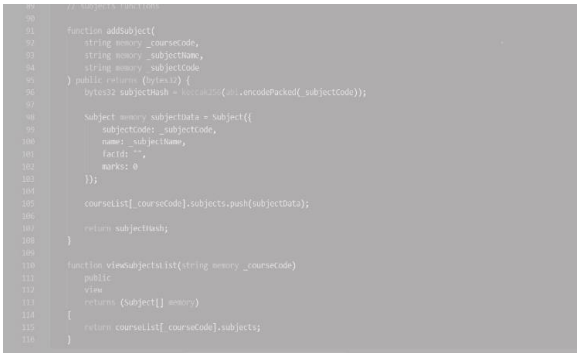
E. Remix-IDE

Remix IDE is an open-source Integrated Development Environment (IDE) for developing and testing smart contracts on the Ethereum blockchain. Remix IDE provides a user-friendly interface that includes a text editor with syntax highlighting, code completion, and debugging tools. It also includes a built-in Solidity compiler and a virtual machine for testing and debugging smart contracts. Remix IDE supports multiple networks, including the Ethereum mainnet, testnets, and private networks, making it a versatile tool for blockchain development. It is widely used by developers and auditors in the Ethereum community due to its simplicity and ease of use.

F. Solidity

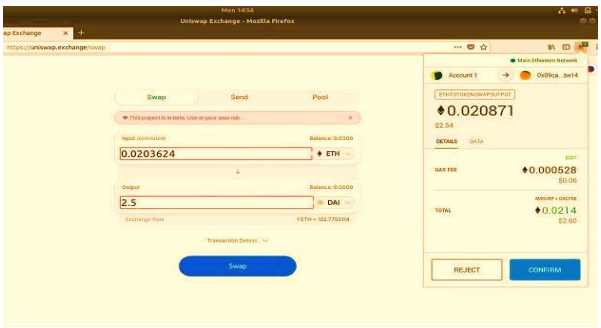
Solidity is a high-level programming language specifically designed for writing smart contracts on the Ethereum blockchain. It is a statically typed language that is similar in syntax to JavaScript and C++. Solidity is an object-oriented language that allows developers to define their own data structures, functions, and variables. It also includes various features such as inheritance, libraries, and modifiers to improve the efficiency and functionality of smart contracts. Solidity code is compiled into bytecode that can be executed on the Ethereum Virtual Machine (EVM). Solidity is the most popular language for smart contract development on the Ethereum platform and is widely used in the development of decentralized

applications (dApps) and other blockchain-based solutions.



MetaMask

Metamask is a browser extension that allows users to access Ethereum-based decentralized applications (dApps) without running a full Ethereum node. It serves as a digital wallet and provides a user-friendly interface for managing Ethereum accounts and interacting with dApps. Metamask supports multiple Ethereum networks, including the Ethereum mainnet, testnets, and private networks, and allows users to switch between them seamlessly. It also includes features such as importing and exporting of private keys, the ability to view transaction history, and a customizable gas fee system. Metamask provides a secure way to store and manage Ethereum-based assets, using industry-standard encryption methods to protect users' private keys. It is widely used by the Ethereum community and is considered one of the most convenient and user-friendly tools for interacting with Ethereum-based dApps.



4. Working Principle

This is a Solidity smart contract that contains several structs and functions related to managing courses, subjects, faculties, students, and their results.

The contract defines the following structs:

- Course: includes the name, course code, an array of subjects, and an array of student IDs.
- Subject: includes the subject code, name, faculty ID, and marks obtained by students.
- Fac: includes a hash value, unique ID, name, and subject code.
- Student: includes a hash value, name, course code, unique ID (roll number), section, and an array of subjects.
- Result: includes the subject code, subject name, and marks obtained by a student.
- The contract also defines several mappings to store data related to courses, faculties, students, and their results.
- The contract includes several functions to add and retrieve data related to courses, subjects, faculties, students, and their results. Some of the important functions are:
- addNewCourse: adds a new course with a name and course code.
- addSubject: adds a new subject to a course with a name and subject code.
- addFac: adds a new faculty member with a unique ID, name, subject code, and index of the subject to which they are assigned.
- addStudent: adds a new student with a name, unique ID, course code, and section.
- fillExamForm: populates the array of subjects for a student based on the course code.
- addMarks: adds marks obtained by a student in a particular subject. This function can only be called by an authorized faculty member.
- getResult: returns the array of subjects and marks obtained by a student.

The code includes a modifier named isAuthorized, which checks whether the caller is an authorized faculty member to add marks to a particular subject. This modifier is used in the addMarks function to ensure that only authorized faculty members can add marks. Linking IPFS to the Smart Contract will lead to us accessing us to faculty details and student details.As well as we can view results as Student as well as Faculty . The whole system can be

integrated with the help of Metamask to simulate a real time transactional process.

5. Future Enhancement

- Hall Ticket Generation -We Could integrate a Hall Ticket generation system where the Transaction Data and The Transaction Hash can be displayed in a function that could ease out for collection and implementing a Hall Ticket in an Examination.
- Grade Card Generation – Students can easily enter a key credential mentioned to generate their Grade Card easily at a click.

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