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Secure Healthcare Website using Blockchain

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Abstract

Blockchain technology is consistently being an interested topic of research for researchers, and multiple of businesses as organizations are highly benefitted from its features. Blockchain technology has many benefits for the healthcare sector, including security, privacy, secrecy, and decentralisation. Privacy and protection of medical data are some of the important issues to looked after while availing any medical services. Secure storage is something which people look up for. Efficient Healthcare System is which allows the users to communicate securely without any worries about their data. This study is about how the blockchain technology can be applied to change the EHR systems and potentially provide a fix for these problems. A framework integrating EHR and blockchain to enable a secure medical data transfer between patients and hospitals is the objective of this study.

Keywords: Blockchain, Privacy, Protection, Healthcare, Distributed Ledger, Decentralization

1. Introduction

The way things are used and perceived is changing as a result of recent technological breakthroughs, which affect every aspect of human life and technology is developing new strategies to progress the healthcare sector, just like how it has improved a variety of other areas of life. Security, user experience, and other improvements are a few of the primary benefits that technological innovations are providing to the healthcare sector. These benefits were offered by electronic medical record (EMR) and electronic health record (EHR) systems. Nevertheless, there are still certain issues with data security, user ownership of data, and data

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integrity. The blockchain technology offers a safer environment, by securing the medical data records and the health care information's [15].

In case of Healthcare System, previously patient records used to be stored on papers. It was difficult for doctors and hospitals to deal with the medical data of patients in an easy manner which would save time along with the resources. It was very difficult for doctors to trace medical history of patients. Also, there exist issues about transparency. Patients who visit more than one hospital mostly undergo similar medical examination every place and this gives rise to issues like data redundancy and duplication. It is an issue because mostly medical organizations are centralized and manage the data of patients themselves. But in such cases, there is no guarantee about security of patient's data. It makes the data prone to threats like hacking, which leads to data security and privacy issues. Medical institutions have been observing frauds done by patients to avoid payment. These cases are difficult to handle as there exists no connection between the insurance companies and medical institutions.

The EHR systems, has created an infrastructure to integrate the conventional paper-based and electronic medical records (EMR) [16]. In many healthcare scenarios these methods were usually employed only in keeping record of clinical notes and the test findings. By this the hospitals were able to reduce the blunders and improve the information access. [17]. The goal of the EHR is to transform the existing healthcare industry into an efficient system that could handle the problem associated with the conventional medical documentation methods [18].

Blockchain is an emerging technology that records the transactions which cannot be altered after. Before inserting the block, it needs to be verified and then are linked to preceding block which then forms a long block chain. Once entered, modifications can't be done to the information written in the Blockchain. Blockchain can never even delete the records without common consensus. It provides organized data sharing which results in accurate medical examination without any waste of time. Blockchain with its following features helps to resolve the issues [3]:

1.1 Verifiability

It is the ability of blockchain to validate and confirm accuracy, integrity and authenticity of data and transactions stored. It ensures that the data can be verified by anyone with the access of blockchain network independently, without any central authorization. Verifiability plays a major role in maintaining EHRs, it ensures integrity, security and trustworthiness of data. It allows patients and doctors or hospitals to independently verify accuracy and authenticity of EHRs while also taking care of privacy. In the end, the EHR ecosystem's verifiability of blockchain encourages data integrity, interoperability, patient empowerment, and improved healthcare results.

1.2 Immutability

Blockchain ensures that once data is added on to the blockchain, it is impossible to alter or delete data without detection. This feature provides high level data integrity and trustworthiness in EHRs, as it helps in preventing unauthorized modifications, deletion or tampering. Transparency, accountability, and security within the healthcare system are enhanced by the immutable nature of blockchain, which can be relied upon by healthcare professionals, patients, and auditors to confirm the accuracy, authenticity, and chronological order of EHR data.

1.3 Decentralization

Blockchain technology's key component of decentralization significantly aids in the upkeep of electronic health records (EHRs). Blockchain prevents the existence of a single entity from having total control over the records by dispersing EHR data among a network of nodes. Because it lessens the possibility of a single point of failure and strengthens the system's resistance to cyberattacks, this decentralized architecture improves security. Decentralization also encourages data accessibility and availability, making it possible for patients, healthcare professionals, and other authorized parties to securely access and share EHRs across the network. Transparency, interoperability, and collaborative decision-making are fostered by the distributed nature of blockchain in maintaining EHRs, which ultimately improves patient care and healthcare outcomes.

This study is about a healthcare system which uses Blockchain, and securely manages personal medical data on the blockchain storage system. It is easy for doctors to access

patient's medical history. Data sharing between the medical institutions saves time and provides efficient treatment. There is no involvement of any third party as it is a decentralized system.

For this system a systematic review is done based on Blockchain technology, its applications in healthcare sector and existing systems with its flaws to find out improvements.

2. Related Work

When Nakamoto [19] created the blockchain technology, the main objective was to create a decentralised currency that was cryptographically safe and useful for financial transactions. In the end, the blockchain concept was applied to many other spheres of life; the healthcare industry is one of them and plans to employ it. Numerous researchers have conducted research in this field, with their studies focusing on the viability of the idea of integrating blockchain technology in the healthcare industry. The benefits, risks, issues, and difficulties that come with using this technology are also described. Some researchers have talked about the difficulties in really putting this into practise on a bigger scale.

Review of researches is done to collect information about the background, current status and previous system flaws, where solution can be found to the unattained problems. A variety of related study is reviewed and summarized as follows:

According to a study by Gauri Lodha, Sarvesh Sahasrabudhe, Manu Pillai, Ankit Solanki, and Ashwini Jarali [1], medical data protection and privacy are essential in healthcare services. Healthcare systems may be profoundly impacted by blockchain technology due to its immutability, decentralisation, transparency, and distributed ledger. This study developed a safe healthcare system that communicates with physicians, patients, insurance providers, and pharmacies. The system compares conventional systems, describes its breadth and potential future research fields.

According to research by Tran Le Nguyen [2], Bitcoin and other cryptocurrencies have grown in popularity because of their quick development and possible use in a variety of industries. In order to handle patient records and medical processes during surgeries, this article set out to develop a diagrammatic conceptual model for a medical app using Blockchain technology. In order to facilitate direct patient management and assist patients in comparing prices, procedures, and pre- and post-surgery preparations, the model concentrated

on mission space conceptual models and simulation space models. The goal of the study was to advance the field by enticing medical stakeholders to act as Blockchain "miners" and provide anonymous data as payment for preserving and protecting the network through Proof of Work[12,13].

According to LALIT GARG and EMEKA CHUKWU's research, blockchain technology has grown in popularity in the healthcare industry, especially among multi-stakeholder organisations. It has the potential to deal with issues like the centralization of power, flaws, and points of vulnerability in EHR systems. This study focused on prototypes and pilot implementations as it examined 143 blockchain-in-healthcare frameworks. The findings demonstrated that, despite frequent performance, storage, and cost trade-offs, blockchain can address the trust, security, and privacy issues associated with conventional EHRs.

In their study, Xingtong Chen, Min Xu, and Gang Kou [4] analysed academic studies on blockchain, notably in business and economics, with an emphasis on the sharing economy, initial coin offers (ICOs), blockchain technology, and economic benefits. It lists five research issues and makes suggestions for future research directions and useful applications.

In the research presented by Farjana N. et al.[5] stated that EHRs are essential for tracking health information and ensuring privacy and security in healthcare. Blockchain-based solutions can address these concerns by providing a decentralized approach to data security. This research presented a system based on blockchain [7] that provides the services of managing and securing patients data using Ethereum networks, Ganache, and programming languages like Solidity and web3.js. The system uses blockchain smart contracts to store patient data and execute functions, providing security and privacy features. A cryptocurrency wallet (MetaMask) is also used to store and secure records. The proposed system aimed to increase efficiency, credibility, and reduce barriers, while facilitating secure storage and transfer of patient medical records. This quick and secure protocol promotes greater openness and ownership of sensitive data, ultimately benefiting the healthcare sector [8,9].

Blockchain technology is revolutionising healthcare by protecting and transmitting patient data through networks in hospitals, diagnostic laboratories, pharmacy enterprises, and physicians, according to Rajiv Suman, Mohd Javaid, Ravi Pratap Singh, Abid Haleem, and

Shanay Rab [6]. It can spot errors and enhance performance, security, and openness in the exchange of medical data. This technology improves the analysis of medical information and offers adaptability, interconnection, accountability, and data access authentication. Additionally, it aids in decentralised data protection and protects against specialised healthcare risks [10,11].

3. Methodology

Security can be interpreted in a variety of ways. Security is usually referred as the confidentiality, which forbids unauthorised information sharing, integrity, which prevents unlawful information modification or deletion, and availability, which forbids unauthorised data withholding.[14].

Using solidity language, a smart contract is then established, storing all of the users' cryptographic keys before being connected to the blockchain as an on-chain component stage to create the suggested smart contract. Smart contracts can be written in the high-level object-oriented language solidity. The Ethereum state can be controlled via smart contracts, a well-known piece of software.

3.1 The Framework Required is

3.1.1. Ethereum [5]

Ethereum is a blockchain-based decentralised network. Ethereum was created with the intention of creating an open-source platform for blockchain-based smart contracts. Another strategy, this technology uses to proliferate is peer-to-peer networking. It also makes use of Ethers, a unique coin. Additionally, Solidity, a programming language that facilitates the creation of custom blockchains, is made available to programmers by Ethereum.

External parties interact with Ethereum through transactions. On the Ethereum blockchain network, it enables external users to change the state of a file or collection of data. The essential components that make up an Ethereum transaction is the sender and the receiver. A customer must first send out ethers, the intermediary monetary value, in order to complete any transaction on the Ethereum network. This is referred to as gas. On the Ethereum network, the computational power required to carry out a transaction or a smart contract is measured in

gas. Gas is significantly less expensive than ether. In Ethereum, the execution and resource usage fees are predefined in terms of Gas units, or gwei.

3.1.2 Smart Contract

To accomplish every transaction on the blockchain, a "smart contract" is a set of instructions. This line of code is executed when users send transactions. Smart Contracts run directly on the blockchain, making them resistant to alteration and manipulation. Smart contracts, which are written using Solidity, can be used to programme any kind of blockchain activity. Once the operations are programmed, the programmers can put them together. Then the program put together, is run, and applied on the Ethereum blockchain. The smart contract code is written in JavaScript using Ethereum's Solidity programming language.

3.2 Software's Used

3.2.1. Ganache

Ganache is used in deploying, developing and testing the in an environment that is secure and monitored. Both the desktop programme and command-line tool for Ethereum are available.

3.2.2 MetaMask

It acts as a gateway enabling one to use the existing browser to access the decentralised web of the future. In the browser, with no need of having to run a full Ethereum node, it enables you to run decentralised Ethereum apps.

3.2.3 Web3

Additionally, there is a library collection that facilitates communication between Ethereum nodes and in-chain parts. It is utilised by Node.js on the server side.

Through an Ethereum node, Web3 connects to the Ethereum network through an HTTP (Hypertext Transfer Protocol) connection. This might be a node for local system ETH wallets. one can utilise the Ethereum platform on the website and access the Ethereum accounts with the aid of the in-browser extension MetaMask. The Web3 provider class is connected to the browser through the browser-based Ethereum wallet MetaMask. Access to

Ethereum nodes that are open to the general public is provided by a data structure called a Web3 provider. The MetaMask enables the user to manage their account including, saving the password etc. The front end and the backend communication of the application is enabled by employing the web3.js, MetaMask , Ethereum and the web interface.

3.2.4 Trufffle

This stable Ethereum Virtual Machine development environment, which also has a test framework and an asset pipeline, uses blockchains. It can perform some functions, such as managing binary dependencies and computing, putting into use, and maintaining smart contracts. It also provides a fully automated environment for testing smart contracts and a scriptable architecture for deployment and migration. It is possible to establish a pipeline with tight integration as well as a direct link to the contract. The Truffle environment is where programmes are executed.

3.2.5 VS Code

Users of Windows, Linux, and macOS can use Microsoft's Visual Studio Code editor. There are options for fixing the bugs, underlining the syntax , intelligent code completion, GitHub administration, and troubleshooting.

3.2.6 Languages

HTML (Hypertext Markup Language), CSS (Cascading Style Sheets), and React.js were used to develop the front-end design of the website. The computer languages Solidity and Node.js are used to operate the server and back end of the website. The system is constructed using Truffle and Ganache, two programmes that generate local Ethereum blockchains. To create an account and access the system, utilise the Local Web3 web interface, Truffle (as an IDE), Yarn (a command-line interface), MetaMask (as a wallet), and Ganache (a command-line interface)[5].

1. First of all, one has to create the smart contract to store the data of patient in the blockchain for that purpose one has to use Solidity Language. Solidity is Object Oriented Language created by Ethereum Network to design the smart contract.

2. Next step is to create the dummy account in the MetaMask and connect to Ganache to get the free Ethereum for testing purpose. Ganache is private Ethereum blockchain environment that allows one to interact with the smart contracts.

3. Then, move the smart contract to Vs code or any other editor from Remix Ide to integrate with frontend. For creating frontend one can use React.

4. After that, connect the smart contract with frontend for that purpose one can use Web3.js or ether, js.

5. To deploy the contract, one need to fetch the ABI (Application Binary Interface) from Remix Ide and then connect to service provider. One can also use the Testnets like "goerli", "Mainet" instead of dummy Ethereums etc. to deploy the smart contract.

6. Then, IPFS (Interplanetary File System) is used to store the data for that purpose the account on Infura is created.

7. After that, select the testnet for the research and then create the account of selected testnet on Metamask. georli testnet is generally use on Infura.

At last, using the key of the research (key of research) connect Infura to the application.

4. System Architecture

When a patient decides to examine their medical history stored in records through MetaMask or using the decentralized website of the healthcare system, Figure 1 shows how the system is organized. The user automatically logs in by getting an access to the private key from the Ethereum wallet. As a result, the risk of compromise is rather low as related to other hot wallets in use. The patients may also easily get a replacement if the gadget is lost, so patients need not worry about losing their medical history details. The wallet may be used similarly to verify information or sign any document. You can use this wallet to carry out multiple-patient verification. Additionally, it can be utilized to develop distributed blockchain-based property identification systems and role-based record access control

systems. The same multiple-party permissions strategy can be used to allow access to the patient's records in the event of a medical emergency. [5].

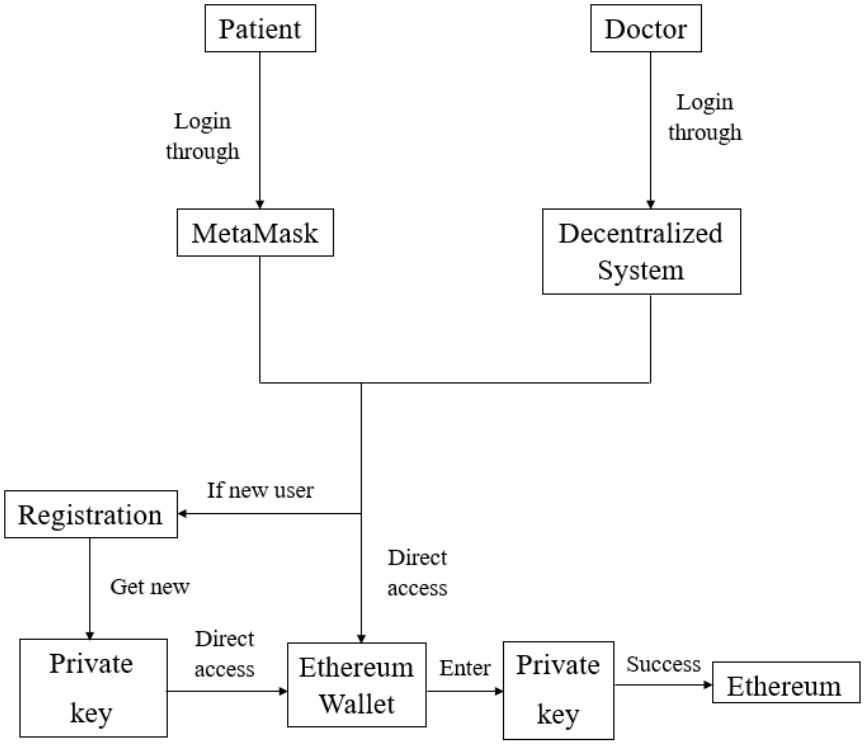

Figure 1. The Architecture Diagram of the EHR System [5]

5. Results and Discussion

Blockchain technology has developed as a method for enhancing the security of distributed systems, allowing to safeguard network users' private data in the cloud. Electronic ledgers known as blockchains are used to store thorough, independently verifiable records of all system transactions. Decentralized blockchains have proven to be a reliable solution for user identity trust concerns. This suggests that in order to guarantee the security of the data transmission, the characteristics of each transaction might be stored. Since each user has their own private and public keys, which were previously granted to them by the system and stored on the smart contract, the main goal of this work is to ensure that the system's authentication is strong and secure against attacks.

This method safeguards data integrity by hashing the data before storing it within a blockchain. The hash data are computed by the users each time it is necessary to access the data.

- The research will help in keeping records of patient medical data in a computerized manner.
- Privacy and Protection of the data is taken care of in this system.
- Being decentralized is overcomes the accessibility issues.

Figure 2 – 5 shown below are the screenshots of the final application:

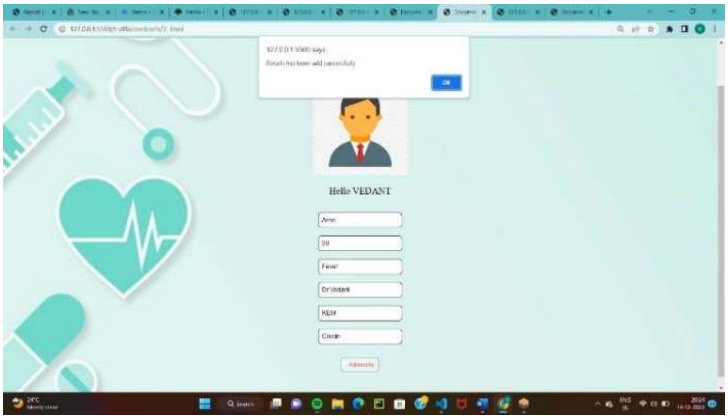

Figure 2. Submitting Details

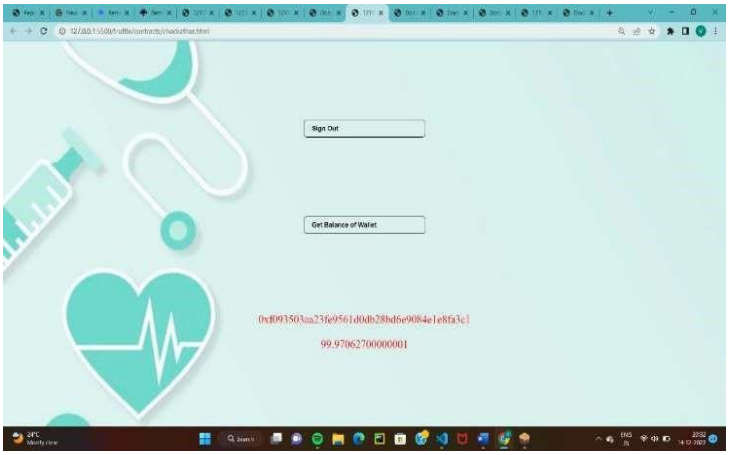

Figure 3. Check Balance of Wallet and Sign Out

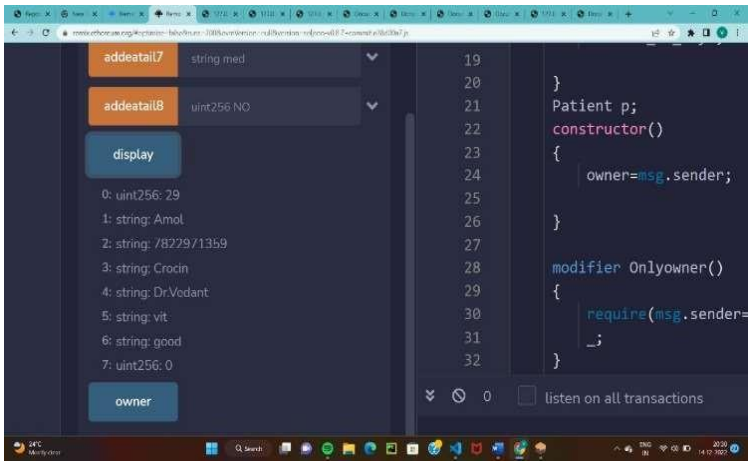

Figure 4. Backend

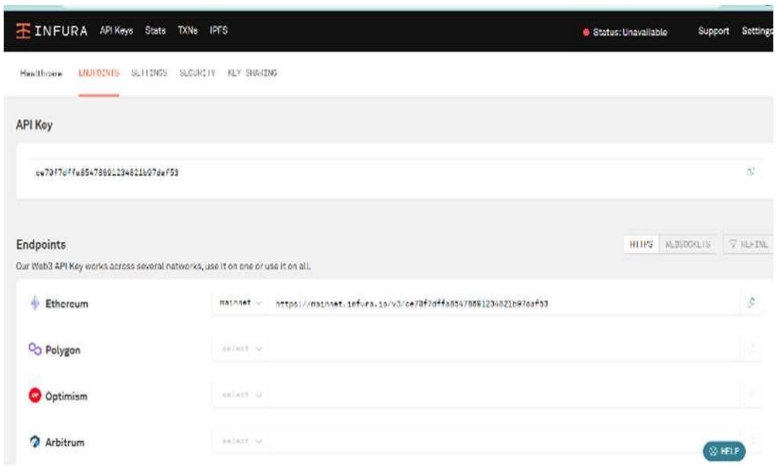

Figure 5. Infura

6. Limitations

Blockchain Technology is used in, Healthcare industry, faces some challenges which are important to review. The huge problem is lack of expertise to use this new, and advanced emerging technology.

7. Future Scope

A new feature of video communication that is a real-time system is aimed for the future development. Payment module can be integrated with the existing system. It is accomplished via the decentralized blockchain technology in which patient pay consultation fees with credit or debit cards.

8. Conclusion

This system gives authorization to authorities easily which helps them withdraw records. The automation is made easy to deploy because of smart contracts and Ethereum. The system is a link for patients who go to different doctors so that their medical information is easily accessible to the other doctors. Security and dependability are provided by the system's cryptographic encryption techniques, which are not only challenging but also impossible to break.

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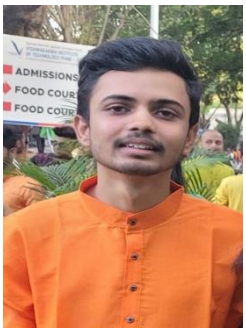
Author's biography

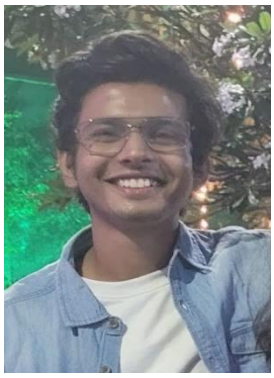


Mr. Vedant Mude is a budding researcher and undergraduate student, demonstrating exceptional enthusiasm and aptitude in the field of Computer Engineering. Currently pursuing B.Tech. at Vishwakarma Institute of Technology, he has shown remarkable initiative and passion for exploring innovative applications of blockchain technology.

Despite being an undergraduate, Mr. Mude has displayed a keen interest in the intersection of Computer and blockchain. His research endeavors focus on blockchain landscape, showcasing a deep curiosity for emerging technologies.

Mr. Mude’s commitment to academic excellence is complemented by active involvement in student-led initiatives and clubs related to Computer technologies.

With an eye for the future, Mr. Mude aspires to bridge academic knowledge with practical applications, showcasing the potential for blockchain to shape the industry. His journey as an undergraduate researcher exemplifies a dedication to lifelong learning and a passion for driving positive change through technological exploration.



Mr. Rutuj Nagrale as an undergraduate student pursuing a degree in Computer Engineering at Vishwakarma Institute of Technology, Mr. Nagrale is making remarkable strides in the world of blockchain research. Despite his status as an undergraduate, he brings a fresh perspective and innovative approach to the intersection of Computer and blockchain technology.

Mr. Nagrale's curiosity and passion for exploring the potential of blockchain have led him to delve into Specific Areas of Interest, reflecting a deep understanding of the technology's implications within his chosen field. His undergraduate research focuses on Key Themes or Challenges, showcasing a commitment to addressing real-world problems through blockchain solutions.

In the dynamic landscape of blockchain technology, Mr. Nagrale stands out as an emerging voice, exemplifying the potential of undergraduate students to contribute meaningfully to cutting-edge research. His journey reflects a passion for leveraging blockchain for positive change in Computer Industry setting the stage for a promising future in both academia and industry.

Ms. Aarya Nirgude is a driven undergraduate student pursuing studies in Computer engineering at Vishwakarma Institute of Technology. Despite being in the early stages of her academic journey, she stands out as a promising researcher with a focus on the dynamic intersection of Compute engineering and blockchain technology.

Passionate about exploring the transformative potential of blockchain, Ms. Nirgude directs her research towards Blockchain, demonstrating a keen interest in understanding the practical applications and implications of this innovative technology. Her commitment to staying at the forefront of emerging trends is evident in her undergraduate research.

Ms. Nirgude's journey as an undergraduate researcher reflects not only her academic prowess but also her aspiration to make meaningful contributions to the evolving world of blockchain

technology. Her unique perspective and dedication make her a rising star in both academia and the broader technology community.

Ms. Tejashri Nirmal as an undergraduate dynamo in Computer Engineering at Vishwakarma Institute of Technology, Ms. Nirmal shines as a rising star in the exciting world of blockchain exploration. Eager to merge her academic journey with cutting-edge technology, she navigates the complex landscape of [Her Major/Field of Study] and blockchain with enthusiasm and determination.

Ms. Nirmal's research endeavors focus on Bloclchain, where she brings a fresh perspective to the challenges and opportunities within the blockchain realm. Despite her status as an undergraduate, her work reflects a keen understanding of the practical applications and implications of blockchain technology, particularly in the context of emerging technologies.

Recognized for her innovative thinking and collaborative spirit, she represents the future generation of female researchers who are breaking barriers and making significant strides in technology.

Ms. Nirmal's journey exemplifies the potential of young, ambitious undergraduates to carve their niche in the dynamic world of blockchain. Her dedication to exploration and learning foreshadows a promising trajectory in both academia and the ever-evolving landscape of technological innovation.