A Project Report on

Healthchain : An Electronic Health Profile Storage Using Blockchain

Submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Engineering

in

Information Technology

by

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Approval Sheet

This Project Report entitled ***"Healthchain -An Electronic Health Profile Storage Using Blockchain"*** Submitted by ***"Sanjana Nalawade (17104056),Sitanshu Mathukia (18204004),Kunal Jadhav (17104026)"*** is approved for the partial fulfillment of the requirenment for the award of the degree of ***Bachelor of Engineering*** in ***Information Technology*** from ***University of Mumbai***.

Prof. Kiran Deshpande

Guide

Prof. Kiran Deshpande
Head Department of Information Technology

Place:A.P.Shah Institute of Technology, Thane
Date:

CERTIFICATE

This is to certify that the project entitled ***"Healthchain -An Electronic Health Profile Storage Using Blockchain"*** Submitted by ***"Sanjana Nalawade (17104056),Sitanshu Mathukia (18204004),Kunal Jadhav (17104026)"*** for the partial fulfillment of the requirement for award of a degree ***Bachelor of Engineering*** in ***Information Technology***,to the University of Mumbai,is a bonafide work carried out during academic year 2020-2021.

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Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, We have adequately cited and referenced the original sources. We also declare that We have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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(Sanjana Nalawade 17104056)
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Date:

Abstract

With an ever-increasing population, the number of diseases is also increasing in today's world. Every year, approximately 60% of the population is diagnosed with a variety of health problems. As a result, the number of health records is growing, some of which are stored digitally and others physically. Maintaining a personal health record for an individual can also be time-consuming, as it runs the risk of being misplaced or damaged. Our research focuses on making the entire process more convenient for patients and healthcare providers by digitising it. It focuses on converting all health records into Electronic Health Records (EHR) and storing them on blockchain because it saves money and improves performance. Healthchain is a platform that digitalizes the entire patient experience, from appointment bookings to appointment meetings, health records to medical bill payments, all in one place. Healthchain also provides doctors with information about the patient's medical history. It keeps track of individual health records issued by doctors, medical chemists, and insurance providers, all of which are under the patient's control.

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EHR: Electronic Healthcare Record
Healthchain: Healthcare Blockchain Network

Chapter 1

Introduction

Blockchain technology has the potential to transform health care by placing the patient at the center of the health system and increasing the security, privacy, and interoperability of health data. This technology could provide a new model for health information exchange (HIE) by making electronic health records (EHRs) more efficient and secure. EHRs contain critical and highly sensitive private information for diagnosis and treatment in healthcare. These data are a valuable source of healthcare intelligence. The sharing of healthcare data is an essential step toward making the healthcare system smarter and improving the quality of healthcare service.
Here are five basic principles underlying the technology.

1. Distributed Database: Each party on a blockchain has complete access to the database and its history. There is no single party in charge of the data or the information. Without the use of an intermediary, each party can independently verify the records of its transaction partners.

2. Peer-to-Peer Transmission: Communication takes place between peers rather than through a central node. Each node stores and transmits data to all other nodes.

3. Transparency with Pseudonymity: Any user who has access to the system can see every transaction and its associated value. Each node, or user, on a blockchain is identified by a unique 30-plus-character alphanumeric address. Users have the option of remaining anonymous or providing proof of their identity to others. Transactions take place between addresses on the blockchain.

4. Irreversibility of Records: Once a transaction is entered into the database and the accounts are updated, the records cannot be changed because they are linked to every previous transaction record (hence the term "chain"). Various computational algorithms and approaches are used to ensure that the database recording is permanent, chronologically ordered, and accessible to everyone on the network.

5. Logic Computation: Due to the ledger's digital nature, blockchain transactions can be linked to computational logic and thus programmed. As a result, users can program algorithms and rules to automatically initiate transactions between nodes.

1.1 Problem Definition

Hospitals keep patient data in their database; similarly, lab reports are kept in the laboratories database, and medical bills are kept in the pharmacies database. All of this dispersed data makes it difficult for the patient to maintain, store, and verify insurance claims. Furthermore, hospitals are sometimes hesitant to share data with patients or other doctors from other hospitals; there is a lack of transparency in the traditional system, and there is a need for centralization and communication among the various entities. Patient data is redundant on various organisations' individual databases, and the security of this data is jeopardised if the database experiences errors. The flow of communication between patients and doctors is an essential component of medical treatment. We all felt the need for digitalization during the covid situation, from online appointment booking to video call scheduling.

1.2 Objectives

- Collaboration Among Healthcare Organizations: It is made possible by providing the healthcare industry with a single, standardised, and consistent database of real-time patients secured with blockchain.
- Safe Data Exchanges: Blockchain protects data while also providing comprehensive data sharing options, allowing patients to unlock only the data required by their healthcare providers while keeping the rest private and secure.
- Valuable Insights for Better Care: Every day, a massive amount of health data is created; it can be a tedious task for patients to keep this data physically, as well as for doctors to go through this vast data every time, which can lead to missing important data in the process.
- Complete healthcare services, including appointment scheduling, video calling, and electronic health record storage.

Chapter 2

Literature Review

2.1 Rationale and Gap Analysis

Blockchain technology has the potential to significantly change the healthcare system by putting the patient at the center of the system and increasing the protection, privacy, and interoperability of health data. This technology could provide a new model for Electronic Health Records (EHR) by making them more effective and safer. [9]
EHRs were not designed to deal with multi-organizational, long-term medical records. Patients must retain the records, which is inconvenient given their medical conditions.[1] As a result, they disperse data around different organizations, and they change providers, resulting in the loss of previous data, which is critical for studying the latest medical situation. Furthermore, the patient does not have full access to all records and interacts with them in a fragmented manner.[1]
Data sharing is hampered by a lack of structured communication among various providers and hospitals. As a consequence, data becomes scattered rather than coherent. Data retrieval and sharing are difficult for both clinicians and patients. [10] We have put the patient first at Healthchain. The integrated, clear image of medical history helps patients. This aids in the creation of trust and involvement in medical systems, as patients who are concerned about the confidentiality of their records, may avoid using such applications or seek treatment online.
Patients are willing to manage their medical data on the internet in the age of online transactions and social media.[9] The patient's medical history is also essential for the study. Clinical trials, surveys, and teaching hospitals all provide data for the study. The patient's real-time medical data will assist in the gathering of more data for study and the provision of better treatment to others.
Because the patient is at the heart of the Healthchain application, he or she has primary access to the records.[9] Patients cannot modify or append data to the blockchain; however, they can grant providers time-limited access. Because this data is appended to the blockchain as transactions, it is secure because blockchain is decentralized and secure. As a healthcare system, Healthchain also offers a list of nearby doctors or specialists, nearby pharmacies and labs, and online appointment booking. On the portal, you can also schedule online video appointment sessions. Doctors share the unique link to join the patient's session in order to avoid unscheduled calls to doctors.
Health tokens are used to pay for doctor's visits, lab fees, and pharmacy bills. Pharmaceutical companies conducting research can request patient data in exchange for token patient data

such as allergies, previous medications, and treatments restored in a discrete format throughout the patient's medical history. Going through and analyzing such a large amount of data can be time-consuming for the doctor. Healthchain analyses medical data and presents it in tables that highlight keywords from all patients' records. The patient's blood pressure and diabetic reports are graphically represented to help understand the changes over time.

2.2 EXISTING SYSTEM

2.2.1 Electronic Health Record Systems

EHR is a record of the care you receive from your doctors or medical facilities. [9] It is created and maintained by health care providers and contains information about health issues, medications, and treatments. If you visit a lot of doctors, you might have a lot of EHR. The patient's data is stored in the cloud or on the local databases of various organisations by EHR systems. Its goal is to convert paper-based medical records into electronic medical records.[16] The data could be stored in an encrypted format or not. Some of this information is available to the patient, whereas others may be restricted to the organisation and cannot be shared.

2.2.2 Practo

An app that can be used to get health checks done right away at the nearest pathology, connect with doctors in your area, and book an online appointment.[**18**] Practo is an online tool designed to assist doctors, labs, and hospitals in managing patient data. It also assists patients by sending them digital reminders about doctor's appointments. It offers two portals: practo ray and practo.com. The former is a doctor management software for doctors that requires a monthly subscription, while the latter is a consumer portal that is free for both patients and doctors.[**18**]

Chapter 3

Proposed System Architecture

3.1 Methodology

- Helathchain is a healthcare system that offers a variety of services, such as viewing doctor profiles, scheduling online appointments, scheduling health checkups in the nearest pathology lab, paying medical bills, and verifying these records for insurance claims, all in one place. Health tokens are used for transactions on the portal, and we can buy and redeem them.

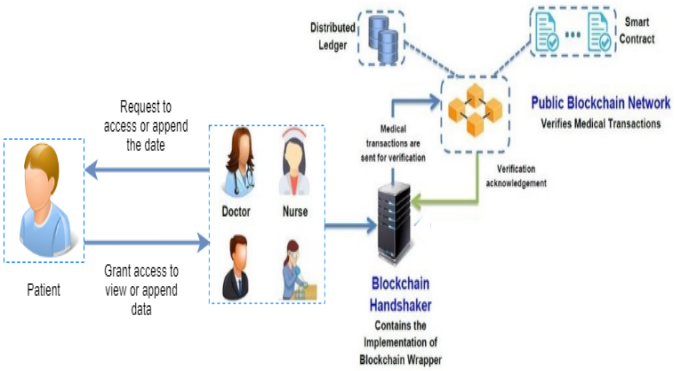

Figure 3.1: System Architecture

- The patient is the most important entity in the healthchain, and patients have granular access to the EHR. They can allow medical practitioners to view or add data to their profile, which is then added to the blockchain.

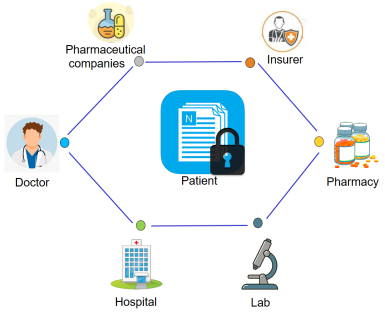

Figure 3.2: Patient Controlled Access

- Healthchain stored medical data containing the patient's medical history is critical for diagnosis. Helathchain analyses this data and provides key highlights as well as graphs for better understanding. Data is also collected from wearable IoT devices such as fitness bands, and applications that track step counts are displayed to help patients understand their progress.

3.2 Prototype

The flow of various entities is explained below

3.2.1 Patient

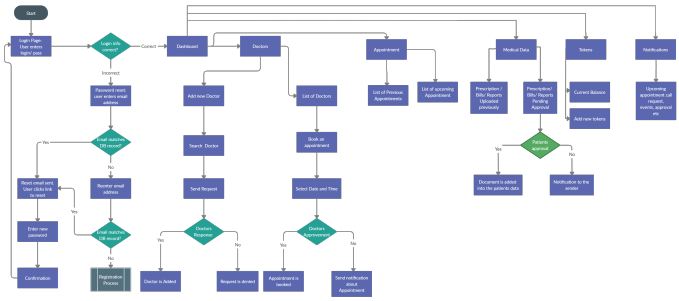

Figure 3.3: Patient Flow

- User logins into the portal
- If incorrect credentials, the user needs to proceed with the forgotten password
- Else, the user is directed to Dashboard, where the user can add Doctors to the profile by sending them a request, booked an appointment, and also join the appointments on doctors initialization.
- On the Dashboard, the user can also view the appointments schedule, Medical Data consists of pending approvals for prescriptions, bills, reports, and approved bills.
- Tokens consist of the current user balance also the user can add new tokens if required
- Notifications consist of notification regarding approval, appointments, etc

3.2.2 Doctor

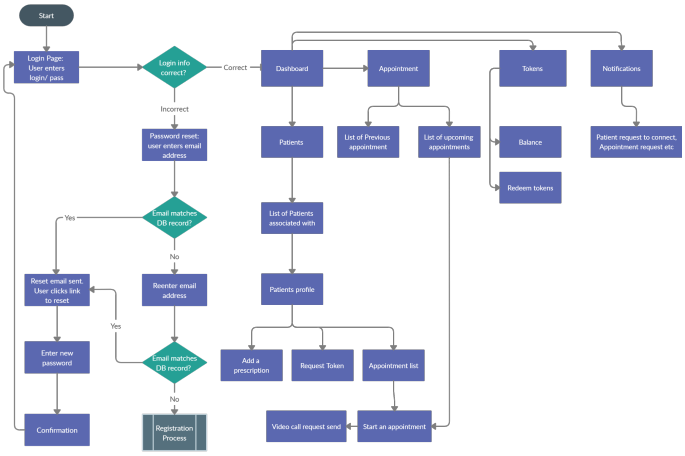

Figure 3.4: Doctor Flow

- Doctors can view Patients' information like a list of patient's profiles can add a prescription to their profile, request tokens, and can also approve appointments and start the video or call appointments from the dashboard.
- On Dashboard, they can also view the appointment schedule
- Tokens consist of the current user balance also the user can redeem tokens if required
- Notifications consist of notification regarding approval, appointments, etc

3.2.3 Labs

- Lab user can view the Patients list, can also add new patients, add new reports or bills, and can also request tokens from the dashboard
- Tokens consist of the current user balance also the user can redeem tokens.
- Notifications consist of notification regarding approval, tokens, etc

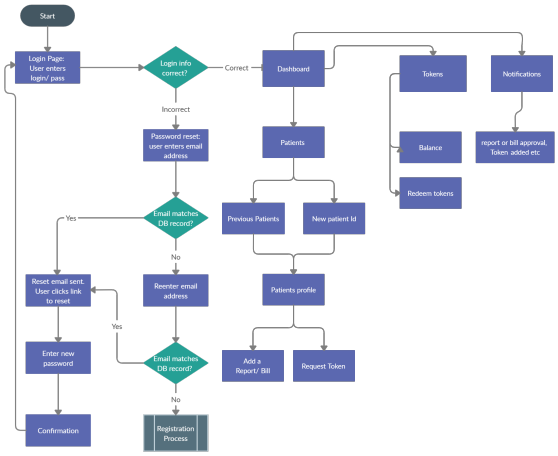

Figure 3.5: Labs Flow

3.2.4 Insurer

- The insurer can view the Patients list and can also add new patients and view their profiles, they can request access to the patients' data for approving the insurance and can also request tokens from the dashboard.
- Tokens consist of the current user balance also the user can redeem.

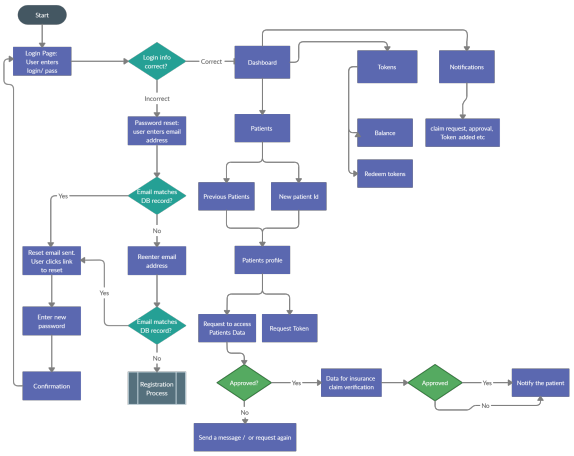

Figure 3.6: Insurance Flow

- Notifications consist of notification regarding approval, tokens, etc

3.2.5 Pharmaceutical Companies

- Company users can view the Patients list and can also add new patients and view their profiles, they can request access to the patients' data for research and can also send tokens for the same from the dashboard.
- Tokens consist of the current user balance also the user can redeem.

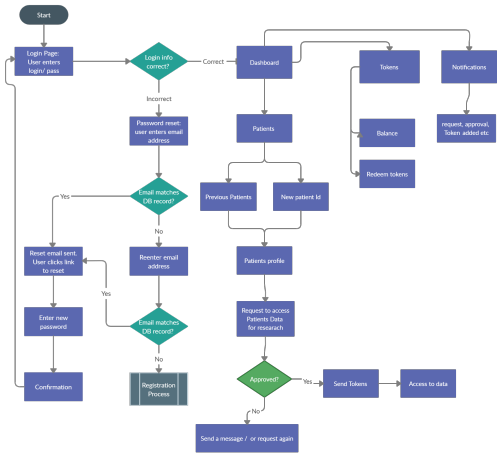

Figure 3.7: Pharmacecutical Companies Flow

- Notifications consist of notification regarding approval, tokens, etc

3.2.6 Expected Outcome/s

- Helathchain in the form of a web application will provide ease to the healthcare providers and patients since it will be a one-stop location for all the records and appointment booking, scheduling.
- Healthchain also makes it easy for the healthcare providers to collaborate, example Doctor A can easily read Doctor B's prescription from the patients' medical history record and can proceed with diagnosis much quickly.
- Data being present at Healthchain also helps Insurance companies to verify the bills and records easily.
- Data losses and redundancy will be minimized, as it is a centralized system that can be used at hospitals, clinics, and labs.
- Security Issue and data tampering with the medical records is minimized since the granular access to the data lies with the patients and only with the access from the patient the healthcare providers can add the data on the blockchain in an encrypted format.
- Data analysis on the patients' medical records which are of utmost importance to understand a patient's medical history, will help the healthcare providers with better insights which in turn will help for better diagnosis.

Chapter 4

Design

4.1 Use Case Diagram

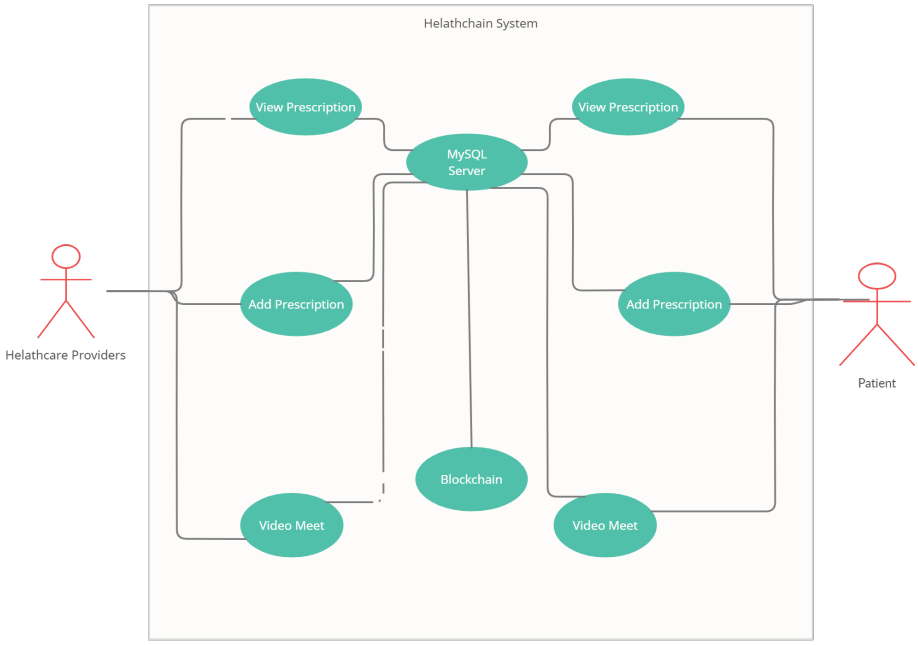

Figure 4.1: Test Cases

In the above figure Healthcare providers and patients use case diagram is shown. We can see that the healthcare provider can view or add data not directly to blockchain, they need access from the patient. The data is first added to a temp database in mysql after approval prom the patient the data is added to blockchain where it is immutable.

Chapter 5

Project Implementation

5.0.1 Program

The smart contract code for uploading document data to the Blockchain Network is shown below. This action can only be performed by the Admin of the Helathchain Account.

Home Presc.sol

```
pragma solidity ^0.6.0;

// Start of Contract
contract Presc {

    // Variables where the data of certificates will be stored

    mapping(string => string) public prescription;

    address owner;

    // To set the owner of the smart contract for Verification.
    constructor() public {
        owner = msg.sender;
    }

    // This allows only the owner to update the data to BlockChain
    modifier conditions {
        require(msg.sender == owner, 'Unauthorized');
        _;
    }

    // New Certificate generation function
    function newPresc(string memory prescription_id, string memory data) public conditions {

        prescription[prescription_id] = data;
    }


}
```

Figure 5.1: Smart Contract

Several important libraries have been added, and database connectivity has been established in the backend.

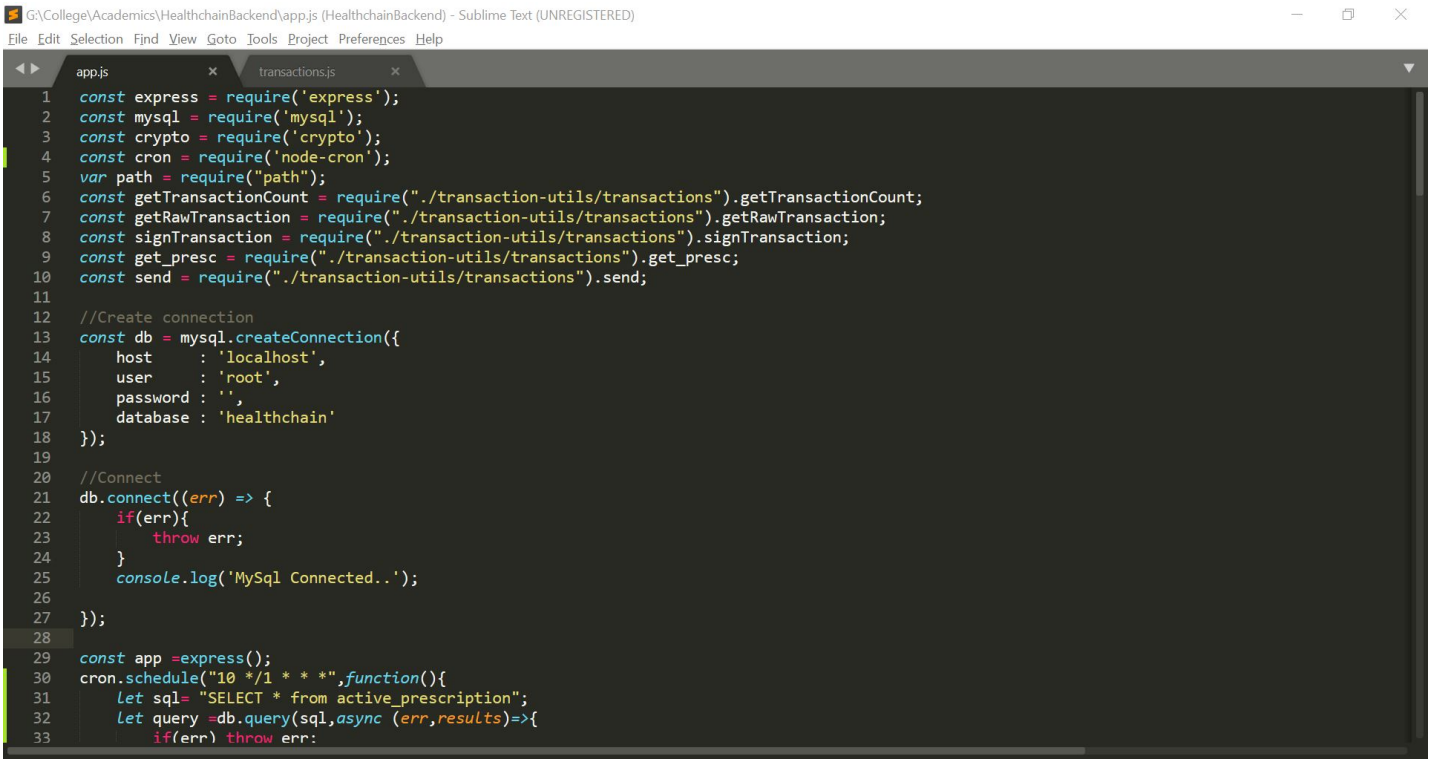

Figure 5.2: Establishing Connection

The parameters required for the Blockchain connection have been set, and an ABI file has been defined.

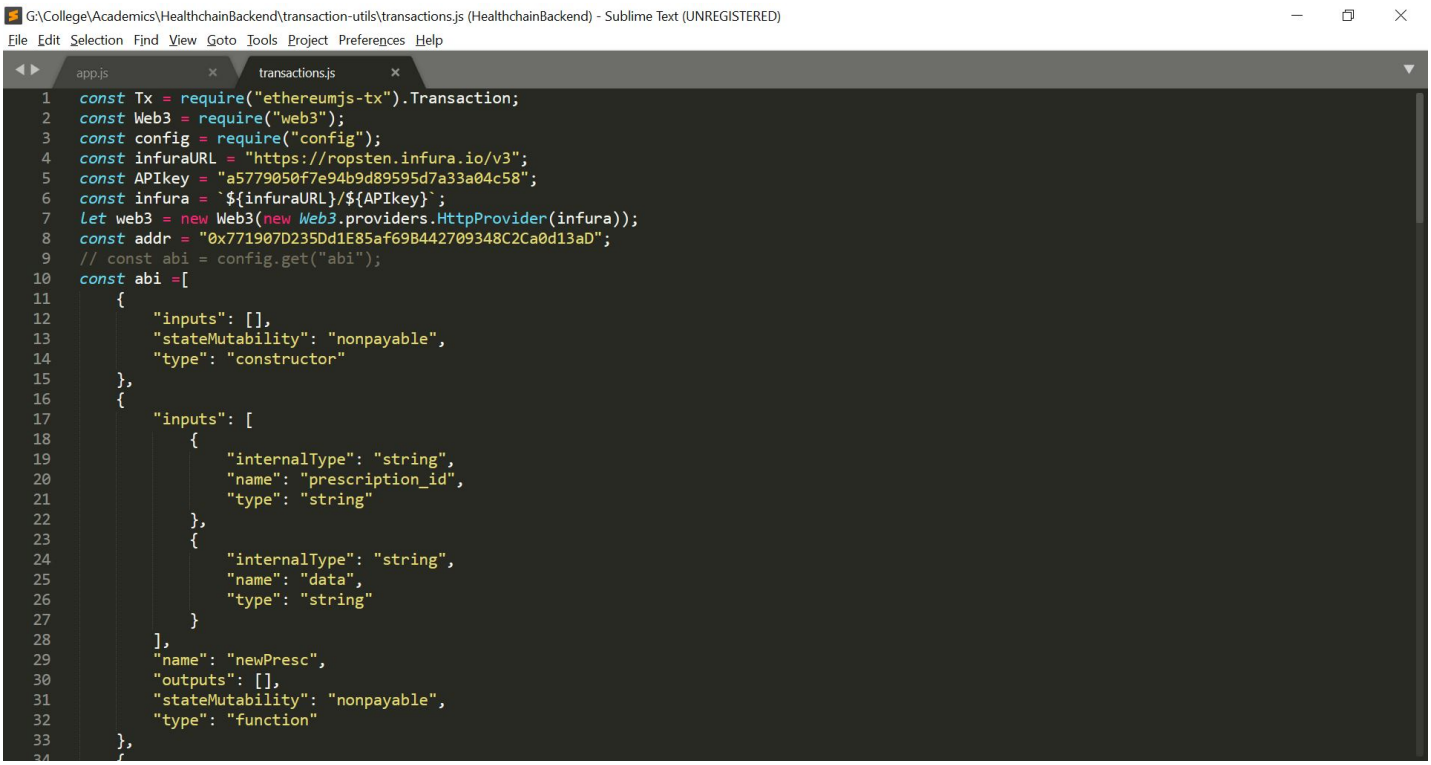

Figure 5.3: Blockchain Parameters defining

The code below demonstrates how data is extracted from a temporal database and sent to a blockchain network, as well as how the database is deleted with subsequent records.

G:\College\Academics\HealthchainBackend\app.js (HealthchainBackend) - Sublime Text (UNREGISTERED)

File Edit Selection Find View Goto Tools Project Preferences Help

app.js transactions.js

```
app.get('/uploadpresc', async (req,res)=>{
    //var flag=0;
    console.log("Request:");
    console.log(req.query.send);
    let sql= "SELECT * FROM prescription where prescription_id=?;";
    //var document_id;
    let query =db.query(sql,[req.query.send],async (err,results)=>{
        if(err) throw err;
        console.log(results);
        console.log(results[0].prescription_id);
        document_id=results[0].prescription_id;
        patient_id=results[0].patient_id;
        var prescription_data=JSON.stringify(results);
        //var hash= await Transactionn_connect(prescription_data,results[0].prescription_id);
        //console.log(Transactionn_connect(prescription_data,results[0].prescription_id));
        var nonce = await getTransactionCount();
        var rawTransaction = await getRawTransaction(
            nonce,
            prescription_data,
            results[0].prescription_id
        );
          var transaction = await signTransaction(rawTransaction);
          var done = await send(transaction);
          console.log(done.transactionHash);
          //return(await done.transactionHash);

         let sql_query = "Insert into blockchain_metadata (document_id, patient_id) values ('"+document_id+"','"+patient_id+"')"
         let sql_query2="Delete from prescription where prescription_id=? "
         let sql_query3="Delete from blockchain_active where prescription_id=? "
         let query1 =db.query(sql_query,async (err,results)=>{
            if(err) throw err;
            let query2 =db.query(sql_query2,[document_id],async (err,results)=>{
                if(err) throw err;
```

Figure 5.4: Uploading the Document to the Blockchain Network

Transactions are signed before being sent to the blockchain network, and they include the following parameters.

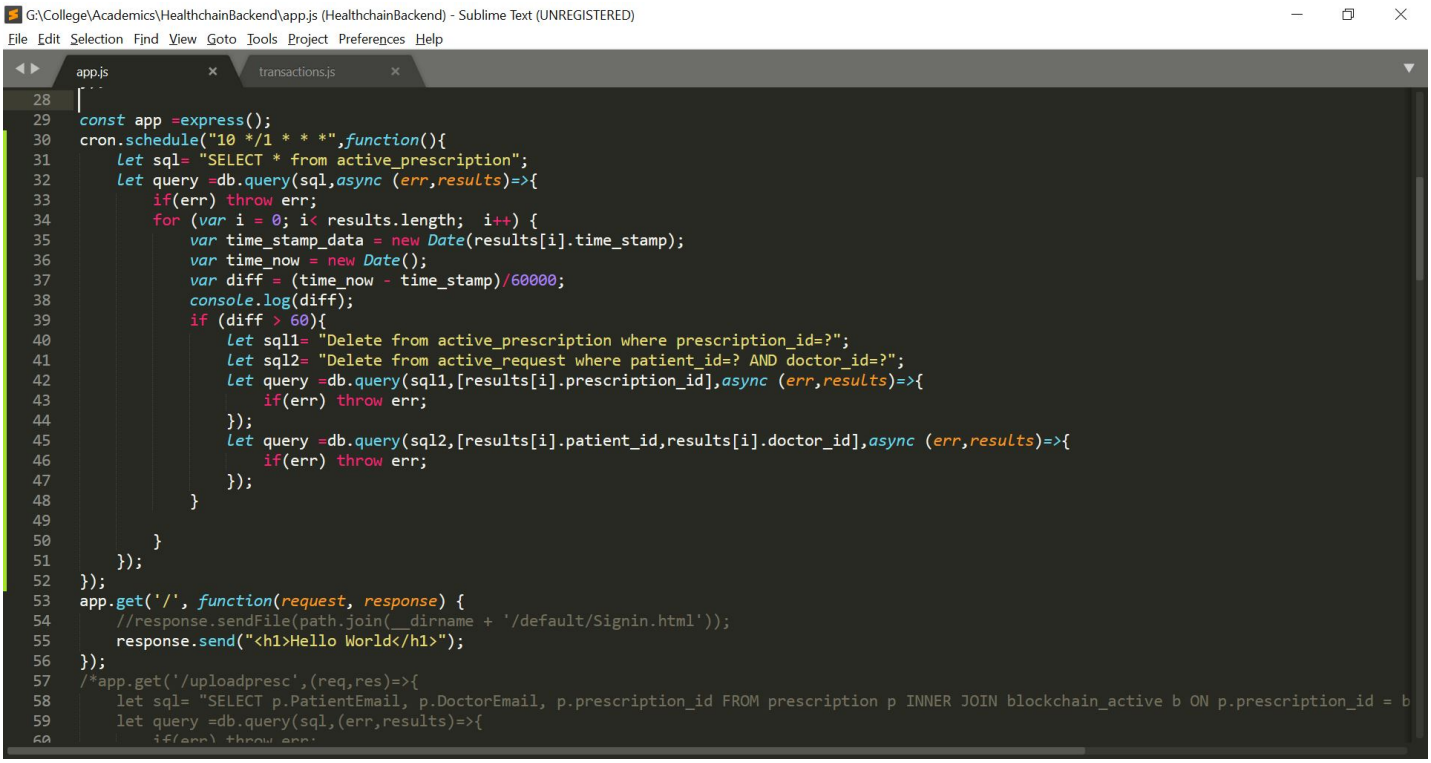

Figure 5.5: Sign Transactions before adding to Blockchain

The code below demonstrates how the data is obtained from the blockchain.

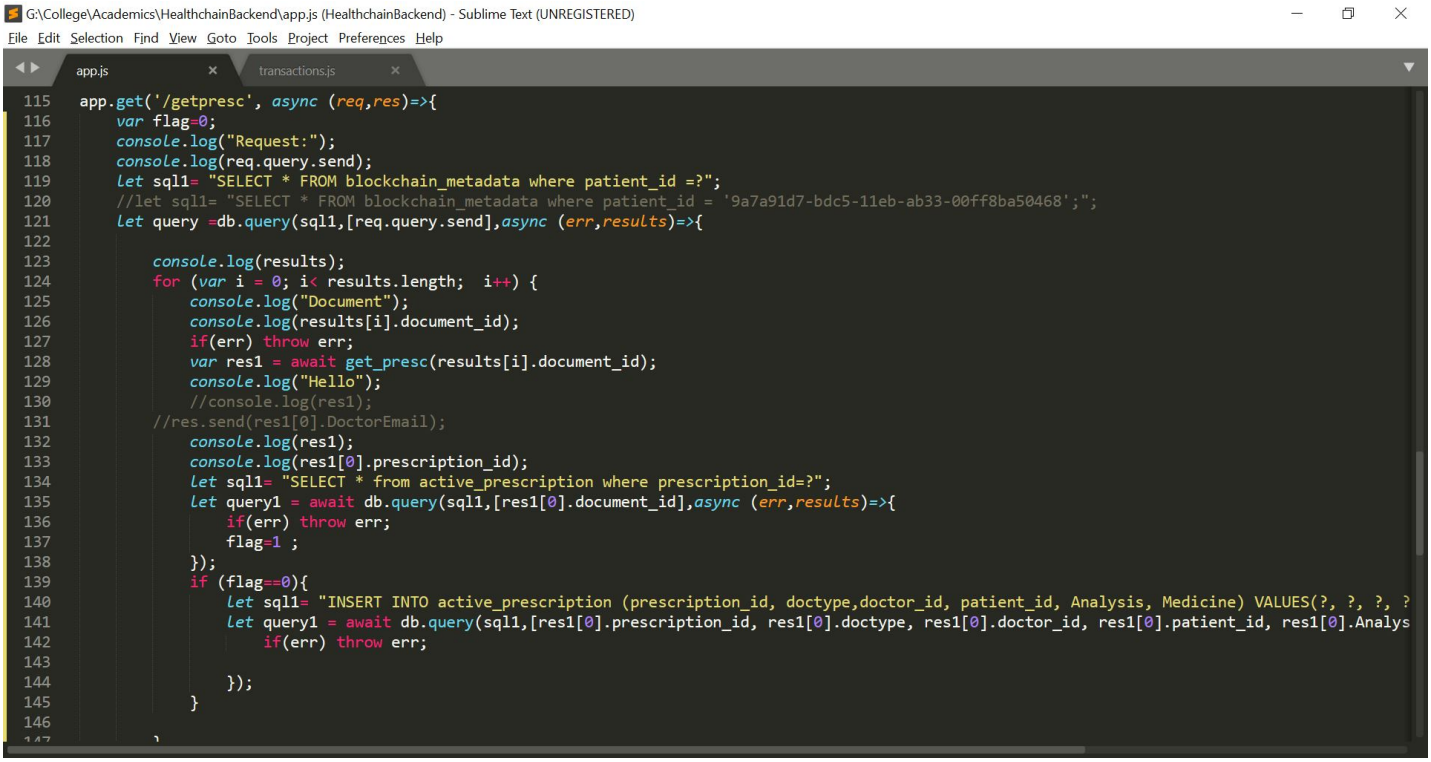

Figure 5.6: Fetch data from blockchain network

Chapter 6

Testing

The following test cases were carried out on the project in order to assess its performance and efficiency. The test also assisted us in determining the correct operation of the solidity code.

Test No	Test Name	Expected Result
1	Registering User	Register User as per their role into databse
2	Login User	User login into their respective subportal
3	Search Doctor	Display and sort the data from Doctors table
4	Add Connection	Connection request to doctor and after acceptance display I in connected doctor
5	Upload Document	Upload document to the temp database
6	Uploading to Blockchain	On patient approval upload it on blockchain network
7	Request Access to View Data	To view data, Request Access From Patient
8	View Data Access Given	Access Approval by patient
9	Map data to the patient	Data fetched from blockchain and stored in temp database
10	Time Limit Access	Time limit access to the user for viewing data
11	Display Data to healthcare provider	displayed to requires user
12	Video call initated by Doctor	Doctor Initaites the video call for recorded appointments
13	Patient joining the video call	Patient succeffully joins the video call
14	Add Graph Data	Graph data is plotted

Figure 6.1: Test Cases

Chapter 7

Result

The following images are the results/output screenshots of our finished application: "HEALTHCHAIN "

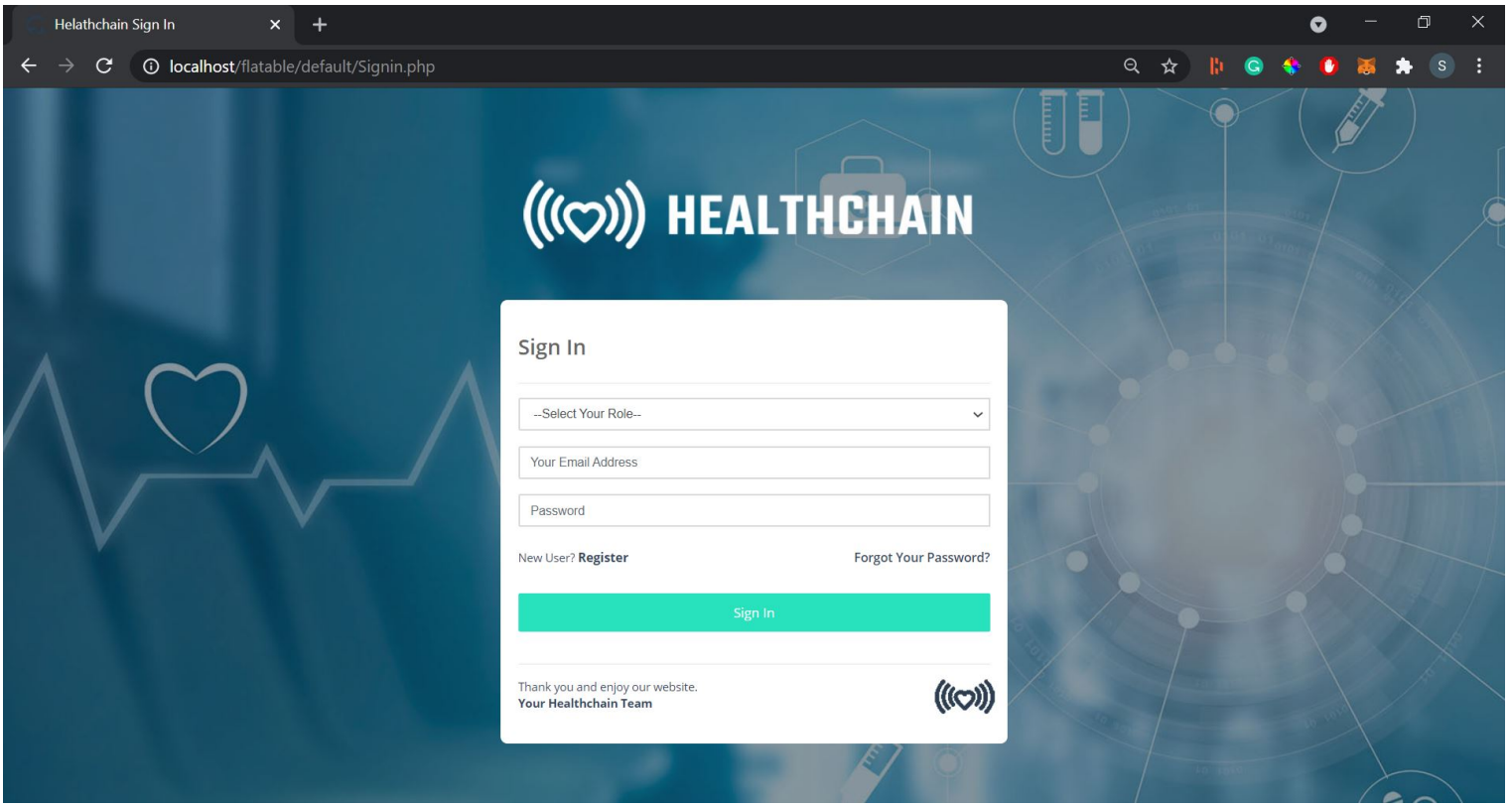

Figure 7.1: Sign In

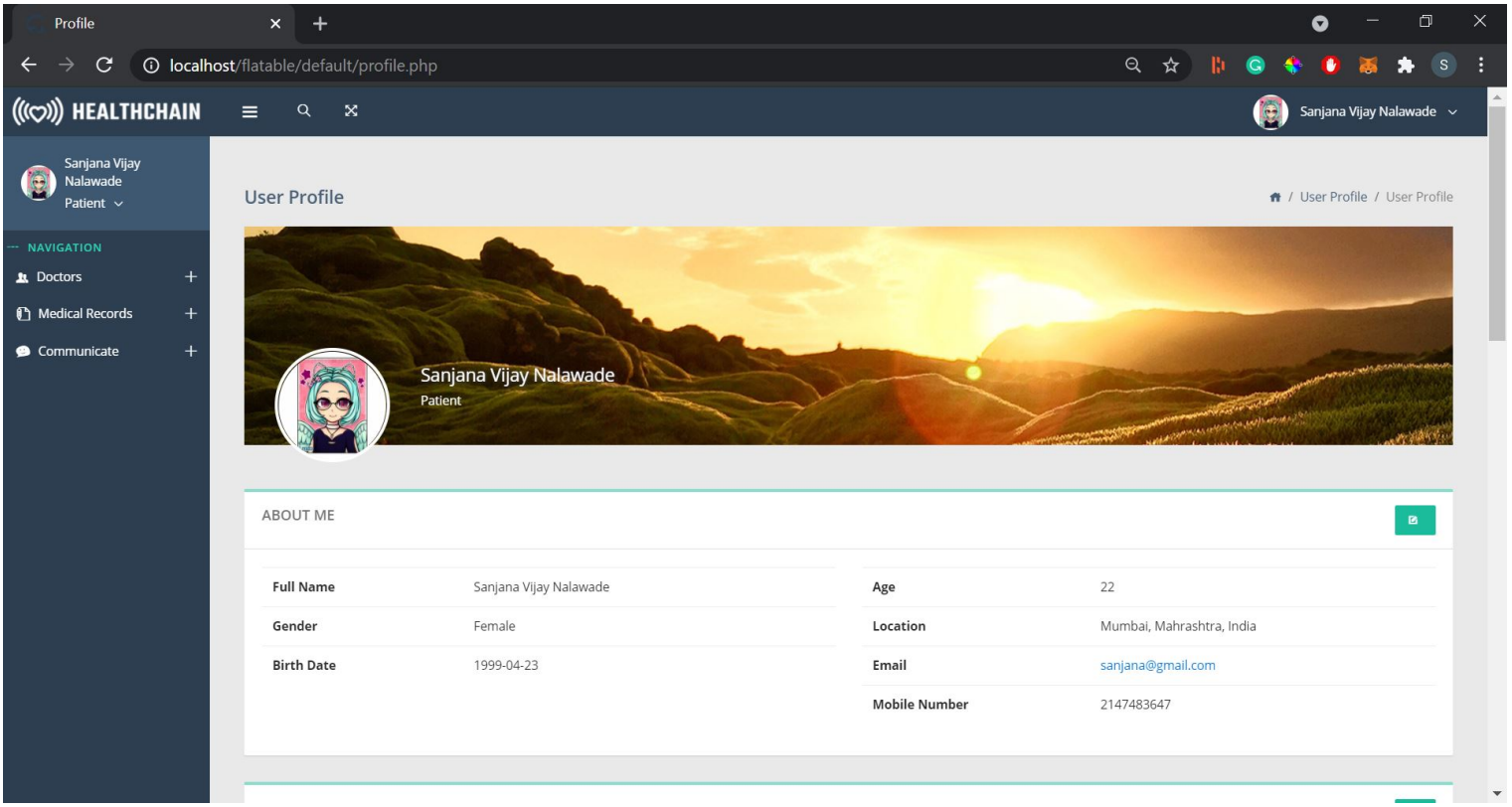

Figure 7.2: Patient Profile

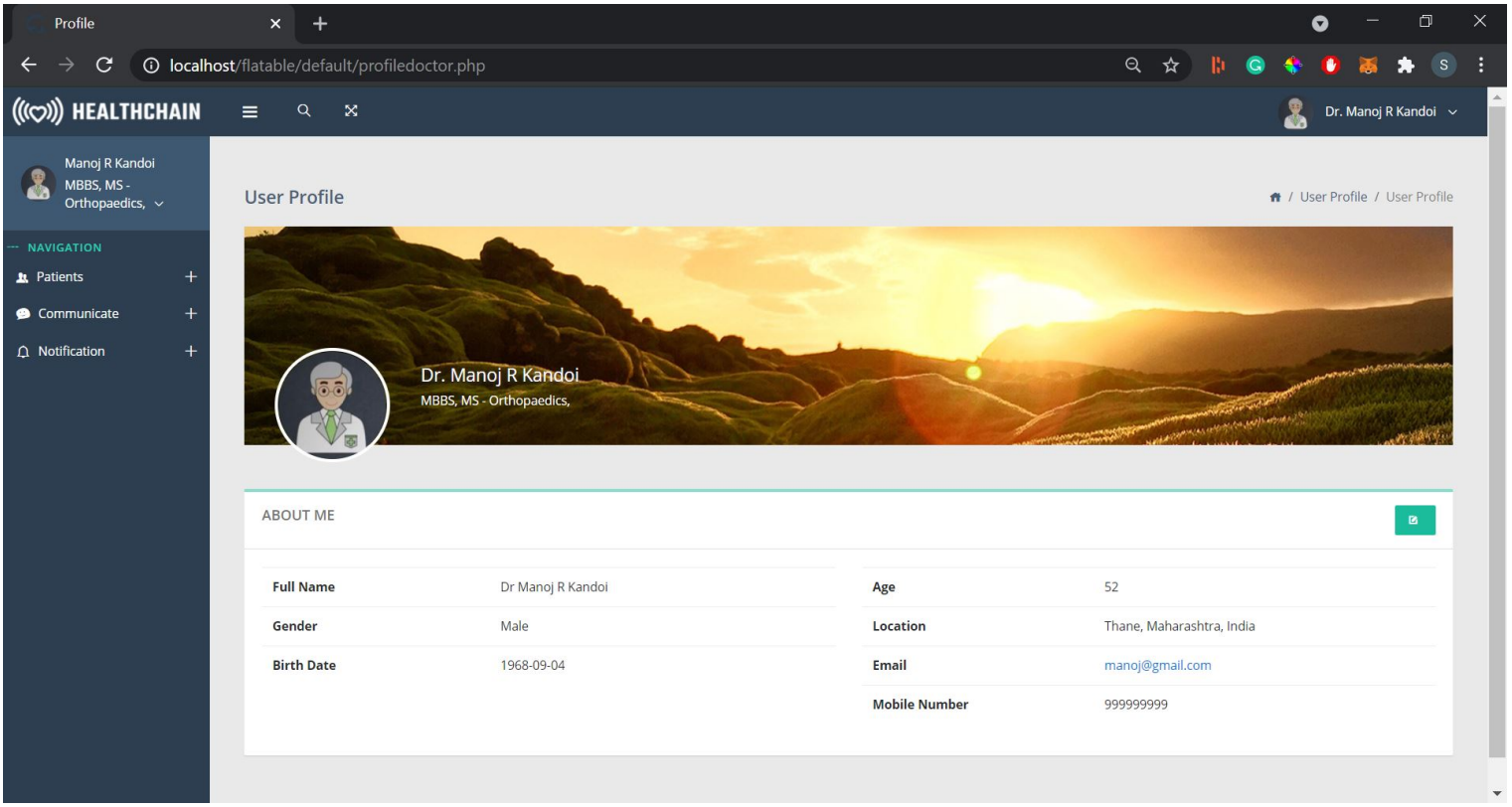

Figure 7.3: Doctor Profile

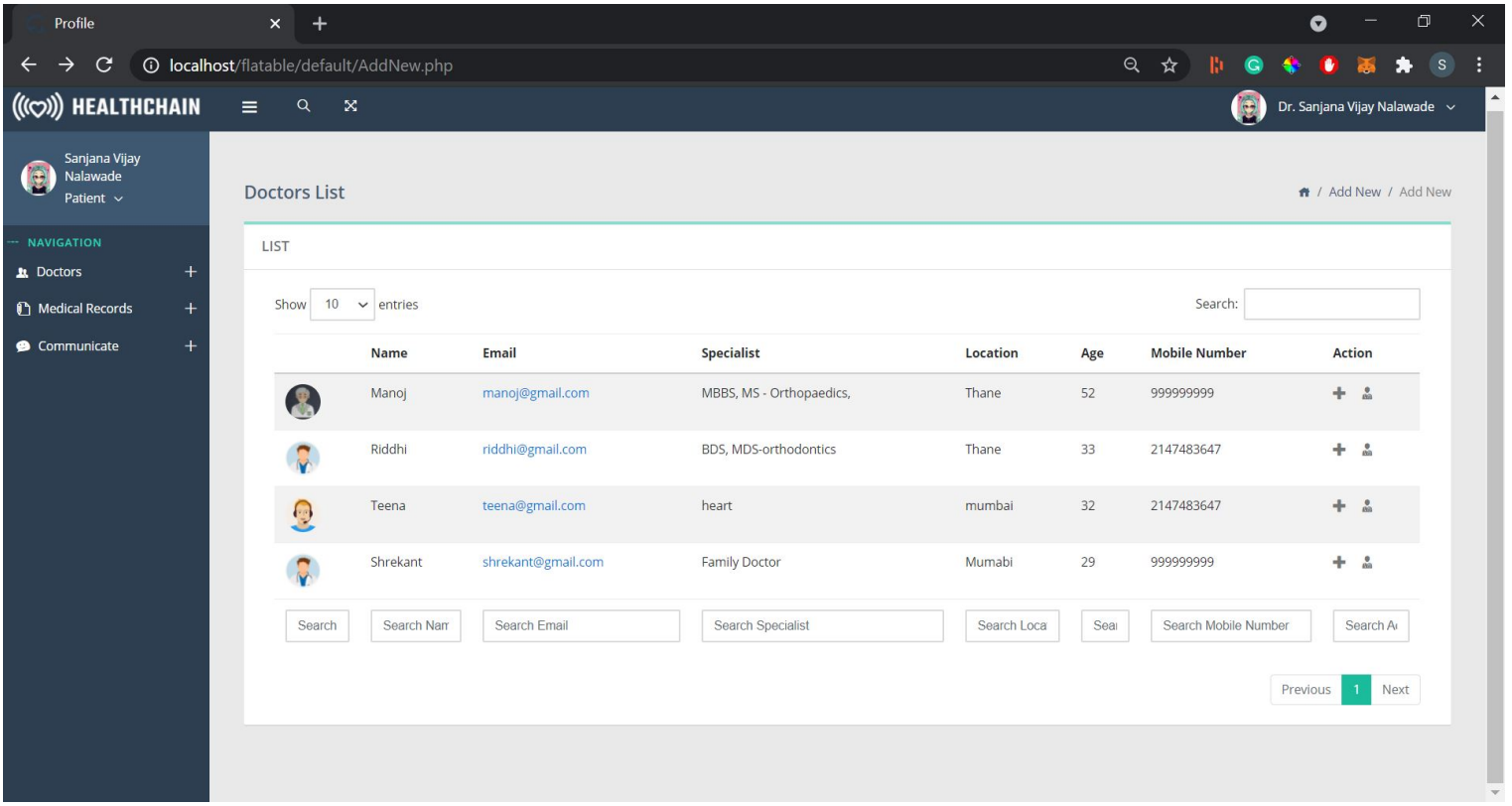

Figure 7.4: Sending connection request

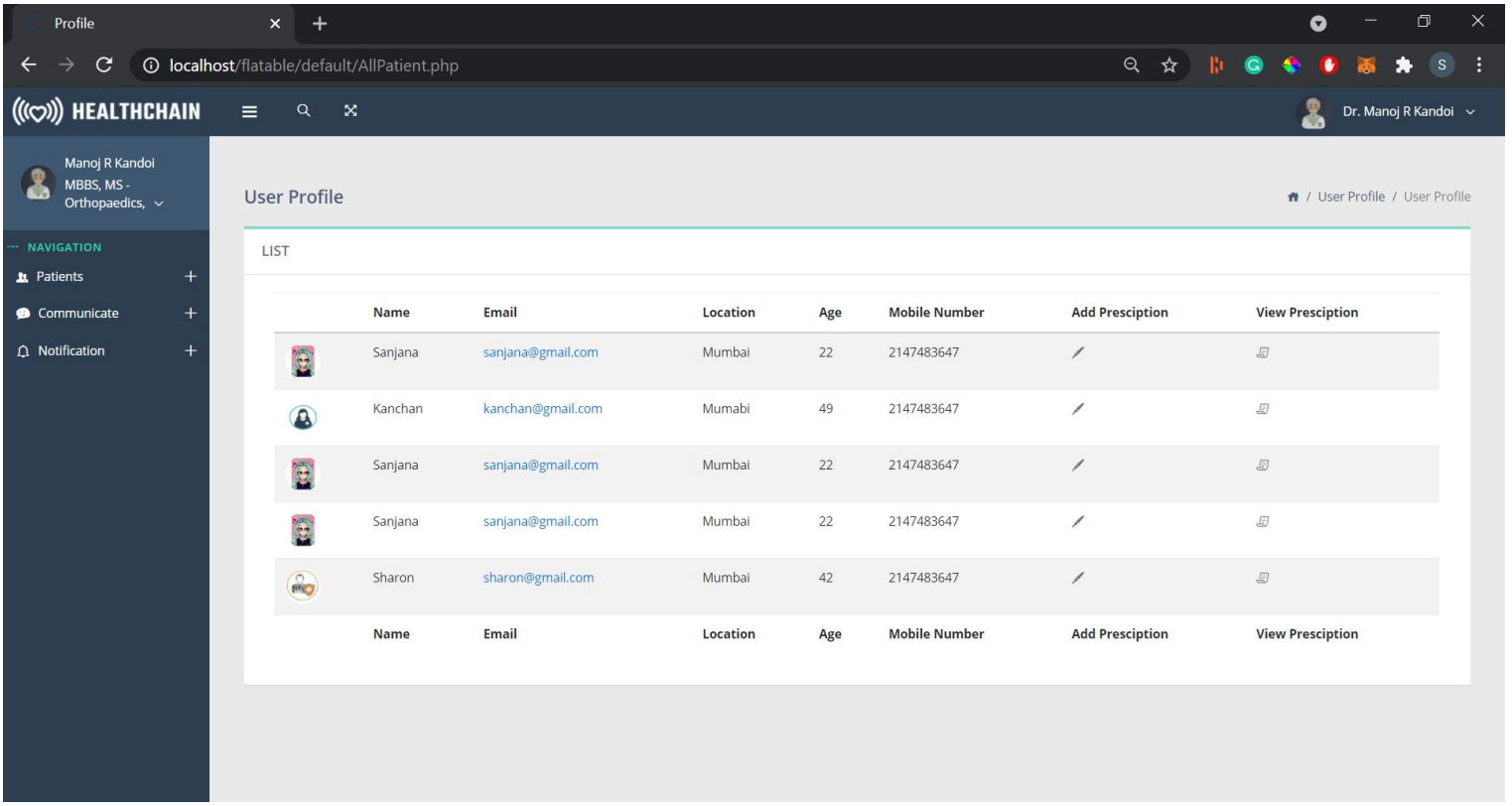

Figure 7.5: Adding and Viewing Prescription view

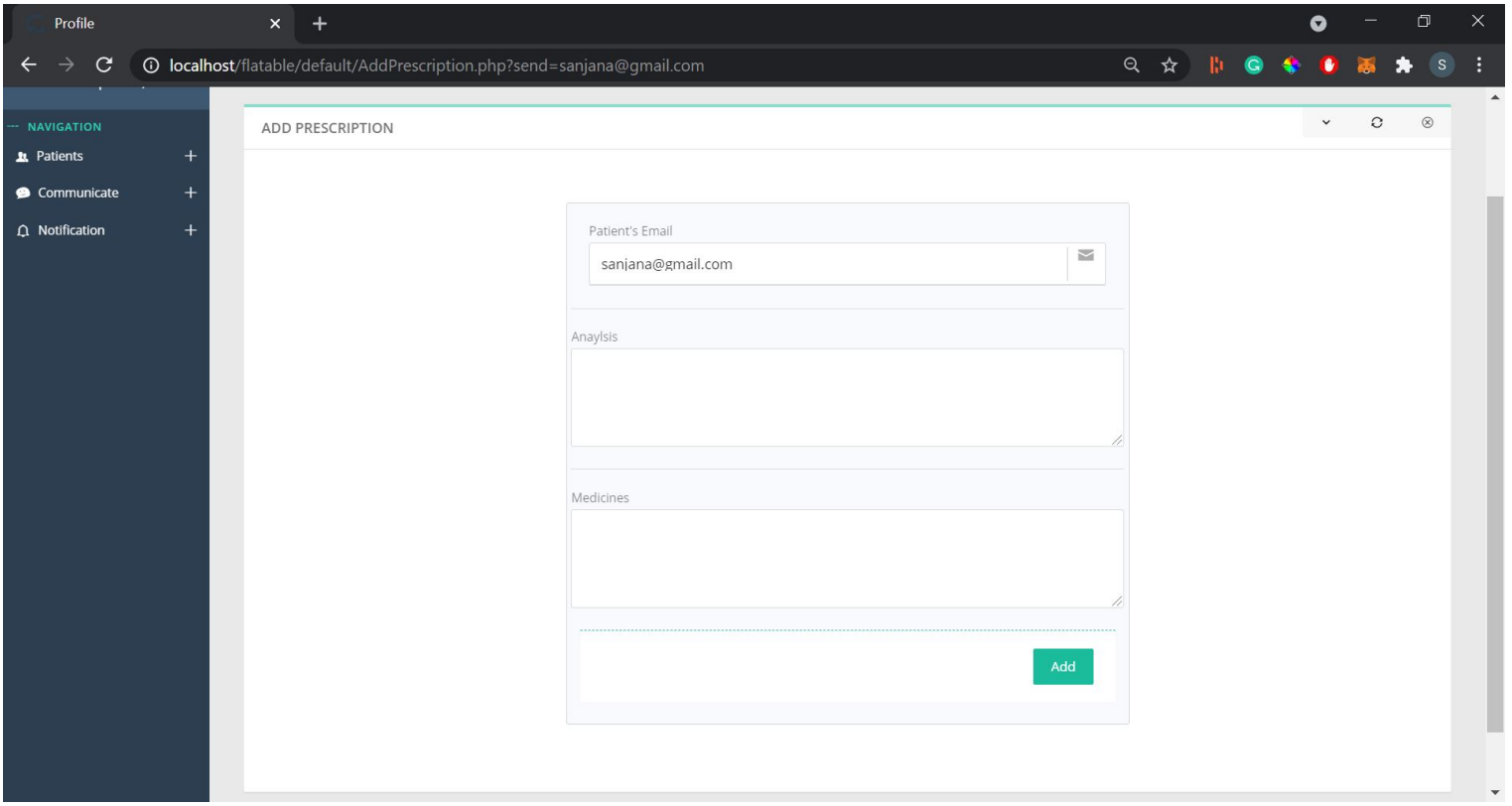

Figure 7.6: Prescription Form

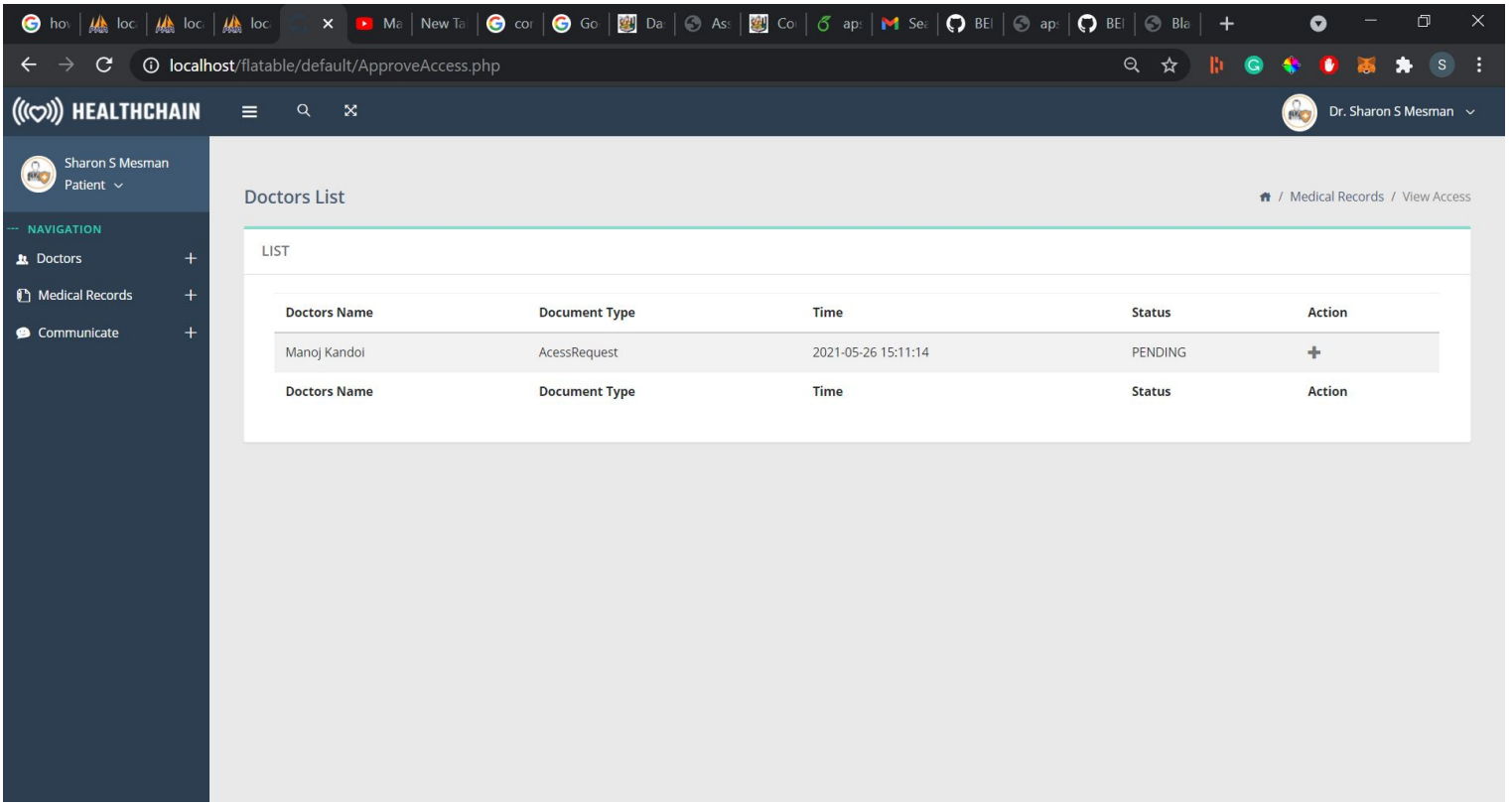

Figure 7.7: Approving Request to View Data

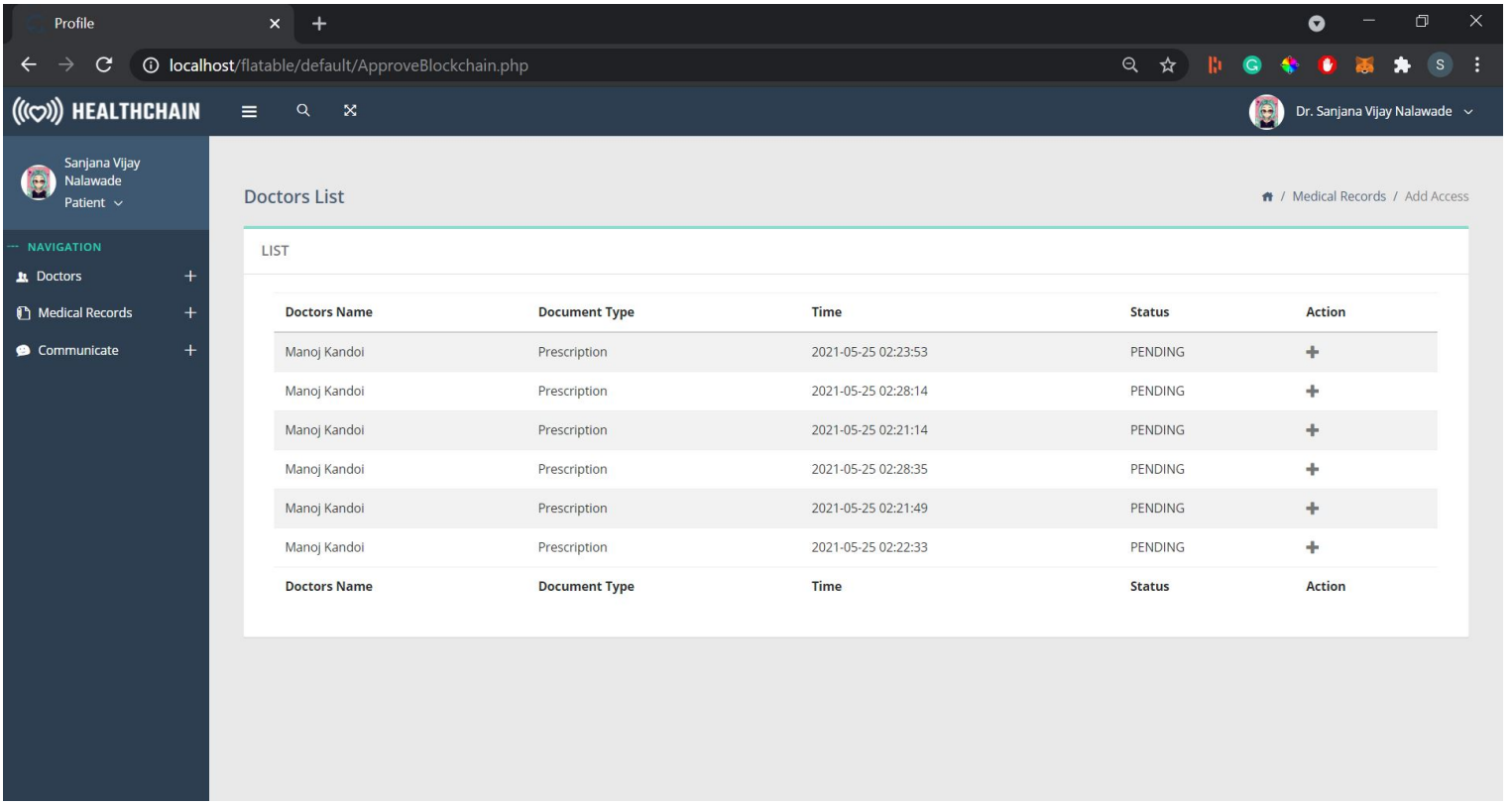

Figure 7.8: Approving to add to blockchain

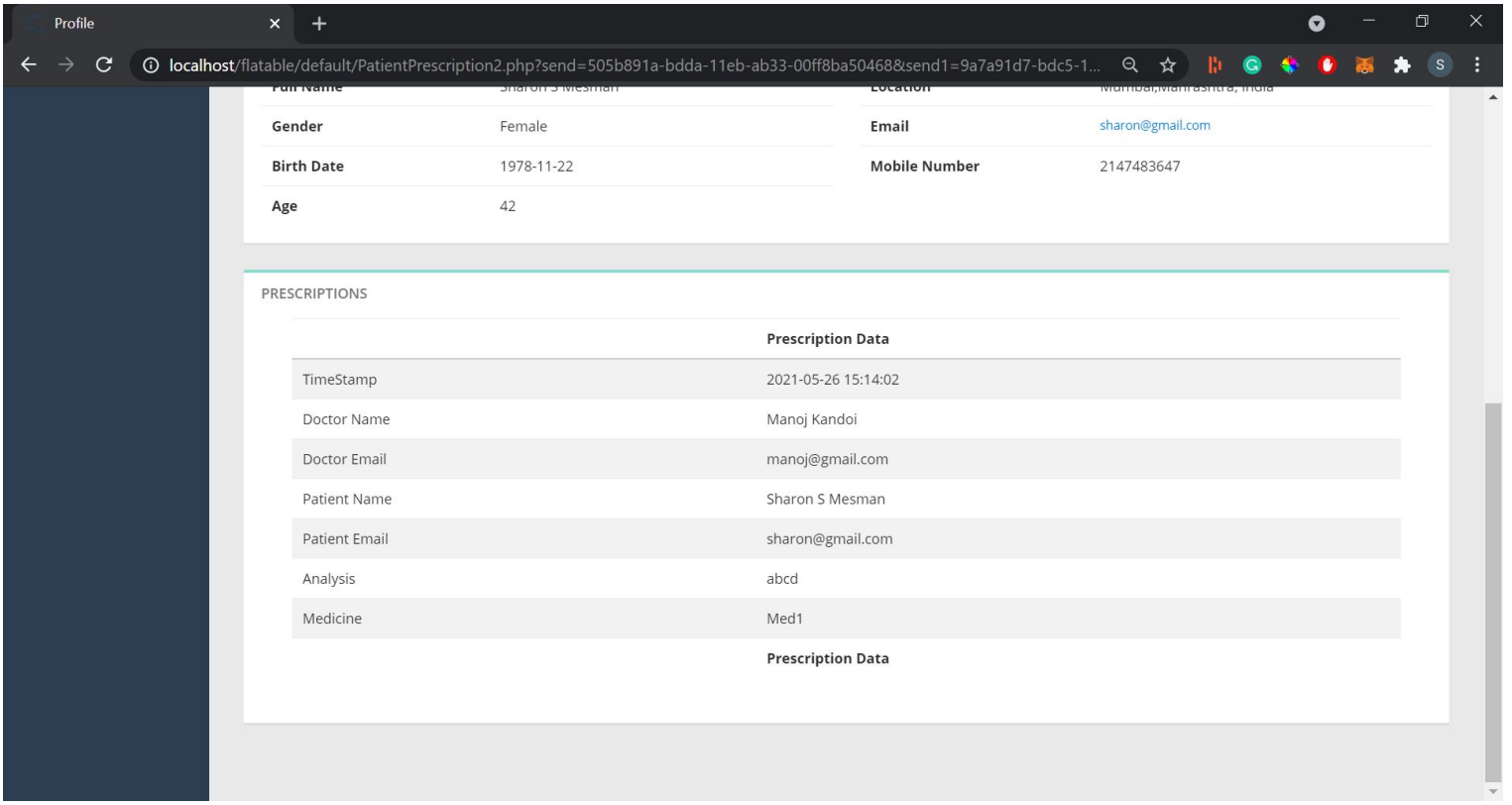

Figure 7.9: Prescription Data

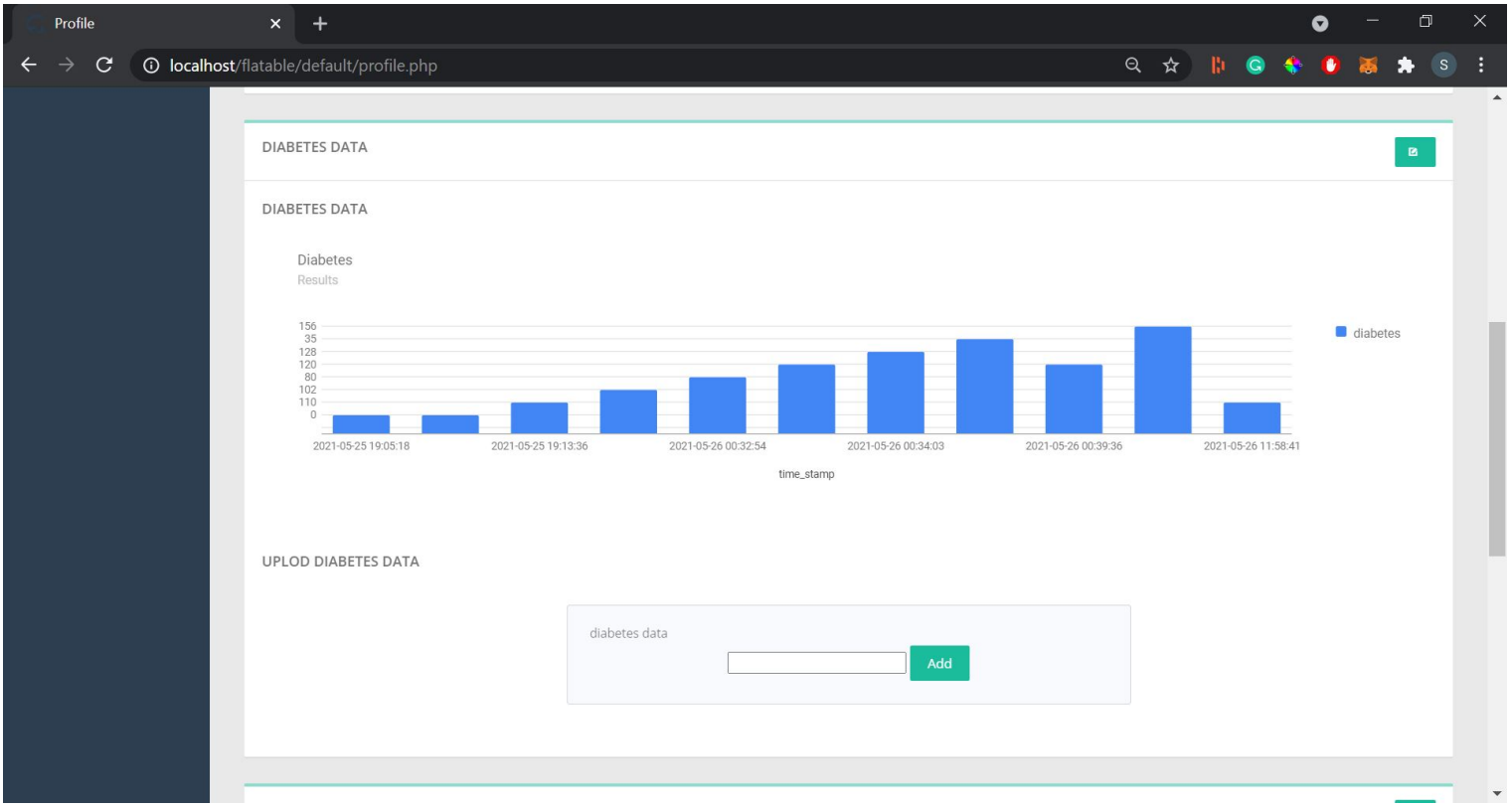

Figure 7.10: Diabetes Graph

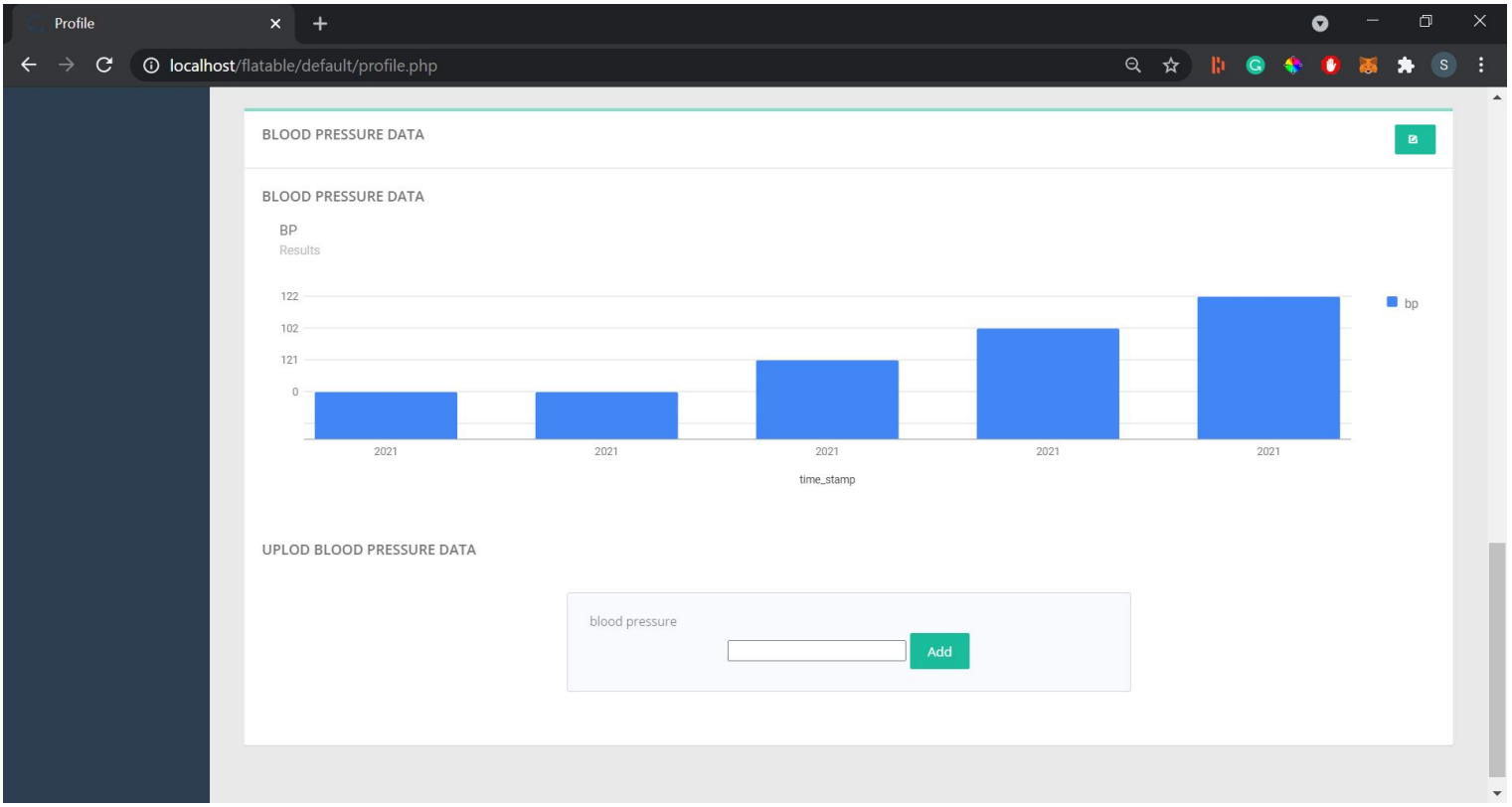

Figure 7.11: Blood Pressure Graph

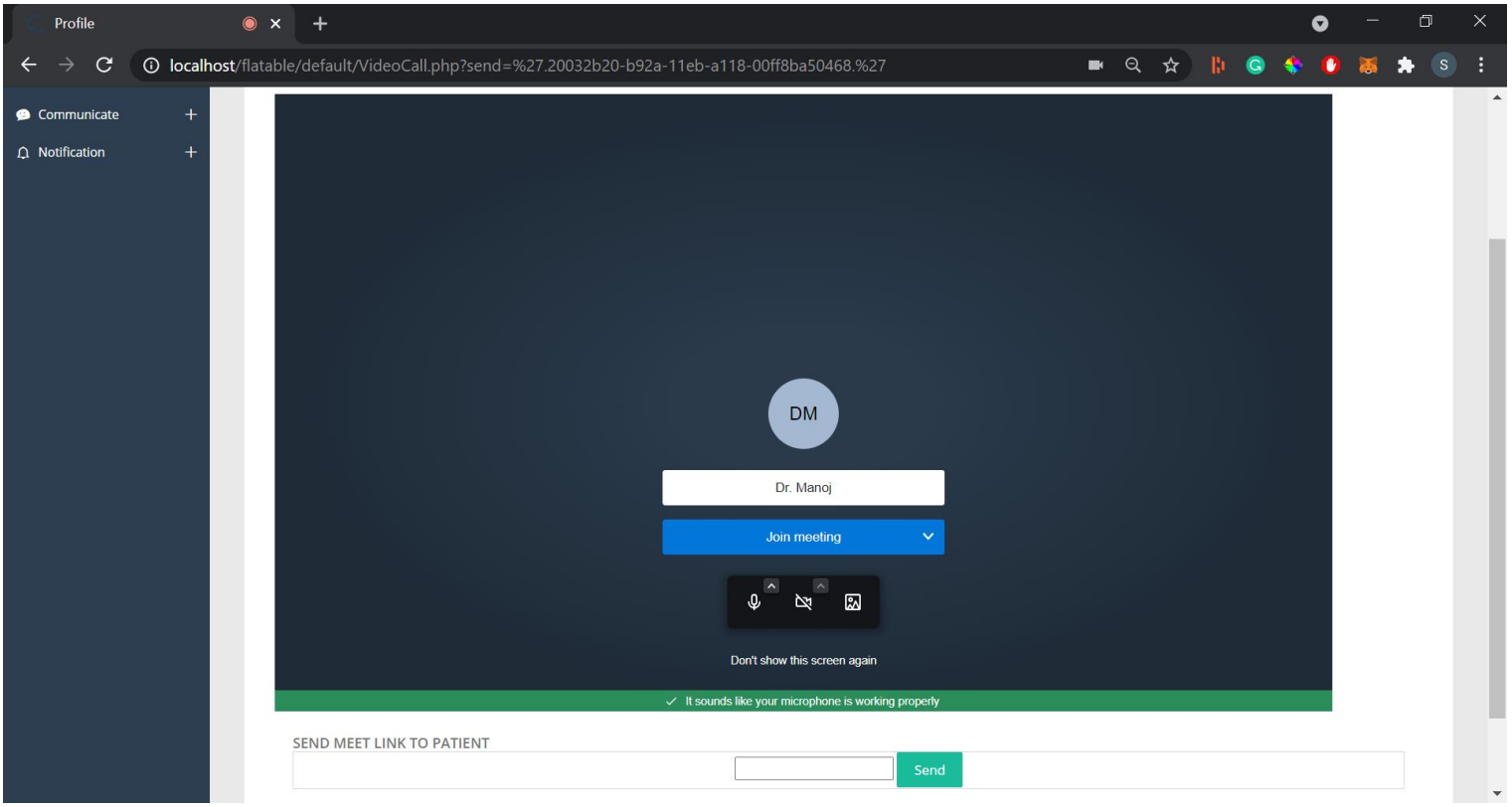

Figure 7.12: Video Calling

Chapter 8

Benefits to the Society

Helathchain benefits society in the following ways:

- Because it is entirely online, it can be accessed at any time and from any location.
- Medical data is stored on the blockchain, which reduces the use of paper, which is susceptible to damage over time. In addition, digital storage makes it easier to access, search, and append data.
- Blockchain has the advantage of not being controlled or owned by any entity, and because it is a decentralised system, transparency is maintained.
- Patients can concentrate on their recovery rather than the hassle of managing, transporting, and storing medical data.
- During appointments, patients may forget to convey a medical history that could have assisted the doctor in making a better diagnosis; this is overcome by using healthchain, which provides valuable insights to the patients' medical history.
- The inability of EHR and health IT systems to share health data is their most significant challenge. This interoperability challenge is addressed by blockchain technology, which uses common technical standards to securely distribute electronic health data.
- The challenges of result shifting and data snooping are addressed by blockchain technology. The system allows for the transfer of time-stamped permanent records of clinical trials and research outcomes, reducing the occurrences of fraud and error in clinical test records.
- The medical record is the most comprehensive record of a person's identification and must be handled with care. Blockchain technology has proven to be extremely effective in ensuring the integrity and security of medical records. Because blockchain-encrypted data cannot be changed or deleted.

Chapter 9

Conclusions and Future Scope

9.0.1 Limitation

- Scalability: Depending on their functionality, healthcare providers have different roles, such as doctors, physicians, nurses, clinicians, and so on. To accommodate these scenarios, the current Healthchain system must be expanded.
- In real-time applications, network latency is a critical issue. Data generated by wearable devices is high in volume and also very fast, resulting in a large amount of traffic on the server. A lightweight blockchain design would be the solution to optimise data processing and transaction communication.

9.0.2 Future Scope

- In the future, we intend to learn more about a better payment system; currently, tokens are used, but a better module for the same item can be developed.
- Machine learning and automation can be applied to medical data to predict patients' health problems in real time. It will assist healthcare providers in providing more efficient and immediate healthcare services.
- Healthchain is a simple blockchain-based application for EHRs that meets some basic requirements. More functionalities and roles, as well as more extensive testing, are required for it to be used by a hospital network.
- Before large-scale production deployments, more research will be needed to determine the scalability, security, and cost-effectiveness of blockchain technology.

9.0.3 Conclusion

In this project, Healthchain is proposed as an online healthcare framework that provides a complete solution for electronic health records and service management. The blockchain framework for EHR management is intended to give patients ownership and control over their EHRs. Patients can securely control access to documents and track how records are used, as well as allow secure record transfer and reduce the ability of unauthorised actors. It aims to solve the current digital problems in the healthcare sector by providing centralization, security, and features such as video calls, making Healthchain the one-stop application for all your health documents and services.

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