Healthcare Applications Using Blockchain with a Cloud-Assisted Decentralized Privacy-Preserving Framework

Cloud services provides heavy computation and storage at very cheaper cost so all health services are migrated to cloud services to manage their patients data and to provide security to patient data heavy security based algorithms were utilized which required expensive computation. All cloud servers will be fixed at particular centralized locations and if two requests from come two different long distance regions then cloud server required heavy computation as its lack of Peer2Peer computation. Peer2Peer servers are decentralized servers where closer nodes are responsible to process data so long distance processing can be avoided.

To avoid long distance processing in Cloud services author suggesting combination of Cloud and Blockchain to manage patient data. Blockchain has inbuilt support for Tamper proof, decentralized and privacy storage.

In propose paper for user authentication and patient privacy author using ECDSA digital signatures and RSA encryption. All keys related to digital signatures and encryption will be stored at Blockchain to authenticate users. All patients reports required heavy storage so Author using IPFS (inter planetary file system) to store patient data. All doctors and patients identify will be verify using Blockchain keys.

Blockchain store each record as transaction/block and associate each record with unique hash code and this hash code will be utilize for future verification and this process is known as ‘Proof of trusted authority’.

In propose paper author using Cloud, Blockchain and IPFS technology along with ECC, ECDSA to generate digital signature and then using RSA algorithm to encrypt patient data. so propose concept is known as CA-DPPF (cloud assisted-decentralized privacy preserving framework).

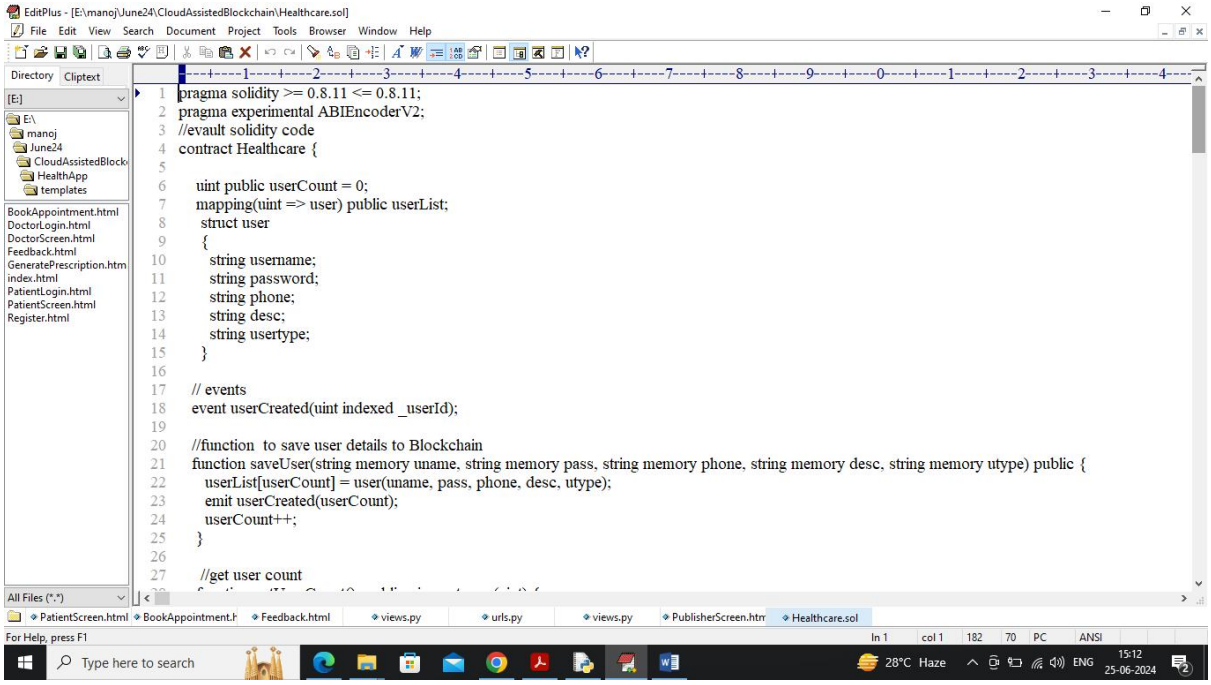
In paper author has define 9 algorithms which is used to verify, store and get doctors and patient data from Blockchain.

Extension Concept1: in propose work author using RSA for encryption which is very old and heavy in computation so as extension we are employing CHACHA20 encryption algorithm which is more secured and lighter in computation

Extension Concept2: in propose work author managing patient and doctor details but patients are not having any facility to know doctor’s popularity and experienced so we provided an extra module where patients will give ratings to

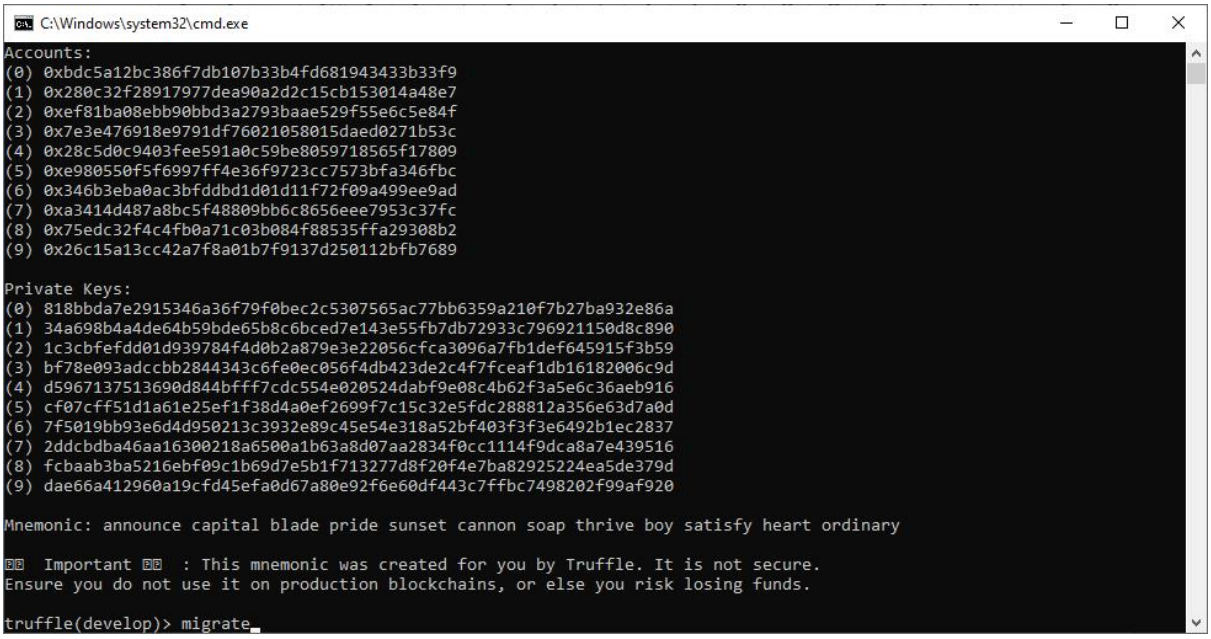
doctors and all those doctor's ratings along with description will be displayed to patients so they can easily select doctor with best ratings. All doctors rating we are managing as Blockchain transaction so all the ratings will be genuine as Blockchain will not allow malicious doctors to bribe users to give him fake ratings.

Blockchain can deals with user data using SMART CONTRACTS which can be designed using solidity programing and this contract contains functions which can be called to save and get data from Blockchain ETHEREUM. To implement this project we have designed following contracts



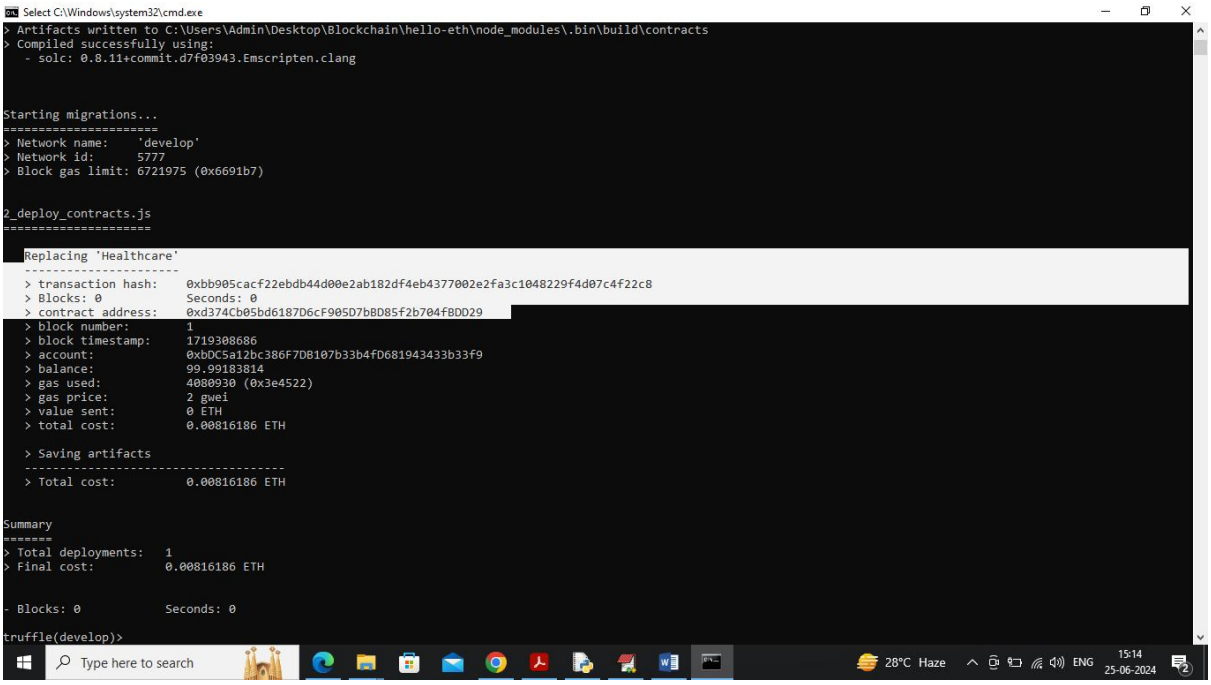
In above contract we have defined all possible functions to manage data in Blockchain and this contract need to deploy in ETHEREUM using below steps

1) First go inside 'hello-eth/node-modules/bin' folder and then find and double click on 'runBlockchain.bat' file to get below page



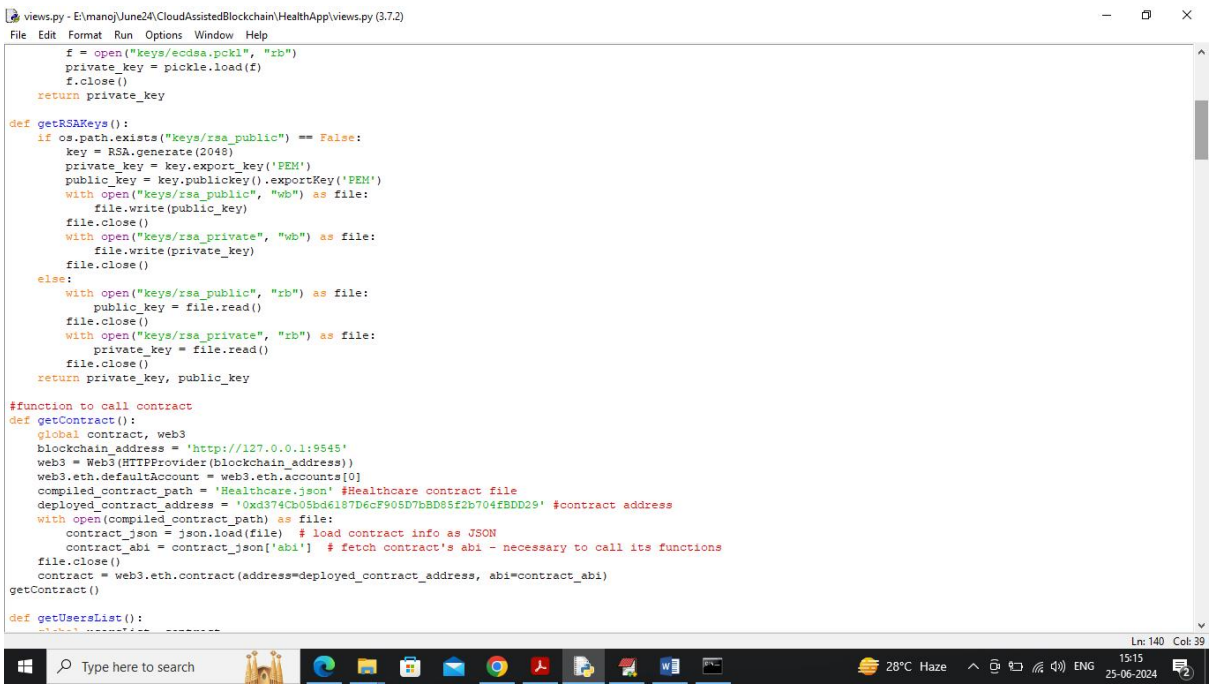
2)

3) In above screen ETHEREUM started with default accounts and private keys and now type command as ‘migrate’ and press enter key to get below page

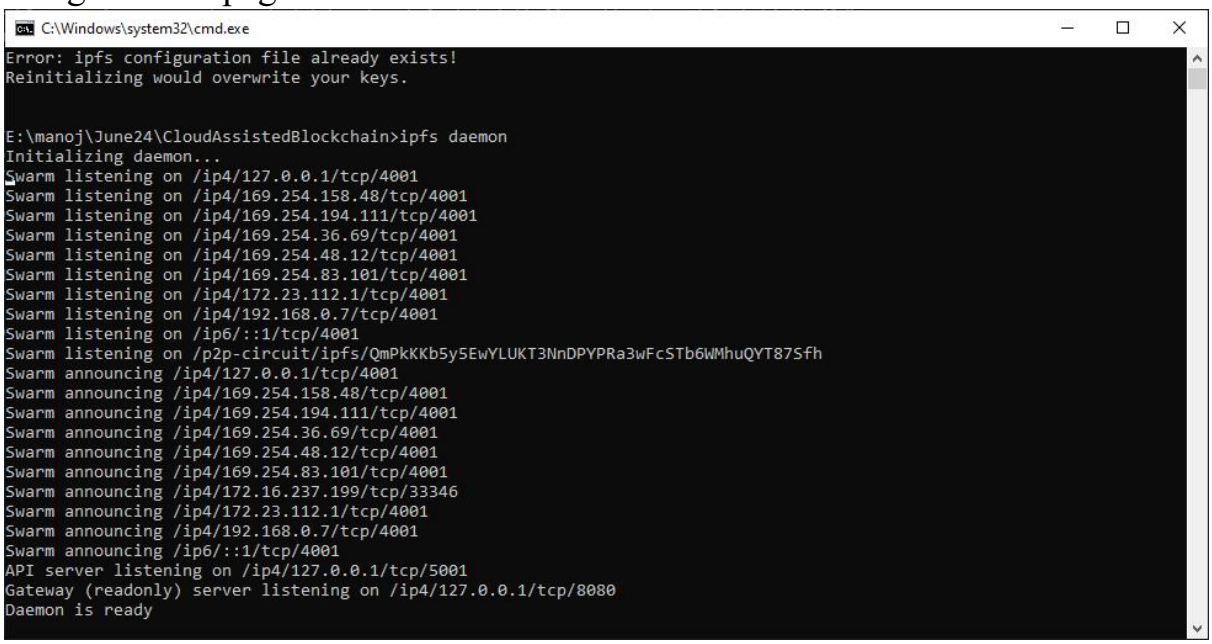


4)

5) In above screen ‘Health Care’ contract deployed and got contract address also and this address need to specify in python code to call contract to save and get data. in below screen showing python code calling above contract

6) 

7) In above screen read red colour comments to know about python code calling contract. In above screen we have seen contract deployed and running and now double click on 'runIPFS.bat' file to start IPFS server and get below page

8) 

9) In above screen IPFS server started and let it run.

To manage patient data in Blockchain we have designed following modules

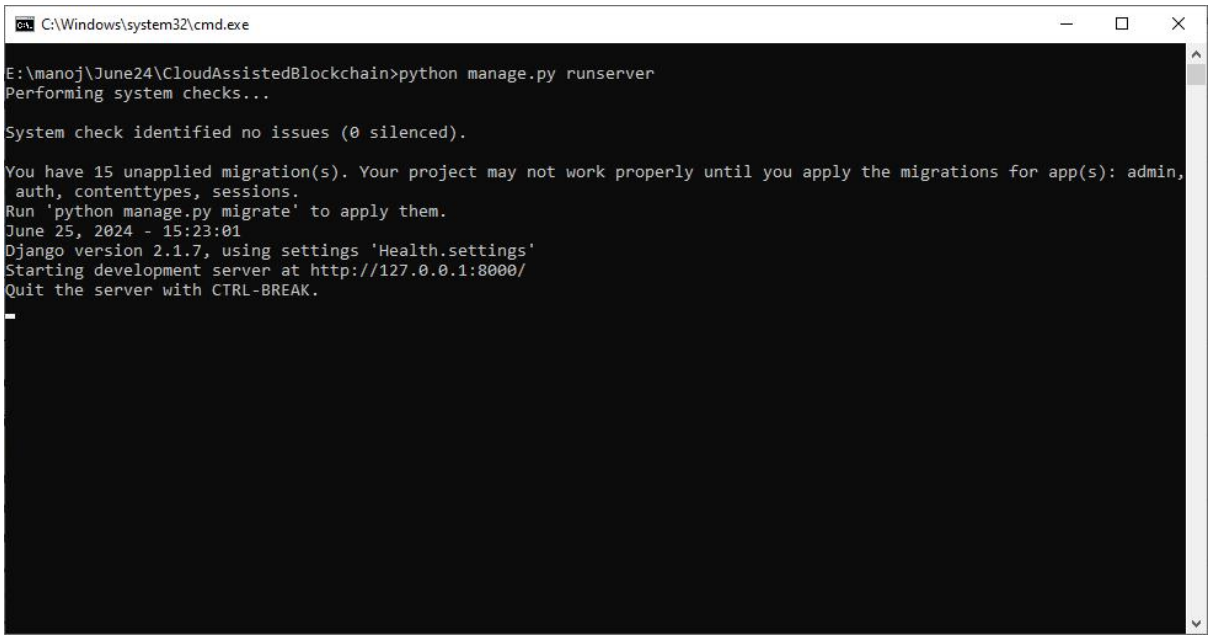
1) New User Sign up: doctors and patients can sign up to application and all details will get saved in Blockchain
2) Patient Login: patient can login to system and then view list of doctors and then can select desired doctor for appointment. While booking

appointment digital signature will be created for the patient to allow only authenticate doctor to view data. RSA encryption will be applied on patient data to provide privacy and doctors with proper decryption keys can able to decrypt data. Blockchain allow only authenticated doctors to access keys to provide privacy to patient data. Patients can view prescriptions and can give feedback and ratings to doctors.

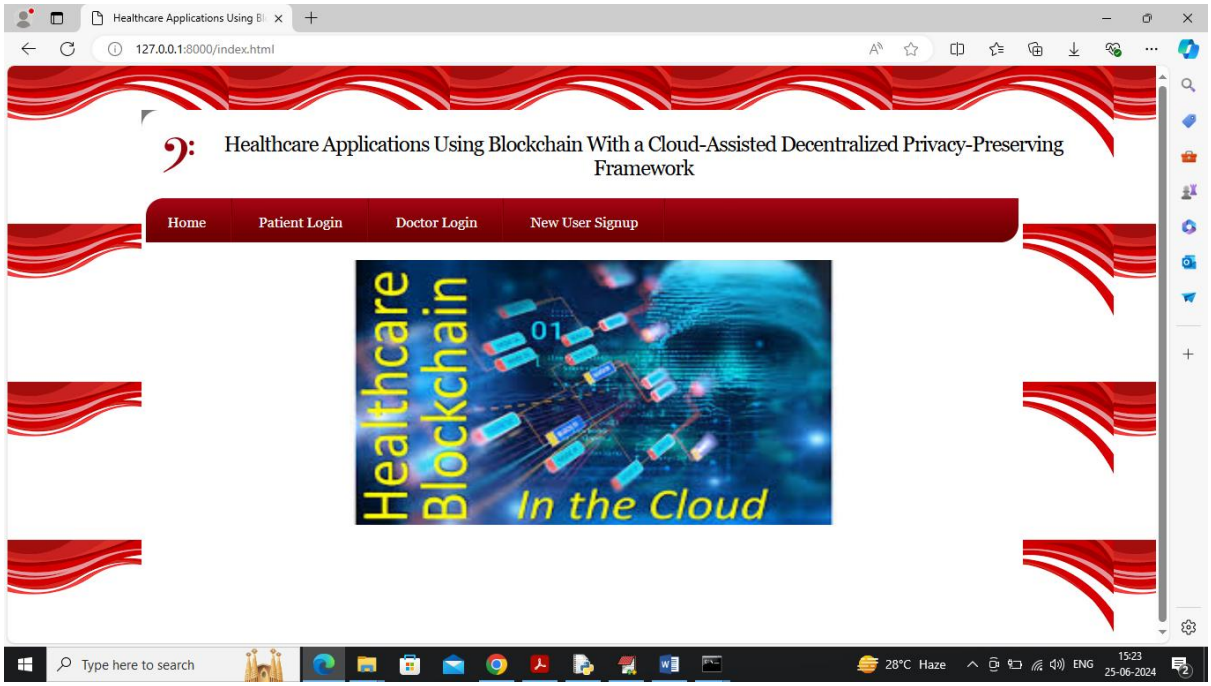
3) Doctor Login: doctor can login to system and then can view list of appointments and can generate prescription reports for the patients.

SCREEN SHOTS

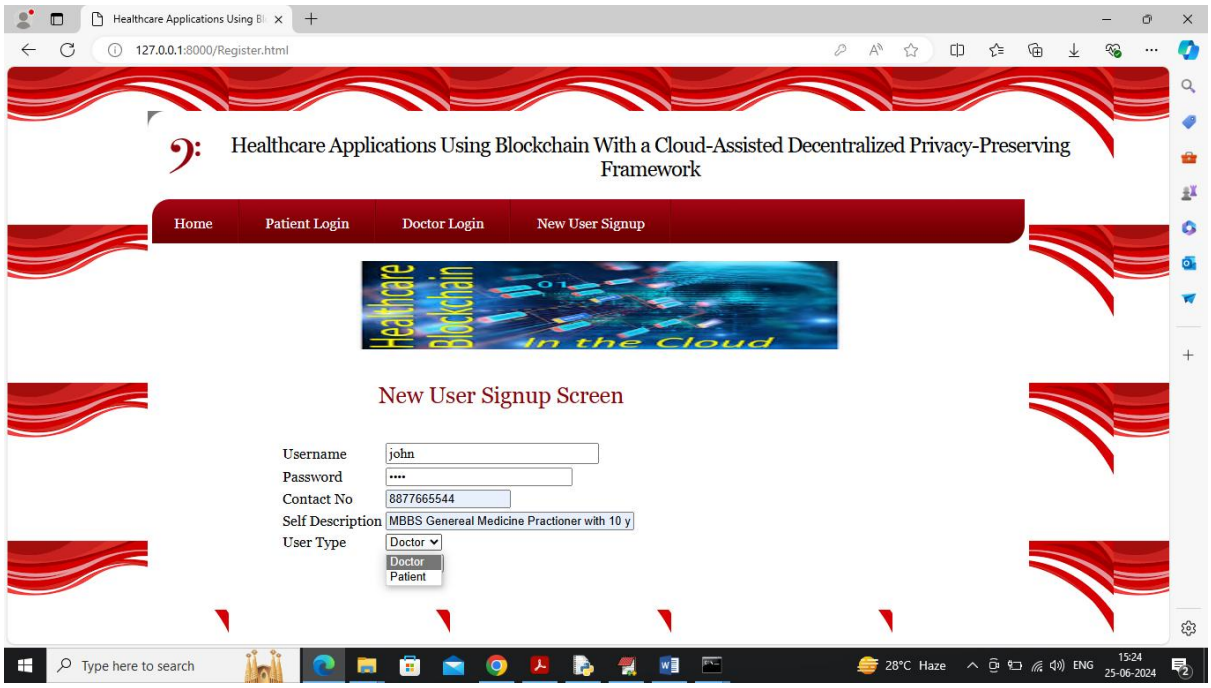
To run project double click on 'runServer.bat' file to start python web cloud server to get below screen



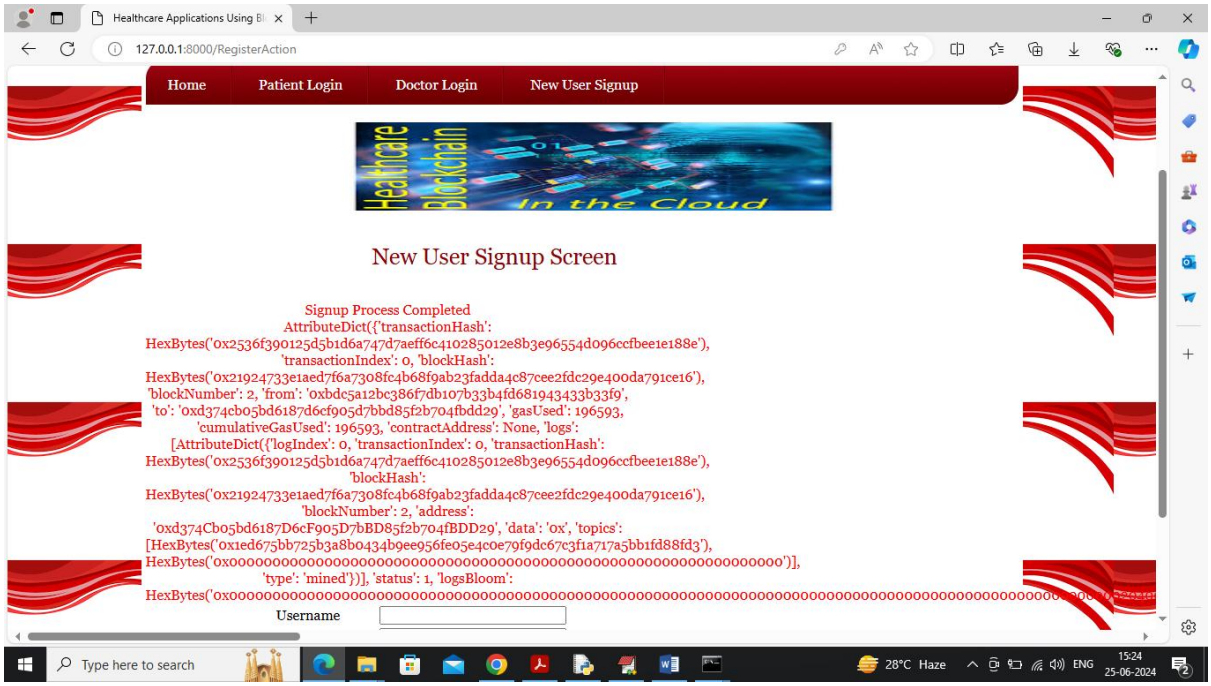
In above screen python server started and now open browser and enter URL as http://127.0.0.1:8000/index.html and press enter key to get below page



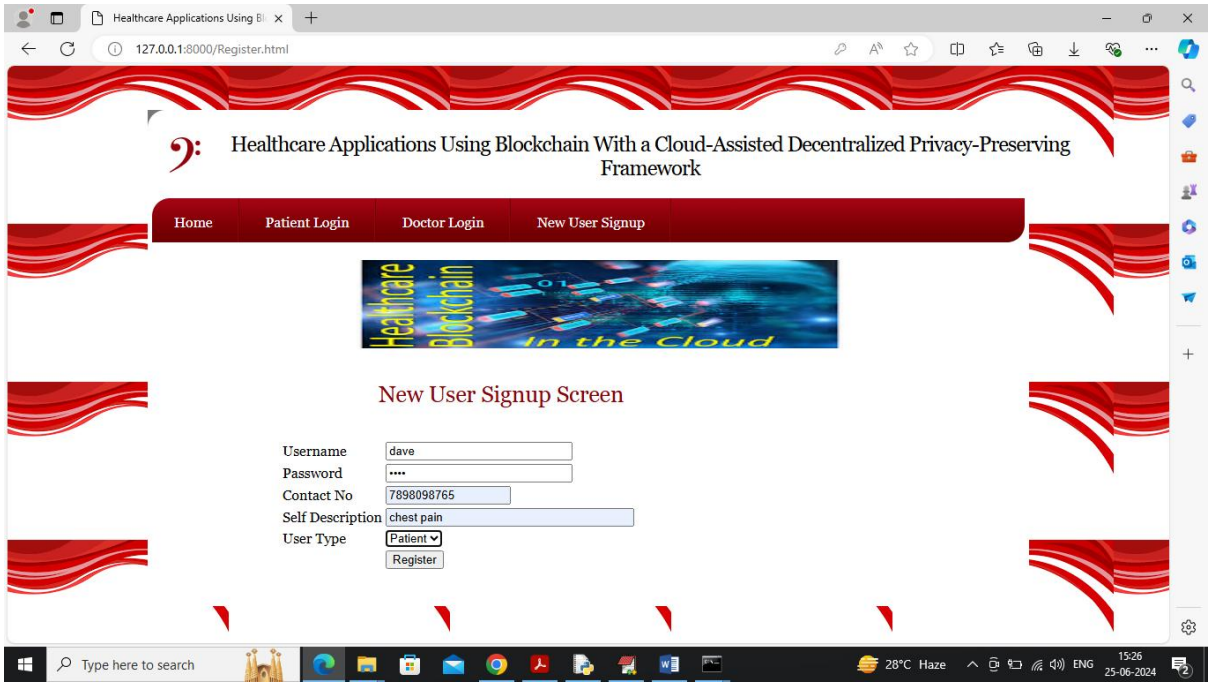
In above screen click on ‘New User Sign up’ link to get below page



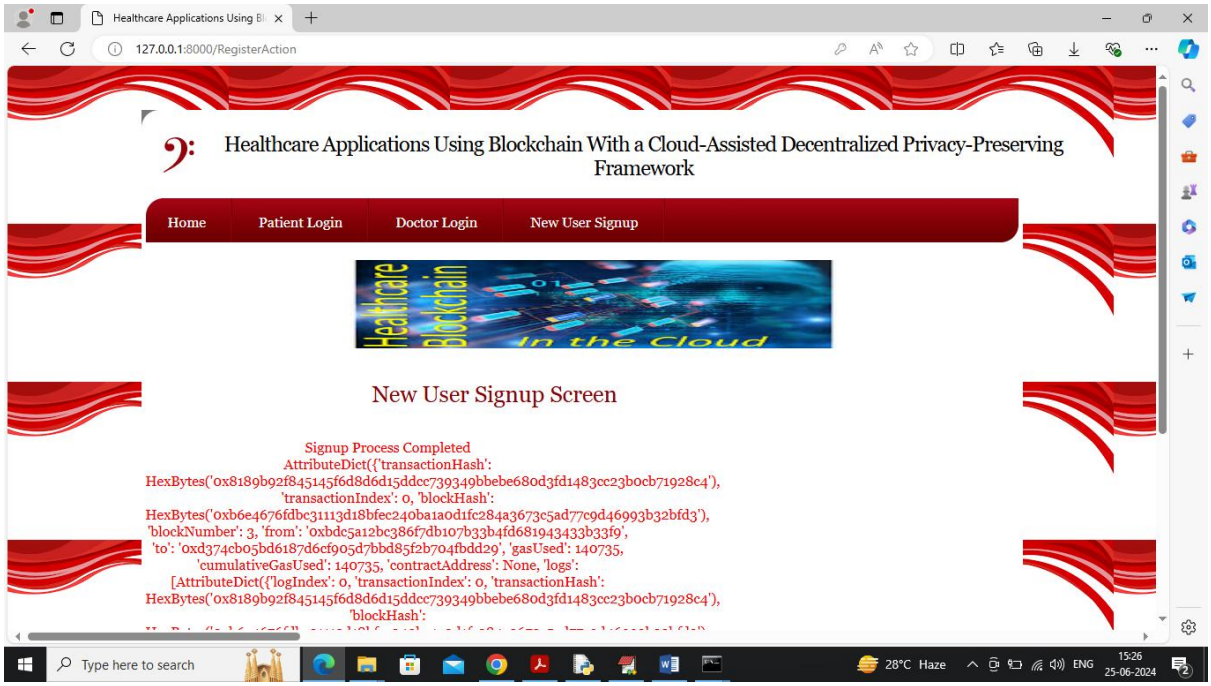
In above screen doctor is entering sign up details and then press button to get below page



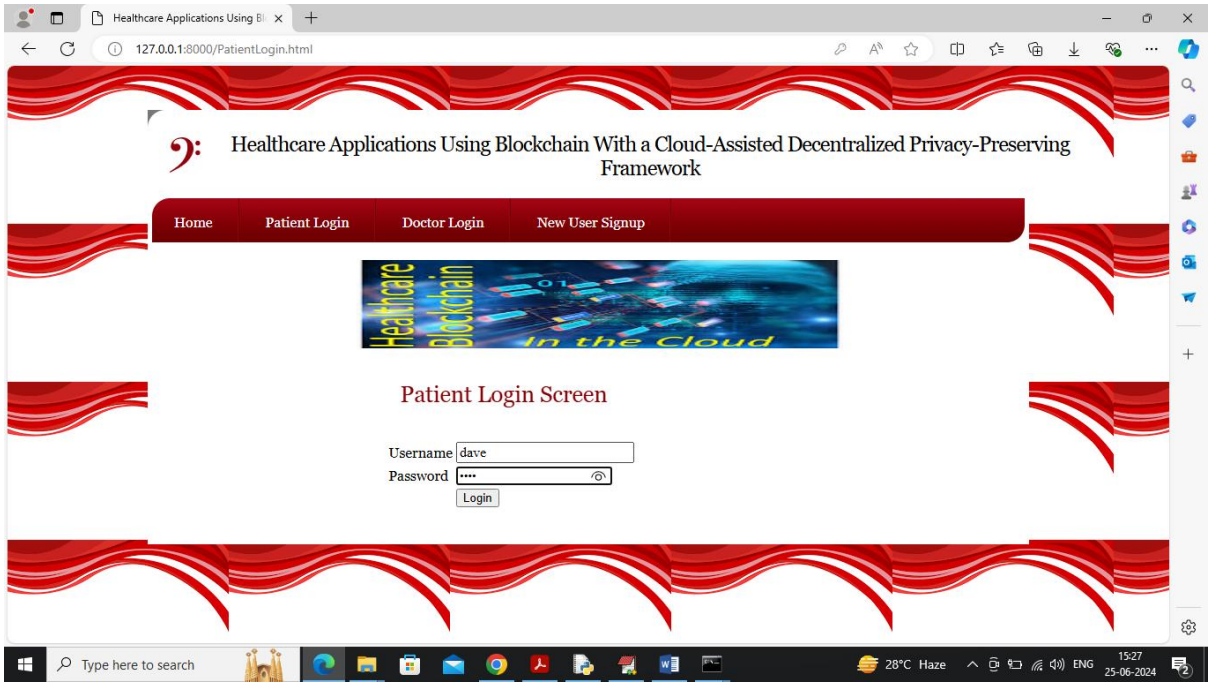
In above screen sign up task completed and I am displaying entire log obtained from Blockchain after storage which contains details like hash code, block no, transaction no and many other details. Similarly add patient details also



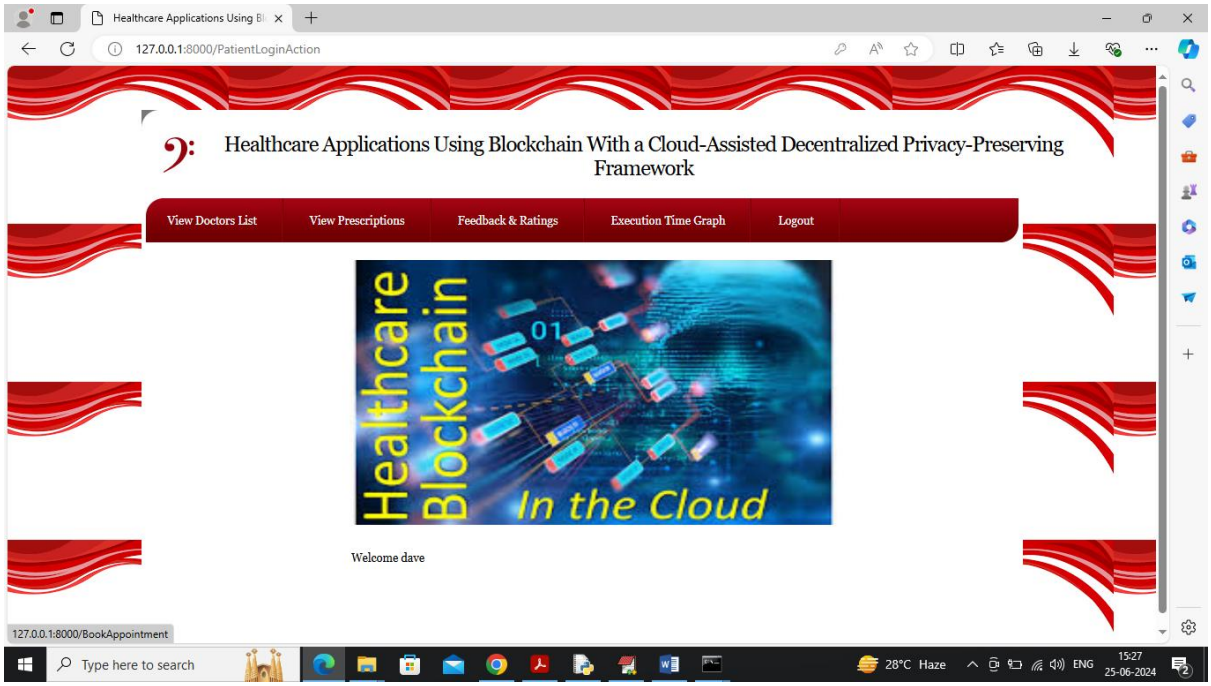
In above screen patient is entering sign up details and press button to get below output



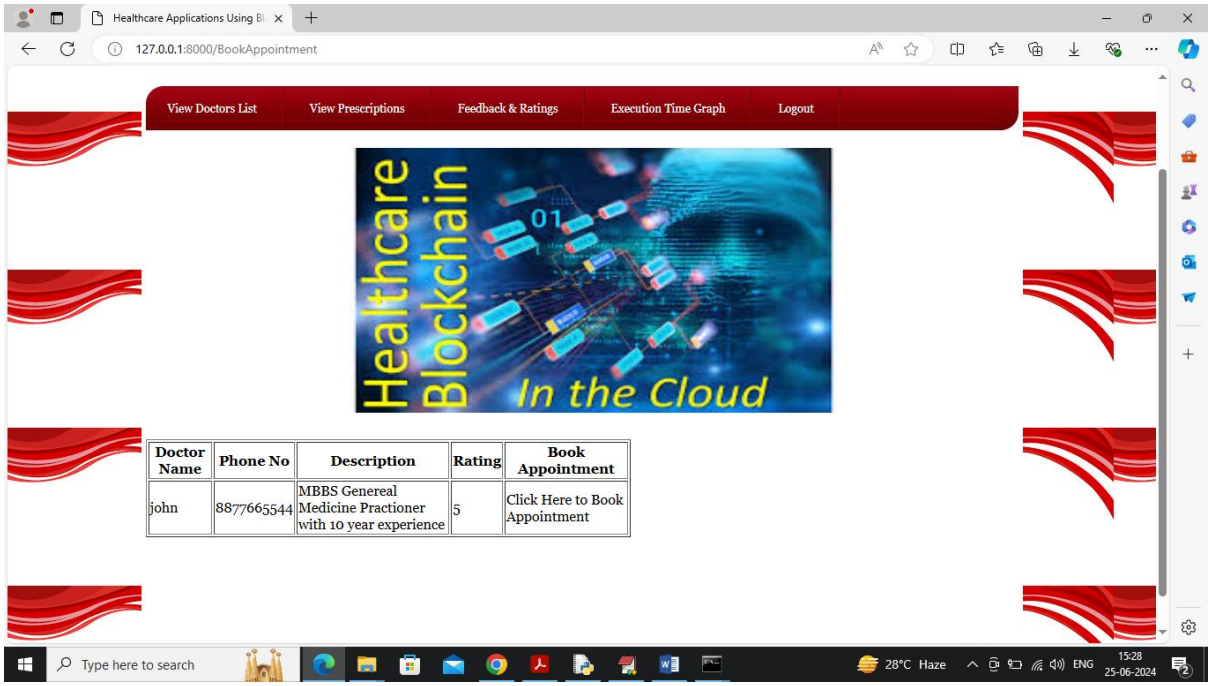
In above screen patient sign up completed and now click on ‘Patient Login’ link to get below page



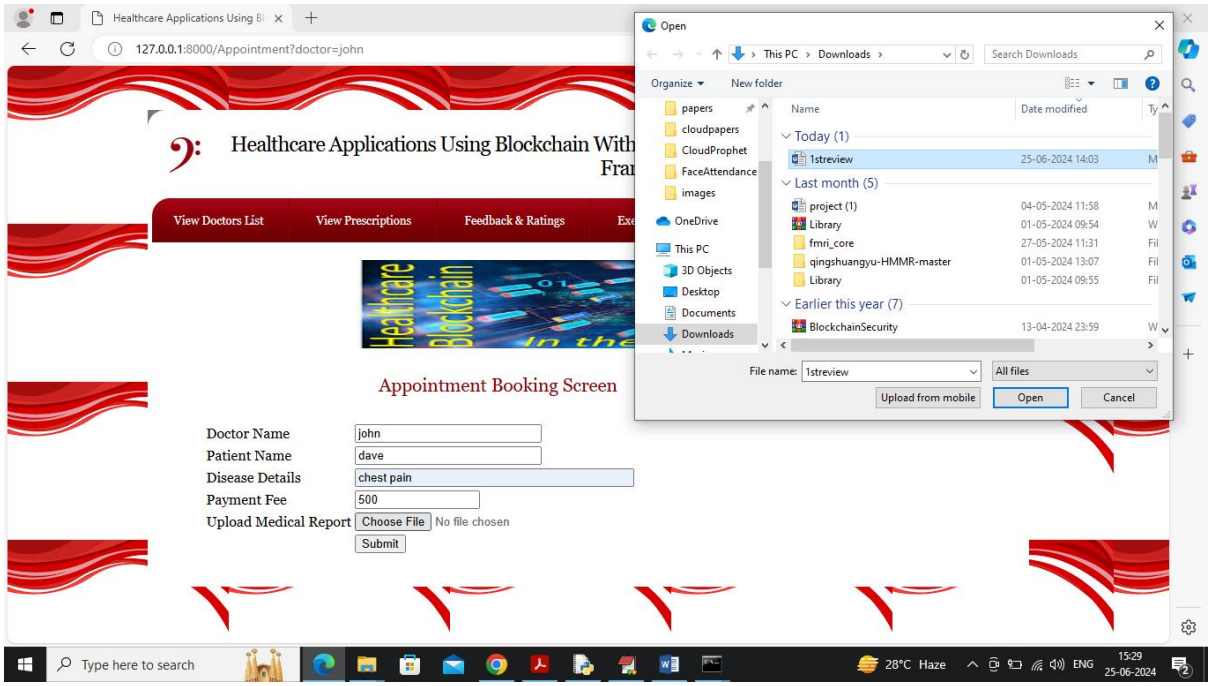
In above screen patient is login and after login will get below page



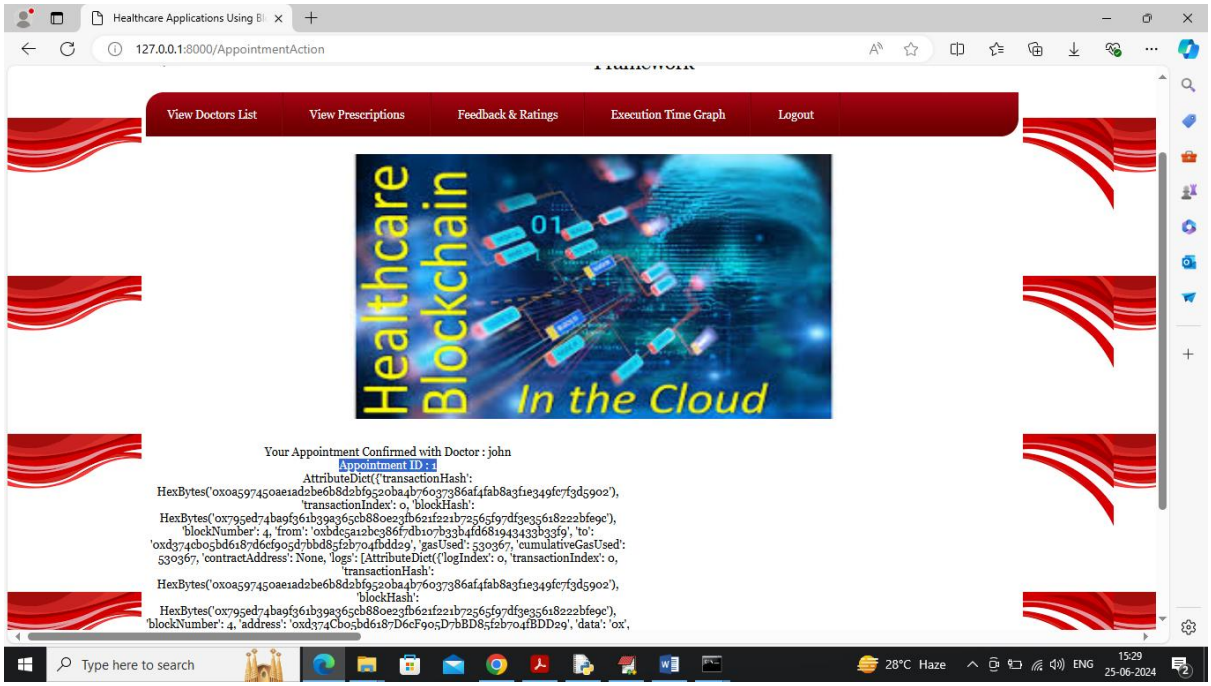
In above screen patient can click on 'View Doctors List' link to view list of doctors from Blockchain



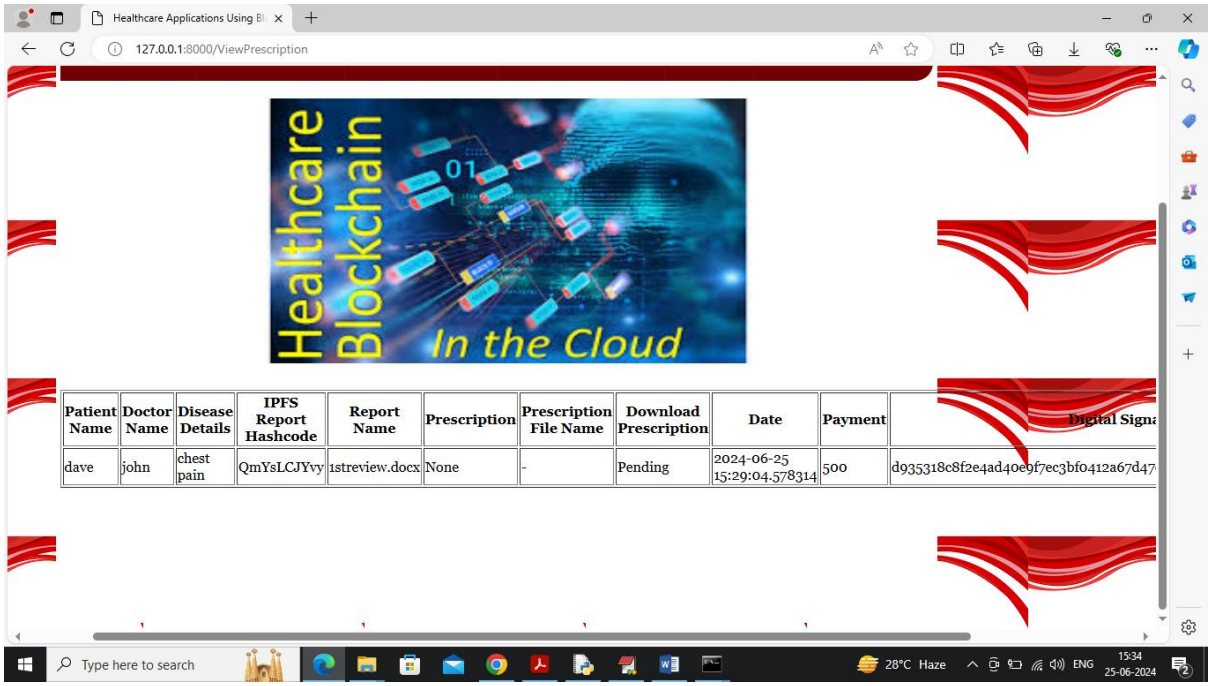
In above screen patient can view list of doctors and can click on 'Click Here to Book Appointment' link to get below page



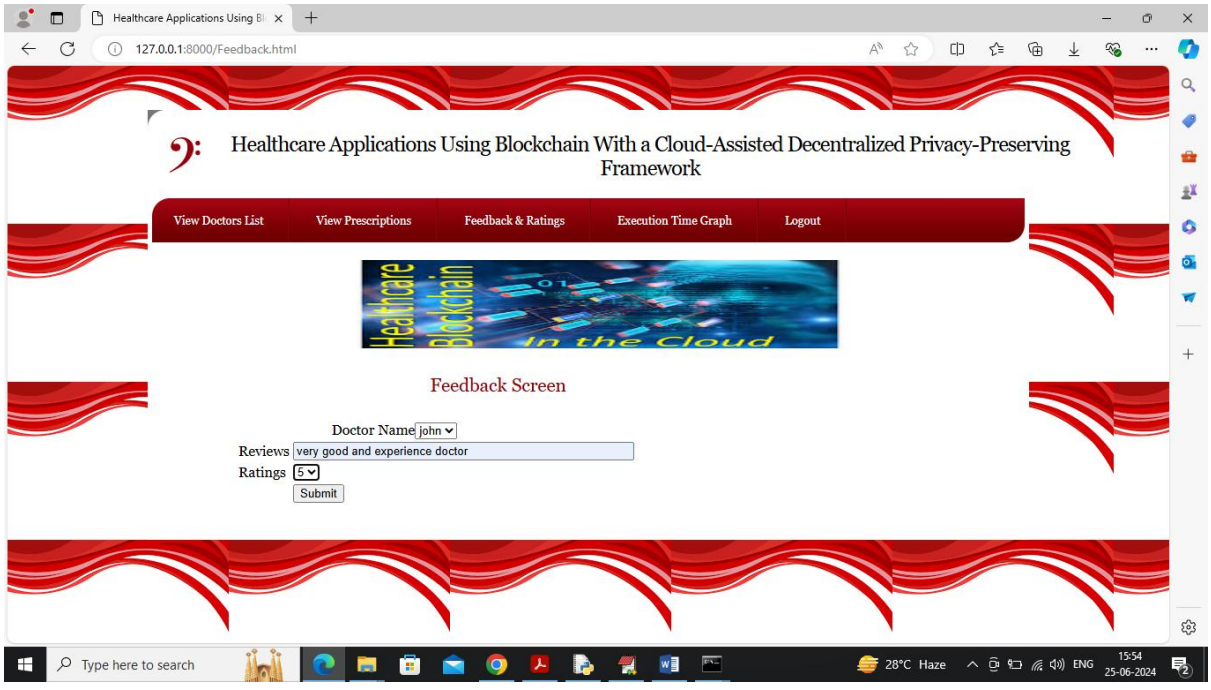
In above screen patient will enter disease details and then upload supporting disease documents to book appointment and get below page



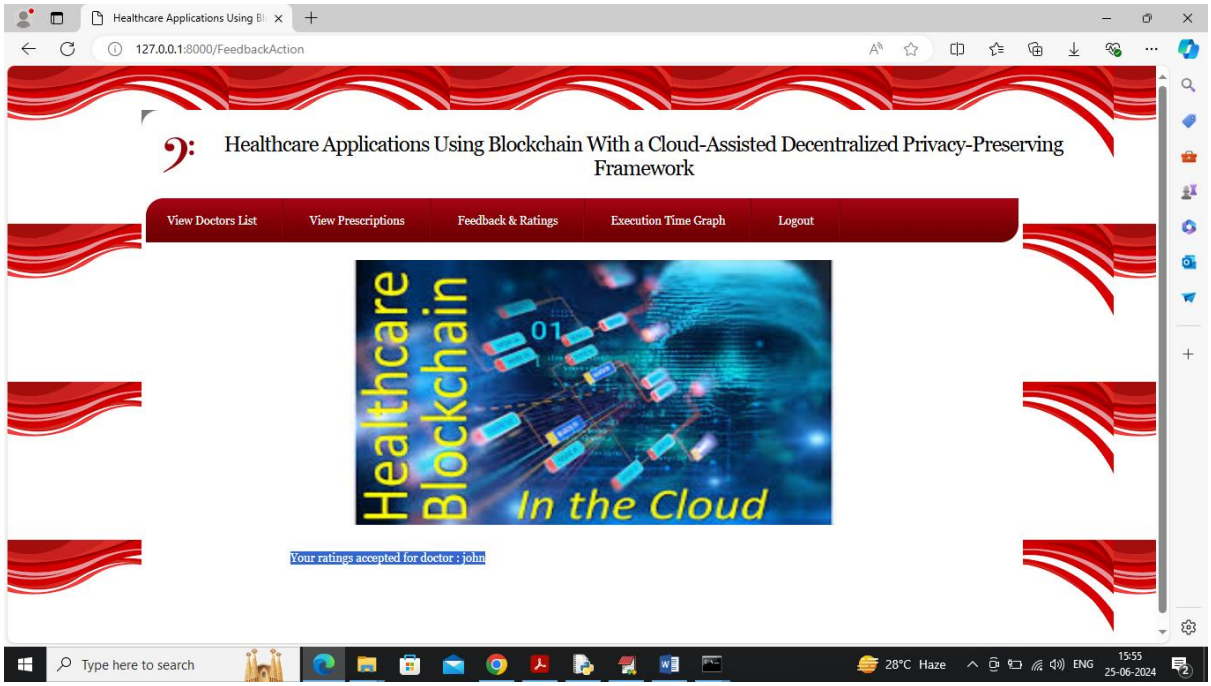
In above screen appointment is confirmed and now click on ‘View Prescription’ link to get below page



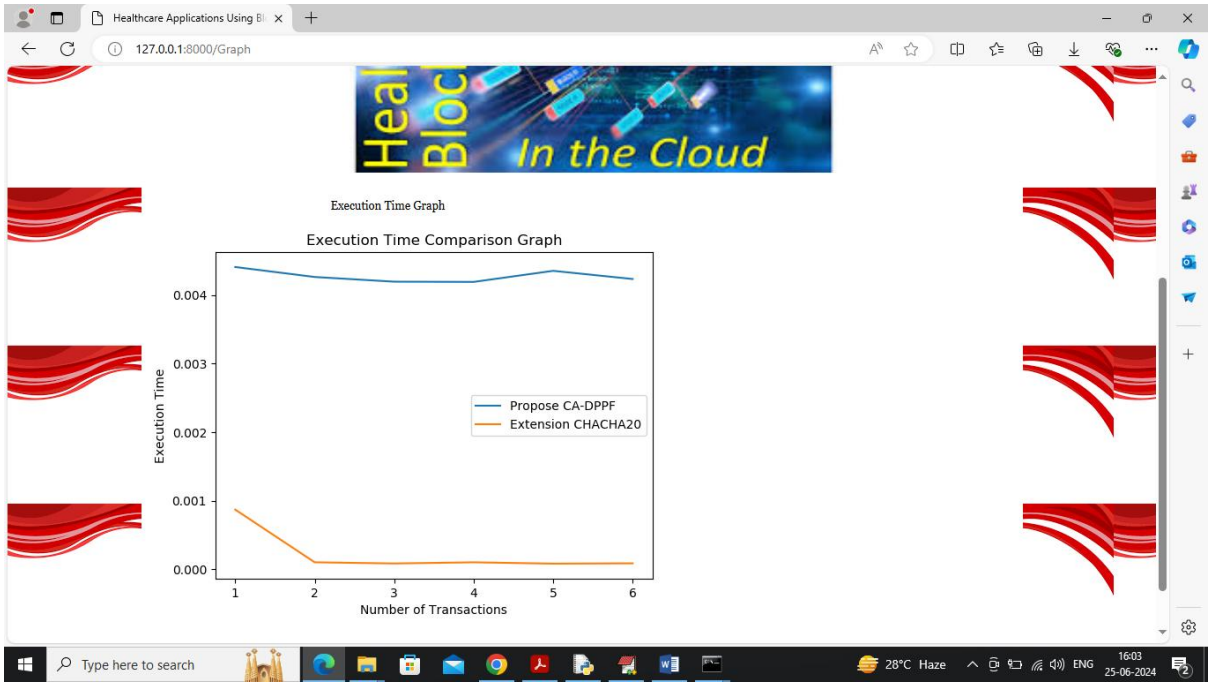
In above screen patient can view all appointment details along with digital signature and prescription is 'None' as doctor not yet generated prescription and after generating prescription user can view prescription details and now click on 'Feedback & ratings' link to generate feedback and get below page



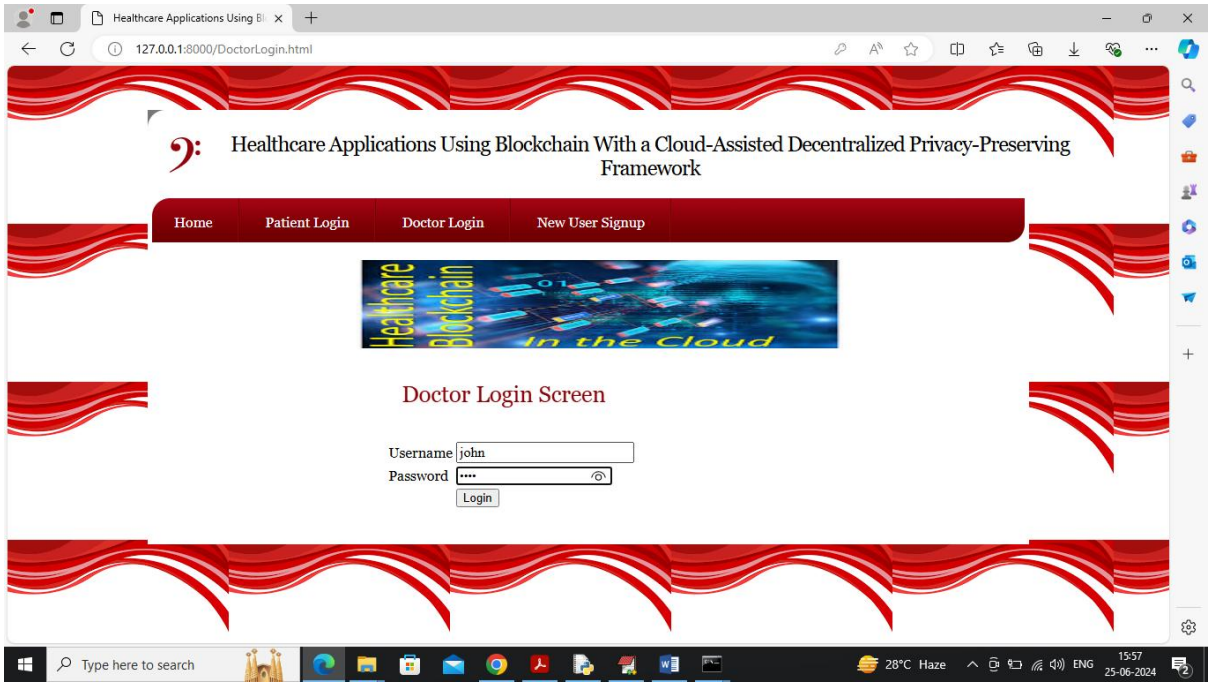
In above screen patient can give feedback and ratings on selected doctor and all details will get saved in Blockchain and then will get below output



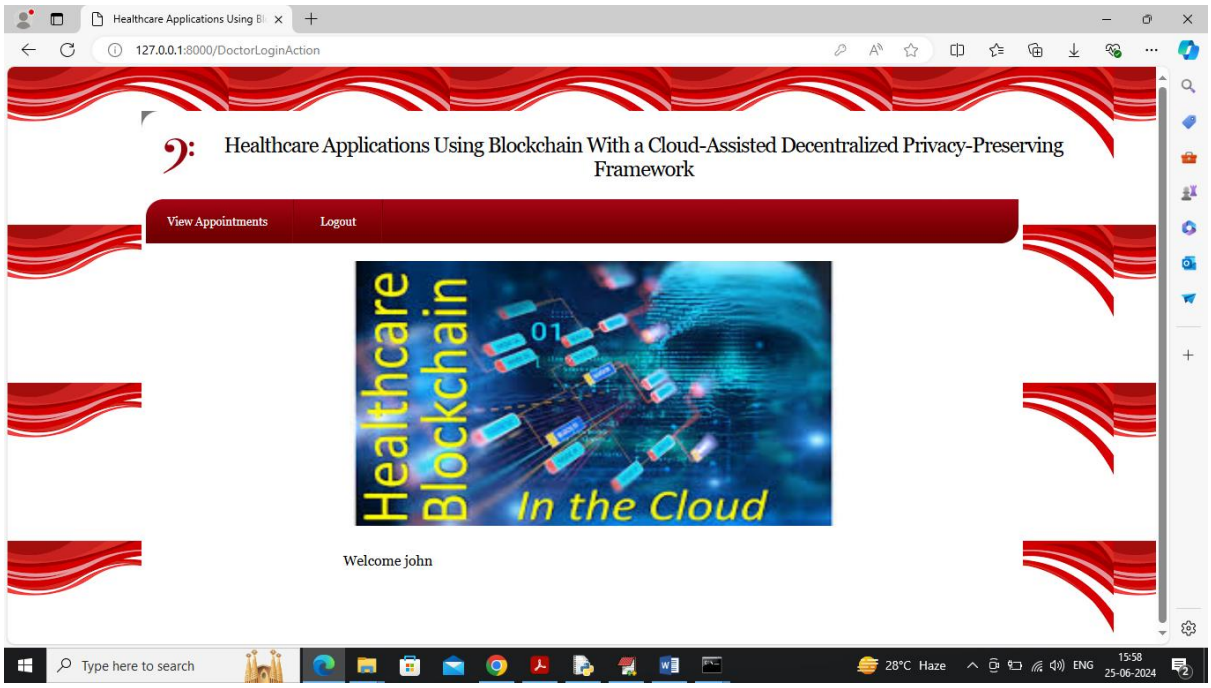
In above screen feedback details saved in Blockchain and now click on 'Execution Time Graph' link to get below page



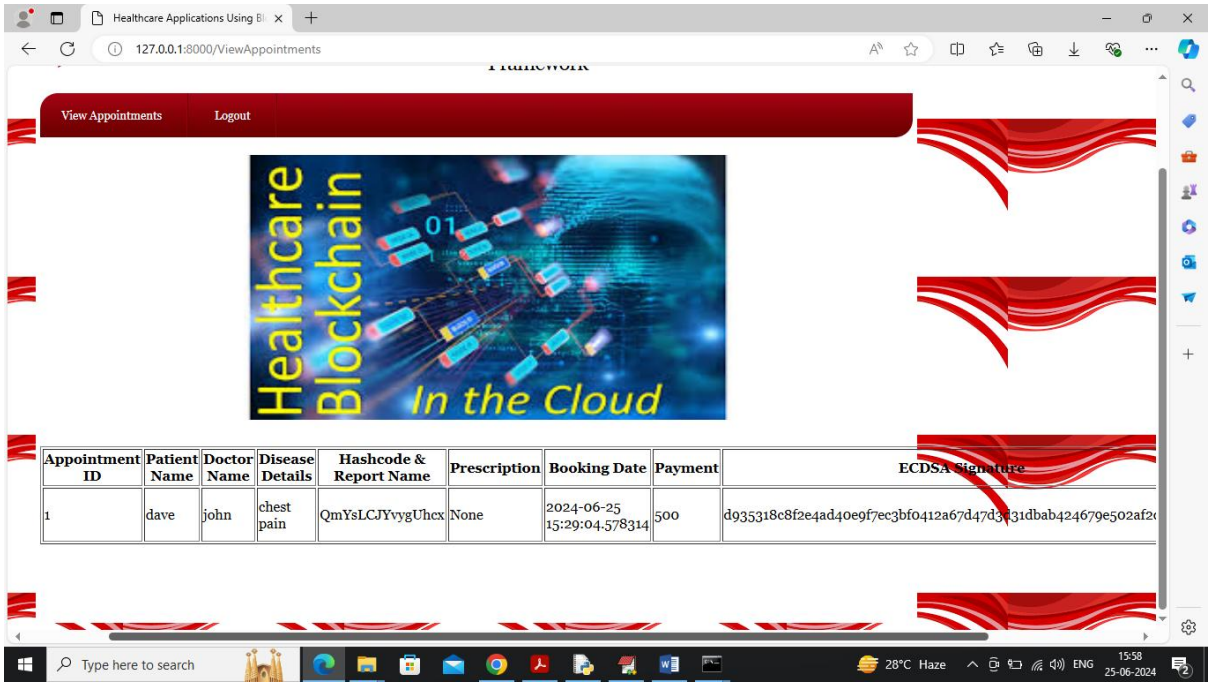
In above graph x-axis represents number of transaction and y-axis represents execution time and propose algorithm taking high time compare to extension algorithm and now logout and login as 'Doctor' to generate prescription

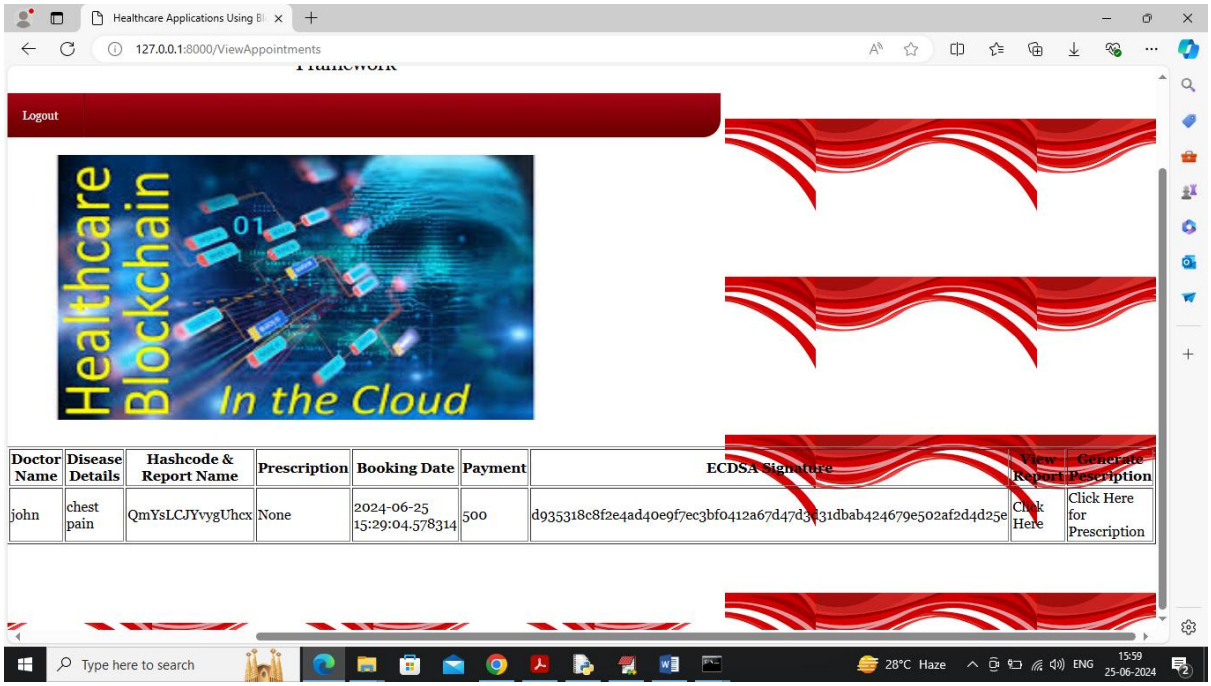


In above screen doctor is login and after login will get below page

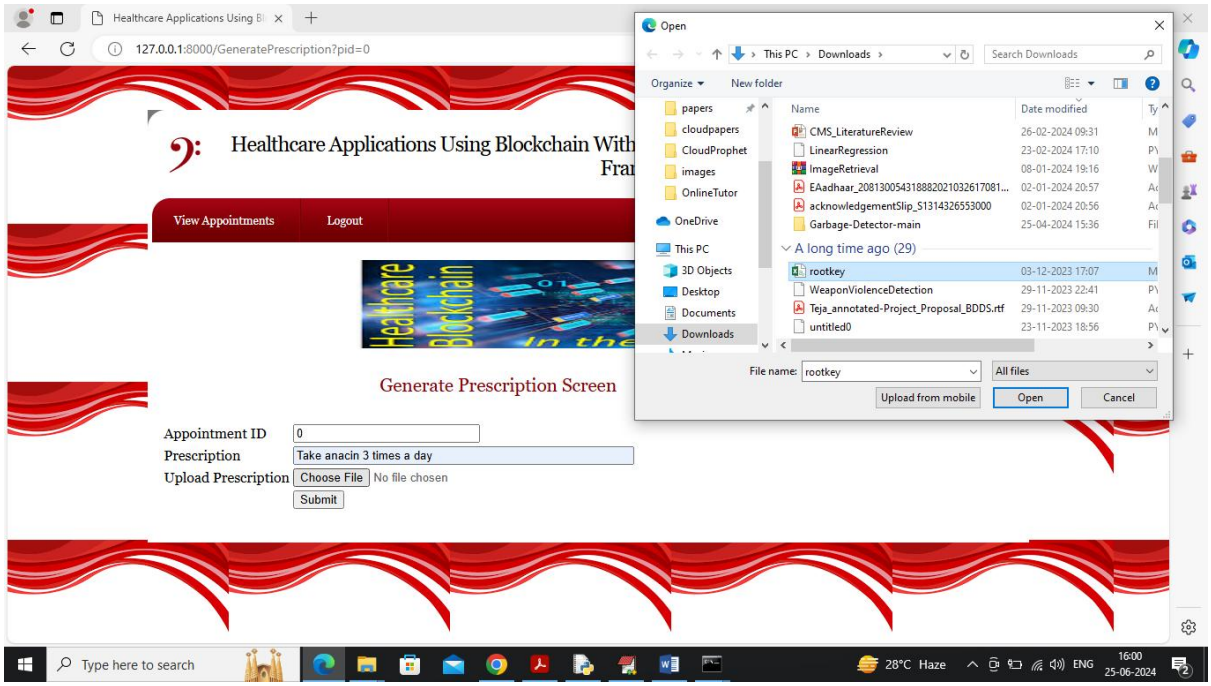


In above screen doctor can click on ‘View appointments’ link to view all his appointments and get below page

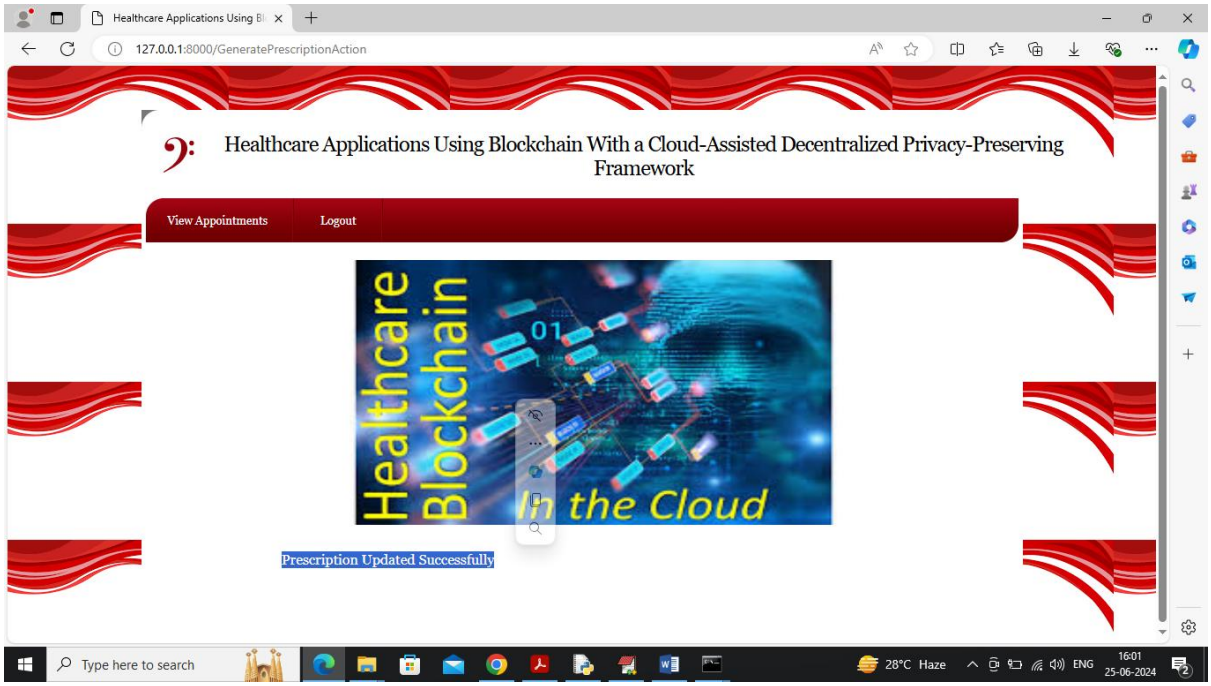




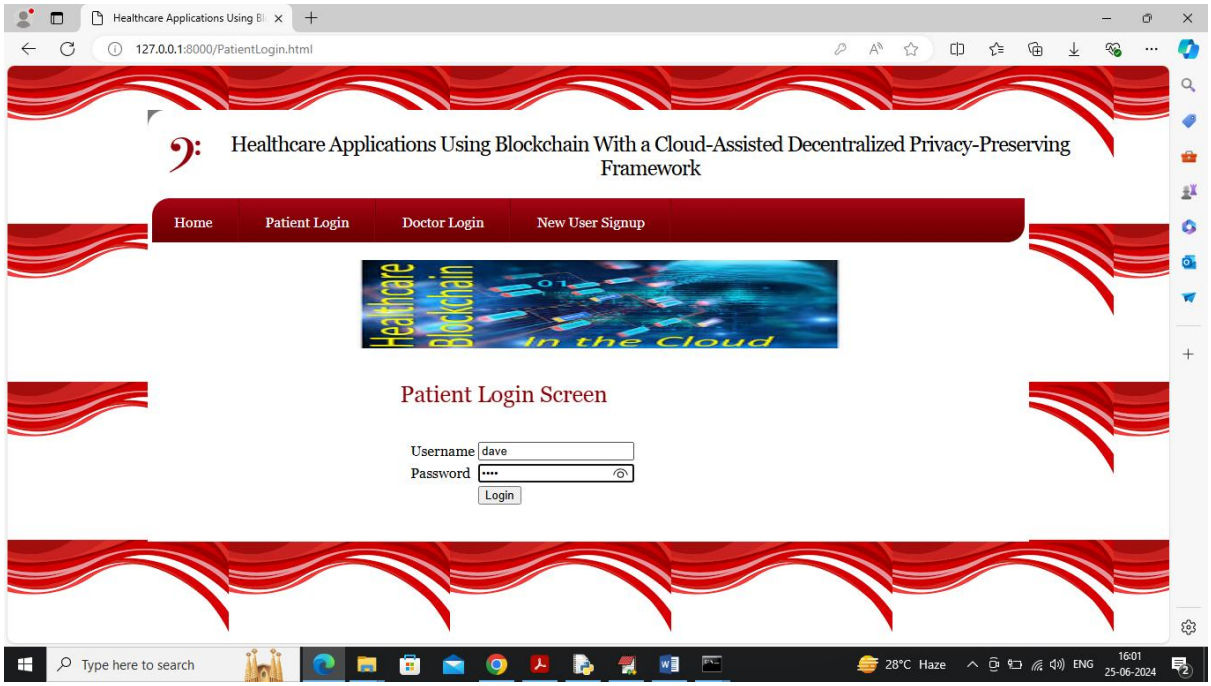
In above screen doctor can view list of appointment along with digital signature can click on ‘Click Here’ link to download and view patient disease supporting documents and can click on ‘Click Here for Prescription’ link to generate prescription



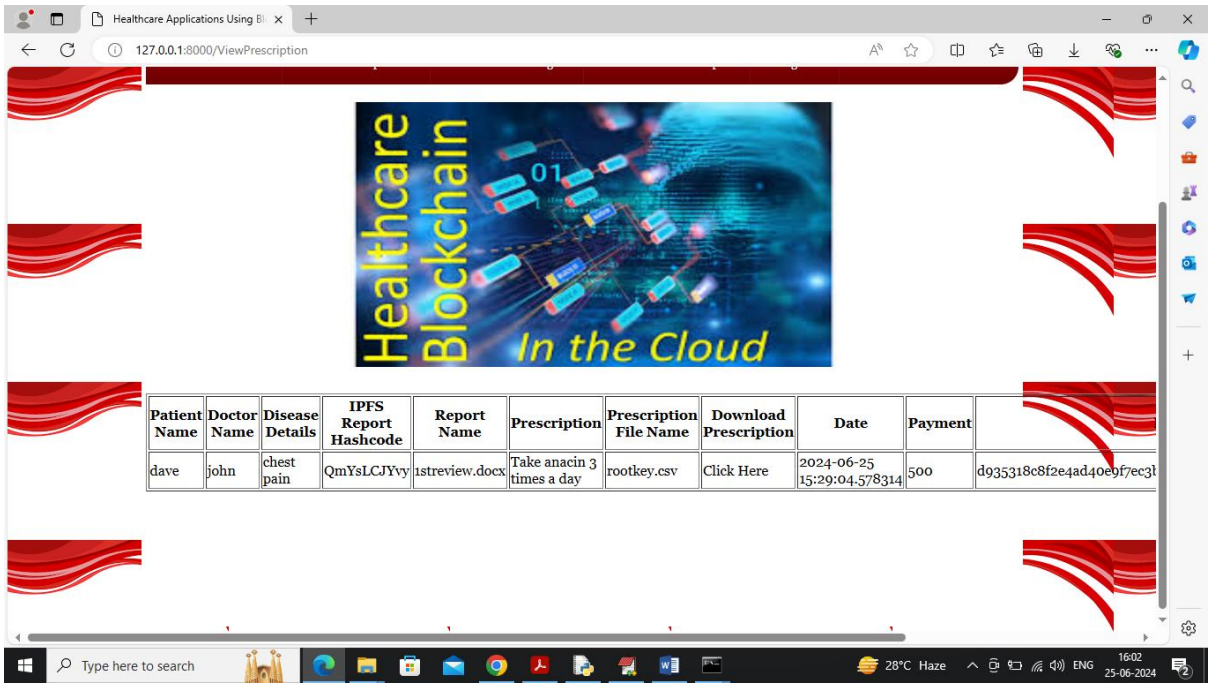
In above screen doctor will write prescription and upload supporting prescription and then press button to get below page



In above screen prescription updated successfully and this prescription can view and download by patients



In above screen patient is login to get below page



In above screen patient can view generated prescription and can download prescription also.

Similarly by following above screens we can provide privacy to patient data using cloud and Blockchain technologies.