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An integrated approach of block chain technology with machine learning and cloud computing for handling healthcare data

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***Abstract*---**Healthcare industry has become one of the world's important sectors. It is one of the quickestand persistently growing industries. Healthcare Technology focuses mainly on patient's empowerment. Blockchain technology is offering healthier scope for accessing medical records privately. Patient confidentiality can be maintained more effectively using block chain. It is very difficult to hack the data because blockchain makes use of decentralized data storage. Nowadays machine learning is used for understanding the data and for analysing and making decisions in various sectors. It is one of the prominent techniques that are being applied in an extensive range of applications to solve a variety of complex problems. Machine learning plays a vital role in healthcare sector, by offering effective methods by saving time, effort and money. Convergence of blockchain technology with machine learning and cloud computing provides extremelyenriched functionalities and services which enables the healthcare industry to revolutionize with substantial results for medical professionals. For experimental results, Ethereum is used. In the proposed work, the patients can also get the disease details using machine learningconcept by providing their symptoms.

***Keywords*---**Smart contracts, Blockchain, Decentralized applications, Electronic Healthcare Records.

Introduction

Health care industry is one of the fastest evolving industries at presentin the world, where the data managing and controllingconfronts are getting raisedprogressively. Nowadaysthere is a changeover from paper-based systems to

computer storage systems(Aziz HA,2016). It gets the patients' personal and medical information in a digital format. Electronic Health Records (EHR) contains patients' sensitive and personal data which will be accessed by health care service providers. Nowadays Patient's treatment does not rely on conventional medical environment. It offers convenient service to the patients by granting the patients to connect with health care service providers whenever and wherever required. This also lowers the cost of traditional way of making frequent visits to the doctors.

The cloud computing technology has enhanced the quality of care available to the patients. In the recent days due to COVID-19, the numbers of patients are getting increased. It is very difficult for all the patients to consult the doctors directly (Singh 2021). The healthcare service providers can treat their patients 24*7 remotely. Remote patient surveillance is mainly useful during Covid-19 Pandemic situation. It is beneficial for pregnant ladies, old aged people and also for the patients in interior and tribal regions.

Electronic Health Record (EHR) contains personal and medical information about the patients. The intruders may illegally access and modify the EHR information. It may result in loss of patient's health record which leads to suggestion of wrong drug to the patient and it also leads to severe illness of patients or even sometimes death(BL Radhakrishnan,2019). The security methodology is required during the transmission and the storage of data in the existing systems to attain the healthcare service with confidentiality and integrity. The proposed blockchain based healthcare system is able to provide medical services to the patients by preserving data security and privacy.The proposed work makes use of block chain for transmission, cloud for backup storage and machine learning concept to find out the disease with the help of inputs. By the invention of imaginative technologies like cloud computing, blockchain and machine learning, the healthcare industries have attained more significant changes which provide easy access among doctors and patients.Naive Bayes can beapplied to map the symptoms with possible diseases using thedataset of various disease symptoms details (Chandrasekhar RaoJetti, 2021).

Methodology

The Proposed healthcare system supports the patients by protecting their medical and personal data with the help of blockchain technology. It allows the patients to communicate with the doctors who have already registered in this system. The doctor can access patient's records after getting permission from the patients. The doctor provides their prescription to the patients and patients can also pay their consultation fees through this system. Apart from this the patients can also learn about the details of the disease using machine learning technique without the intervention of doctor. Finally all the data transactions will be stored in the cloud for doctor's reference.

Transmission of Patient's data

Blockchain technology is used for transferring the data given by the user. It transmits the data in the form of blocks. It creates the block for each and every

data provided by the user. The miner of the block chain network validates the data entered by the user, after checking the data the value will be converted into a block. In the proposed work, super admin is the miner. In the proposed system, Ganache tool is used to access blockchain. It also checks deployed smart contracts. Ganache allows developing, deploying and testing decentralized applications in a safe environment.

Smart contracts can be defined as the programs which will execute when predetermined conditions are met. The main purpose of the smart contract is to automate the execution of an agreement which enables all the participants to be assured of the result immediately without the need of intermediary. It is a collection of code and data that available in blockchain in a specific address. They can also automate a work and trigger the further action when required terms and conditions are met. In the proposed work, smart contracts are created using Java language.In the proposed healthcare system, Metamask is used which act as a wallet to access the Ethereum blockchain. The users can make use of the Ethereum wallet with the help of the browser extension. It acts as a middleware for interacting with decentralized applications.

In the proposed healthcare system, the blocks will be created and stored in the merkle tree format. Merkle tree is a tree in which each leaf is named with the label using the hash value. Each and every non leaf node is named with the label using cryptographic hash value of the labels of its child nodes.

In the proposed work, super admin login into the proposed healthcare system first, therefore the first block will be created with super admin data, there is no previous hash value for this block, since this is the first block. After that the user will enter the data into the proposed system and then the separate block will be created for the user (patient) whose previous hash value is the hash value of the super admin (miner) block, so that the patient block can be connected with the miner block as a chain.

After this if the doctor enters the data, a block will be created whose previous hash value is the hash value of patient's block and the doctor's block gets connected to the patient's block, similarly the blocks will be created for all the data entered by the users of the proposed healthcare system and it will be connected together as a chain that forms a blockchain network. If the user or the doctor enters any illegal data then an alert will be passed to miner (super admin) so that the fake details cannot be added in the blockchain network. Patients can upload their historical medical records in the proposed healthcare system, so that the doctor can easily understand the current health status of the patients and can proceed further. Patients can also upload medical reports like X-rays, Scans etc. in the system for doctor's better understanding.

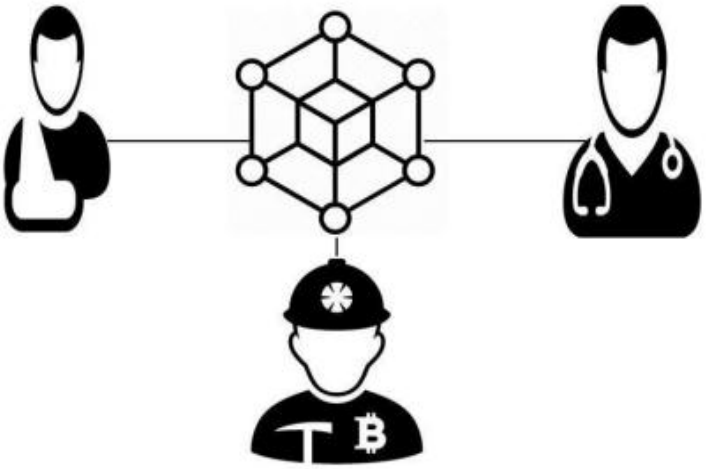

Fig 1. Interaction between doctor, patient and miner

Blockchain generates hash value for each and every data generated by the user. This hash value will prevent the process of hacking and secures the personal and the medical data of the patients. Since each and every block has connected with each other, it is not possible to hack the blockchain. Each block contains its data, own hash value and previous block's hash value. If any third party wants to hack the data, its hash value will be changed which will make the whole blockchain network invalid. Blockchain makes use of SHA-256 algorithm to compute hash value.

Doctor accessing patient's records

The doctor can view the patient data only after the patient's permission. The doctor has to make a request to access the patient's data. This request will be first passed to the admin then it will be relayed to the patient. If the patient accepts the request and grants permission, then the doctor can view the data. The doctor will check all the contents filled by the patients about their diseases and he will extract all the uploaded contents of the patient in order to know the whole history of the patients. After complete checking the doctor will decide about the patient's health condition and he will send the prescription to the patients. The doctor will also generate the bill for consultation and he will pass it to the patients and the patients can also pay their doctor consultation fees through the proposed healthcare system. This transmission occurs with the help of block chain technique so that third parties can never access the data shared by the doctor to the patients. It saves the time and cost of the patients and also doctors also can treat more numbers of patients in a less time.

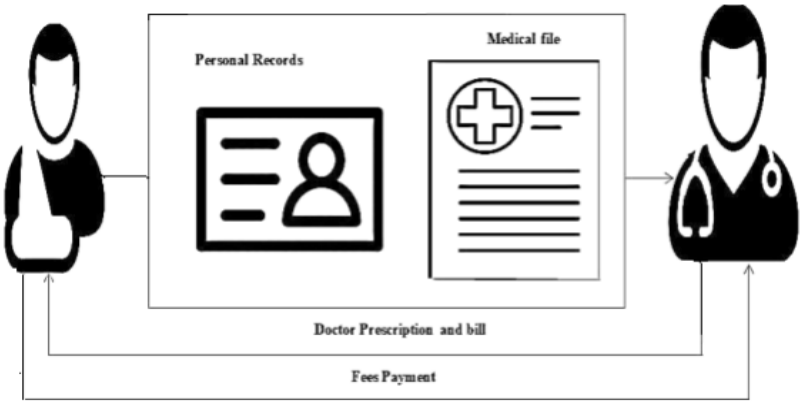

Fig 2. Doctor accessing Patient's records

Cloud Storage

All the data about the patients will be stored in the cloud finally. Doctor will save the patient's data in the cloud. Whenever required the doctor can use it with the miner's permission by specifying the date and time of transaction. The miner will provide details about all the transactions performed on the specified date and time. If the same patient comes for the next time, the doctor can use the old records stored in the cloud repository for further treatment. It will save the time and money of the doctors and patients. This proposed system also allows the registered patients to use the system frequently. Cloud allows storing the patient's data in a safe and secured manner. Patients can submit their details in the proposed healthcare system to avoid loss of their personal and medical data.

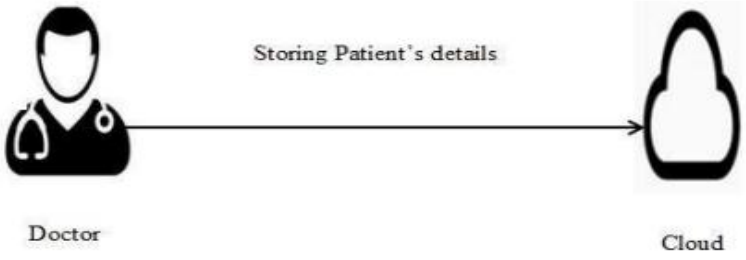

Fig 3. Cloud Storage

Searching diseases

The proposed system predicts the disease based on the symptoms specified by the patients. In the traditional diagnosis approach, patients have to visit the doctor directly and they have to take different medical tests and finally the doctor will come to a conclusion but this process is very time consuming. In order to save the time and money for primary symptoms diagnosis process, automated disease prediction technique is proposed. This process does not require the intervention

of the doctor, it will work based on the datasets uploaded in the system. The dataset contains the symptoms of various types of diseases. The smart healthcare system will predict the disease with the help of the symptoms specified by the patients. The proposed system makes use of Naive Bayes algorithm.

This algorithm works on the principle of Bayes theorem and it can be mainly utilized to solve classification problems. It depends on the concept of conditional probability. It is a simple and efficient algorithm to make predictions. This algorithm can be mainly used for text classification. Naive Bayes comes under supervised learning technique and one feature's occurrence does not depend on the occurrence of other features. Naive Bayesian algorithm makes use of probabilistic approach especially multinomial since multiple symptoms are considered. In the proposed system Naive Bayes algorithm is used for medical data classification and real-time predictions. The classifier uses the frequency of data for the predictions. By inputting the symptoms the proposed system makes a prediction.

It is classical diagnosis to increase medical attention given to the patients. The feature of one class does not depend on the other features of same class. This works with an assumption of independence with predictors. Even if all the features are interrelated with each other, Naive Bayes algorithm will observe it independently. This algorithm will also work well for multiclass prediction feature. Naive Bayes classifiers conclude that all the features or variables are not related with each other. The absence or existence of one variable does not affect the absence or existence of any other variable. Naive Bayes algorithm collects the symptoms from the user and it will predict the most probable diseases. It makes use of multinomial Naive Bayes because multiple symptoms are considered for each and every disease in the healthcare system.

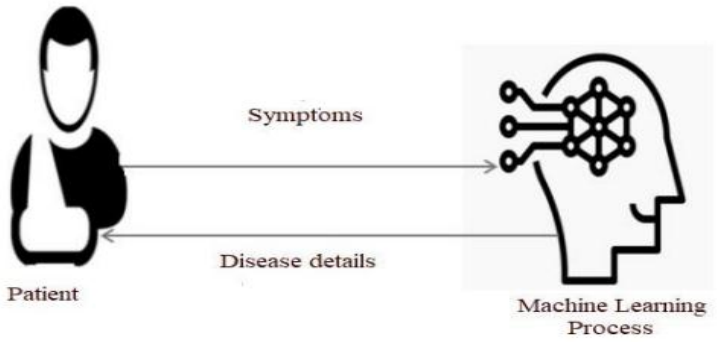

Fig 4. Searching disease

Symptoms present for the particular disease were marked as one and others were marked as zero. The user can specify almost all of their symptoms to predict their disease. The accuracy will be more if more numbers of symptoms are specified. Disease prediction is an approach to know about patient's health status by applying machine learning techniques. In Supervised learning both training and testing datasets are used. It is not required that the distribution among the datasets should be same.

To check accuracies and precisions the datasets are divided into training and testing data sets. Using similar data in training and testing dataset will reduce the data discrepancies and also helps to understand characteristics of the model in a better manner.If the size of the data is large, accuracy of the algorithm will be high. Accuracy depends on the size of the dataset. Dataset is a collection of data. It is the heart of the machine learning process. It is not possible to work in machine learning without data. Collecting the required data is an important task of machine learning. If the dataset is in the form of tables, each row indicates a record and each column indicates a specific variable and each value is known as datum, Dataset may also have documents or files.

The proposed system allows the patients to select their symptoms instead of entering it. This has been done to avoid confusions. Each user will use different types of keywords, the system has to understand those keywords. For example high fever can be entered in different term like hyperpyrexia and sweating can be mentioned as Diaphoresis. The dataset has been uploaded with almost all the common symptoms in simple terms which will allow the patients to choose the symptoms and signs easily.

The sample dataset contains the symptoms of a disease which are used to predict the disease correctly. Each and every disease will have different number of symptoms. If the symptom is there it will be marked with one otherwise zero. In the uploaded dataset all the diseases will be represented using same number of columns (symptoms) even though the symptom is present or not. In the sample datasets only few uncommon symptoms are taken. But the ML algorithm works only with the common columns of symptoms for all the diseases. 1's denotes the presence of the system and 0's represent the absence of the symptom.

Table1
Symptoms of Jaundice

Itching	Vomiting	Fatigue	Weight loss	High Fever	Yellowish skin	Dark urine	Pain behind the eyes	Back pain	Abdominal pain	Prognosis
1	1	1	1	1	1	1	0	0	1	Jaundice

Table 2
Symptoms of Diabetes

Fatigue	Weight loss	Restlessness	Irregular sugar level	Cough	High fever	Blurred vision	Obesity	Excessive hunger	Prognosis
1	1	1	1	0	0	1	1	1	Diabetes

Results and Discussions

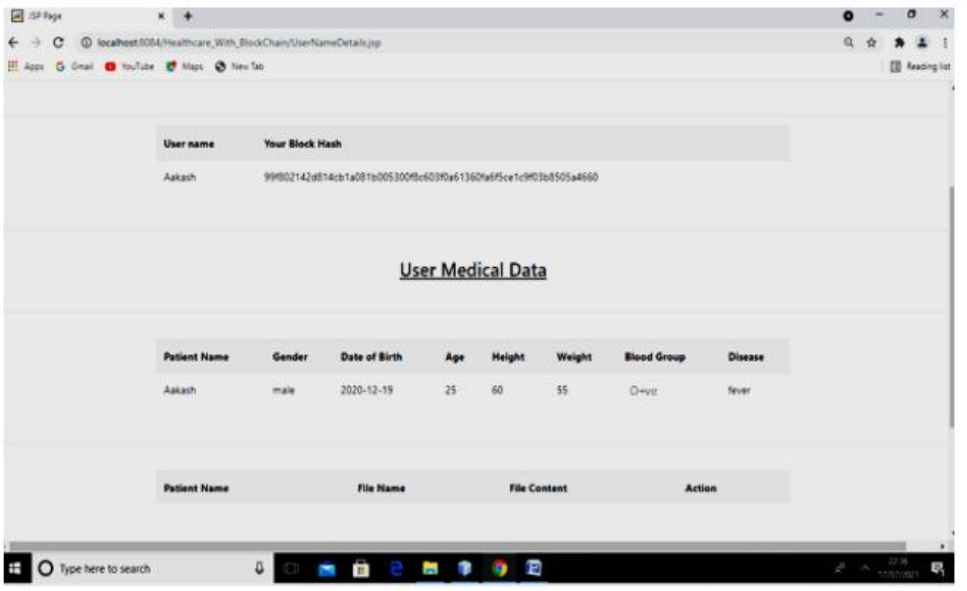

Fig 5. Doctors's viewing the patients records

Fig. 5 and 6 represents the patient records entered and uploaded by the patients for doctor's consultation. After checking the records thoroughly the doctor will provide a prescription to the patients.

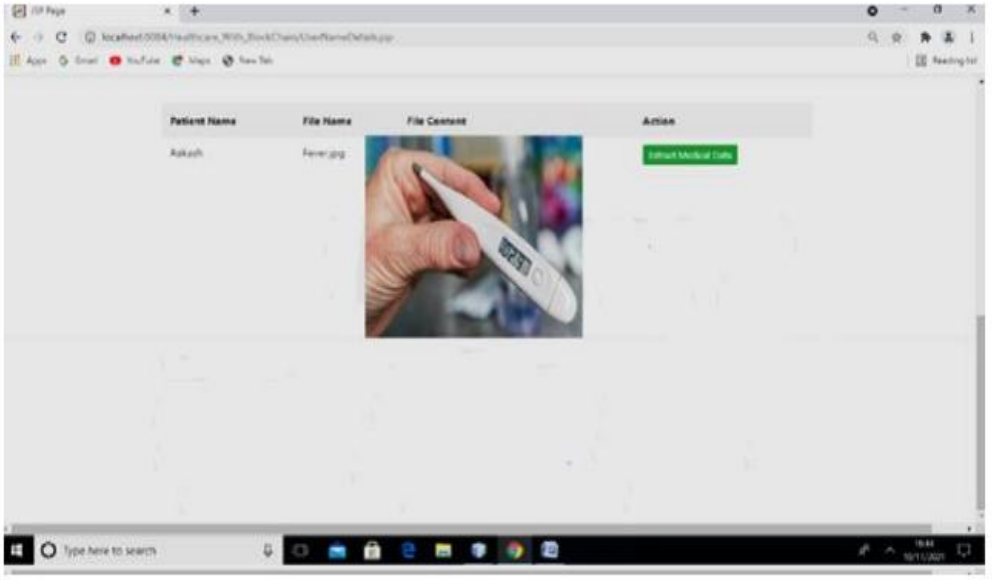

Fig 6. Doctors's viewing the images uploaded by patients

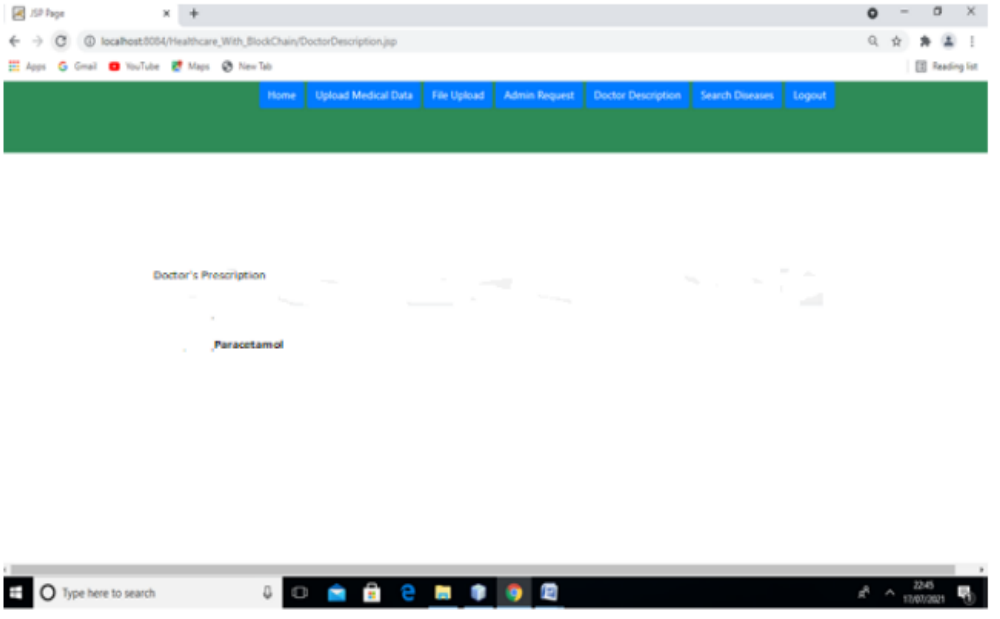

Fig 7. Doctor's Prescription

The doctor will generate an invoice, the patients have to pay their consutataion fee after getting their prescription.

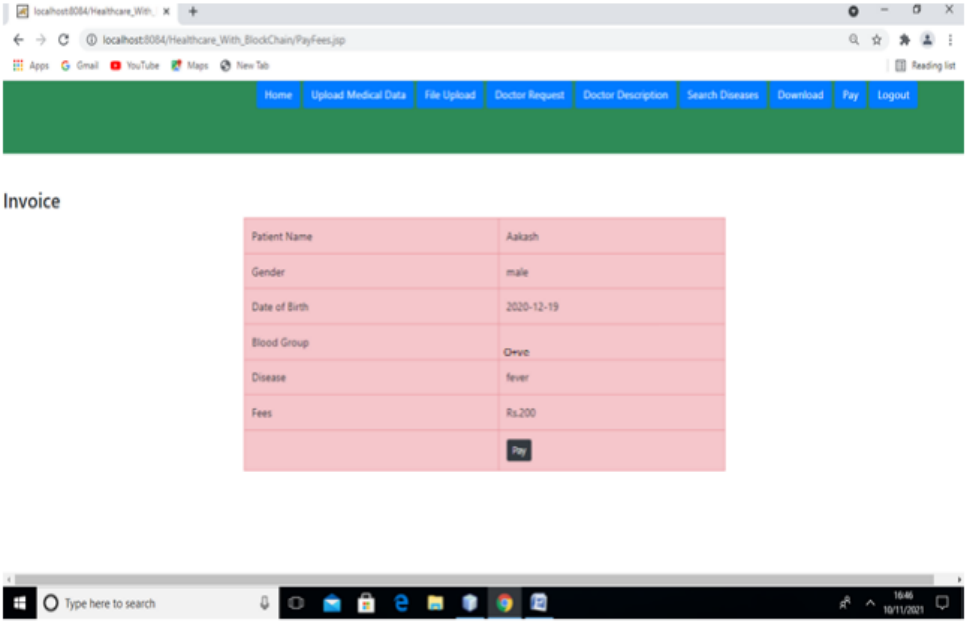

Fig 8. Invoice generated by doctor

The patients can select the symptoms experienced by them. The patient can select nearly five symptoms to find their disease. After selecting all the symptoms the proposed system will predict the disease using Naive Bayes algorithm and displays the output. In the example patients selected symptoms like itching, yellowish skin which resembles the disease Jaundice. Similarly the patients can enter their symptoms and find their actual disease.

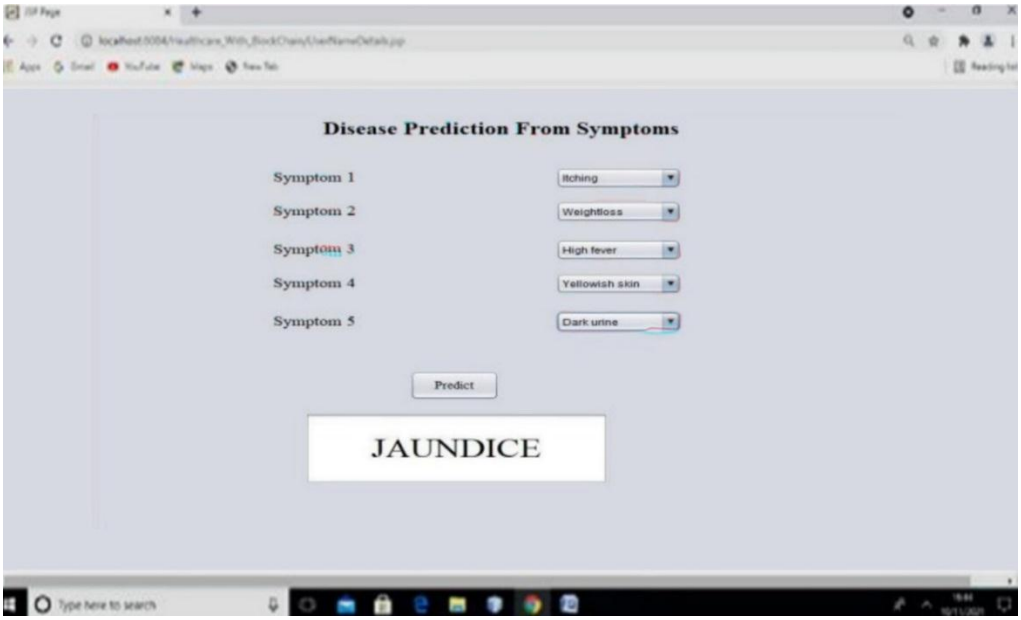

Fig 9. Finding Disease using symptoms

The Proposed system integrates block chain technology, machine learning technique and cloud computing with healthcare industry which will allow the patients and doctors to share the healthcare related data with the security and privacy. During emergency the doctors can immediately access patient's medical records using cloud repository. The patients can view their actual disease details by mentioning their symptoms in the proposed system using the concept of machine learning. The proposed work store, share and protect patient's data which improves the quality of data and ensures that the patients can lead a healthy life by connecting their electronic medical data across various healthcare service providers

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