Patient Health Monitoring and Heart Disease Prediction System

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Abstract

Nowadays, applications of IoT is everywhere and it is making our life much easier because of its sensor technology, interconnected devices which can collect necessary information and process it. In the past decades, it is seen that many patients die due to heart related diseases due to lack of medical facilities. Due to these applications of IoT, it is having huge applications in medical sector also and with the help of IoT we can get the health parameters of patient using different sensors like temperature sensor, heart rate, blood pressure and SPo2 sensor. So, this paper proposes an idea which can collect all these health parameters from patient and creating a machine learning model using the random forest algorithm which can predict the different types of heart diseases like Coronary artery disease, Angina, Myocardial infraction and Silent Ischemia. Now, patient can come in contact with all these sensors and sensed data will sent to cloud and feed these inputs to machine learning model. This model will predict whether the patient is having any heart disease or not.

1. INTRODUCTION

Heart is very important organ in our body because it pumps the blood to all our other body parts. So it is necessary to take intense care for our heart and maintain it. Many number of deaths occurred due to heart related diseases in the past decades and it has become threatening disease not only in our India but also in other countries. So there is need of feasible system which can diagnose these heart disease and diagnosis of heart diseases in medical sector is considered as significant and great work. Many researchers worked on these types of projects and they brought major development in heath sector[4]. Many of them have used machine learning techniques and data mining techniques which made prediction of cardiovascular diseases easier. So we came up with the idea which uses machine learning technique like random forest algorithm to predict the disease. It is giving the better accuracy in prediction. Using this types of prediction system can decrease the large scale of deaths. These decision making activities can help the doctors and physicians to diagnose the patients and also find the relationship of patterns formed in the data. There is lots of data in health sector in the form of datasets which can be used for training the machine learning model. Based on the usage of this technology we come to know that it will be greater improvement and development in medical sector and reduce the deaths happened due to lack of medical facilities.

2. LITERATURE SURVEY

In paper [1], it tells us about the asset monitoring system. The parts are directly connected to each other. The wireless sensors are connected to PC application with TCP/IP connection. It consists of a temperature sensor, to check the temperature of the patient and it contains ECG which it checks the heart rate of the patient, acceleration and activity of the patient. The database which is collected from sensors is stored in database.

In paper [2], it tells us about the patient monitoring system. The components of the system are connected with the help of Raspberry Pi. The sensors which have been used are Temperature, Heartbeat, ECG and Accelerometer. To secure the data of the patient Shamir's Secret Key Sharing Algorithm and to diagnose the heart disease prediction algorithm support vector machine has been used. The data of the patient is continuously monitored but if there is any odd behaviour then with the help of IoT, an email is sent to the doctor about the condition of the patient.

In paper [3], it tells us that machine learning can be used to predict disease. There are two algorithms which are K-Nearest Neighbour (KNN) and Convolutional Neural Network (CNN) but CNN is efficient to use because it's accuracy is 84.5%. The CNN determines risk of general disease i.e. if any disease is detected then it has higher risk or lower risk.

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In paper [4], it tells us that in order to help the patients in golden hours machine learning is useful and its applications are prediction algorithms. There are different dataset for the patients who are suffering from Heart disease, Breast Cancer and Diabetes. Also there are different classifiers, clustering and machine learning algorithms are used for each disease.

In paper [5], it tells us that prediction model can be generated with the help of machine learning for heart disease. Prediction model was intercalated with different combinations of features and techniques. For deriving the accurate answer of the condition of the patient Hybrid Random Forest Algorithm was used because it has accuracy of 88.7%.

From the above literature review we can derive that Raspberry Pi is costlier which can cause increase in the budget of the project so Arduino-Uno is feasible and also it functions similar to Raspberry Pi. The algorithms which have been used in different papers we can conclude that Random Forest Algorithm is accurate than other algorithms. The sensors are connected to the arduino because it might be the possibility that wireless sensor can be lost. The sensor will send data to the arduino and further it will be sent to the cloud i.e. Firebase. It will get stored and sent to a website and also the patient can enter other parameters which would help to determine the health of the patient.

3. PROPOSED SYSTEM

The main goal of the proposed system is to reduce patient's time and doctor's time for diagnosis of disease. In the proposed system we are going to take the patient's real time health parameters from sensors and remaining parameter values are given by the patient and collect it in Google Cloud (Firebase). The proposed system is further divided into the following modules:

3.1. IoT Infrastructure Setup:

Here, we are using a wireless sensor network which includes Arduino NANO ATMEGA328, Blood pressure sensor, DS18B20 Temperature sensor, SPO2 sensor, M212 Heart Rate pulse sensor, Power supply and ESP8266 wifi module. This WSN is used to take patient's real time health parameters like heart rate, blood pressure, temperature and oxygen levels. These parameters are sent to google cloud (Firebase) using wifi module. At the same time, patient will give the values like age, sex, chest pain, resting blood pressure, serum cholesterol, fasting blood sugar, resting electrocardiographic results, maximum heart rate achieved, Exercise induced angina, ST depression, Slope of the peak exercise ST segment, Number of major vessels colored by fluoroscopy and thal. There are 4 wearable sensors namely Blood pressure sensor, DS18B20 Temperature sensor, SPO2 sensor, M212 Heart Rate pulse sensor which are connected to Arduino Nano ATMEGA328. For any hardware to work, power supply is necessary. The power is supplied to Arduino and the readings of sensors are sent to Arduino. Google Cloud (Firebase) will store the sensors reading which is sent from Arduino through ESP8266 Wi-Fi module. Our proposed System mainly comprises of heart disease prediction system which consists of hardware and software module. We will describe each part one by one.

3.1.1. Hardware module (Wireless Sensor Network)

Our hardware module (wireless sensor network) consists of Arduino Nano board (ATMEGA328), Temperature sensor (DS18B20), Spo2 sensor, Blood pressure, Heart rate pulse sensor (M212), wi-fi module (ESP8266) and LCD screen. And there is power supply which is made up of transformer, capacitors. All these sensors are connected to Arduino. When patient come in contact with all these sensors, health parameters are sensed and sent to cloud using wifi module and from cloud model takes these parameters as input and predict the disease.

3.1.2. Software module

Software module consists of web application developed with python flask and to take sensed values from Arduino, Arduino language is used. In web application, patient need to enter the age, sex and all health parameters or attributes. In next interface, patient need to select the algorithm whoich is random forest algorithm and automatically disease is predicted by module. We have taken the dataset from UCI Machine Learning Repository[7]. There are also other section in web application, where the information like how the dataset is cleaned, how the dataset is splited into training and testing set, how the model is trained with random forest is showed. Different types of graphs related to data set is also shown.

3.2. Algorithm

We are using random forest algorithm [5], random forest algorithm consists of different decision trees and decision of all these trees are taken to predict the disease. All of

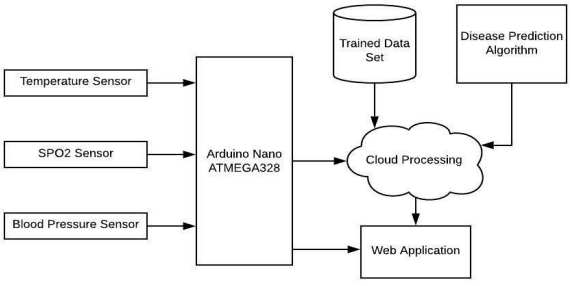

Figure 1: Block diagram of Proposed System

them did not give same answer but majority is considered. It is supervised learning model, it is needed to train first. It learns from labelled data to classify the unlabelled data. Following figure shows how the random forest algorithm works with respect to decision trees.

3.3. Prediction

The data set for this research was taken from UCI data repository[7]. Many machine learning communities, for the purpose of empirical analyzing the machine learning algorithms have been used from UCI machine learning repository. The overall objective of our proposed system is to predict the presence of heart disease more accurately. In this paper, UCI repository dataset are used to get more accurate results. We have applied random forest algorithm to database containing 17 parameters with one output label which consists of five outputs. There are five predicting output labels which are No disease detected, Coronary artery disease, Angina, Coronary Artery disease, Silent Ischemia and Myocardial Infarction. In the actual dataset, we had 76 parameters but for our study, we chose only 17 parameters. In the past few decades, many machine learning techniques have been used for health care applications. However, the problem parameter tuning issue arises in standard machine learning techniques. Therefore, to improve the performance of the existing machine learning techniques, efficient tuning of the parameters should be used. As Random forest (RF) algorithm is one of the most effective ensemble learning method for both regression and classification approaches. RF algorithm creates of many decision trees, each decision tree will give the prediction result and the voting is performed on every predicted result.

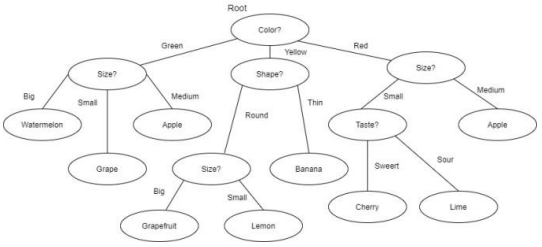

Figure 2: Random Forest Algorithm

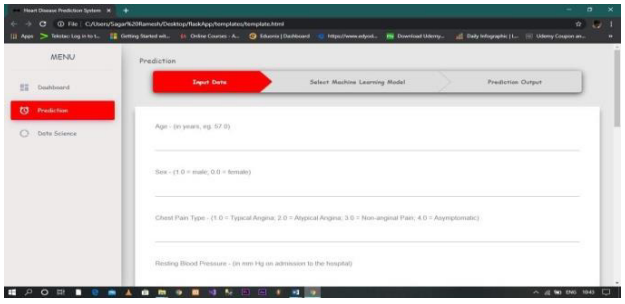

Figure 2: Input parameters entered by the patient

And finally, the algorithm selects the most voted prediction result as the final prediction result. RF method is better than single decision tree because it reduces the over- fitting problem. RF method combines random selection of features and bagging. There are two important tuning parameters in random forest algorithm:

- Number of estimators (trees)
- Depth of the tree

After this, cleaning of the data is done i.e. filling all the missing values in the data and also removes all the dirty data or inconsistent data. The data is cleaned and pre-processed before training and testing of the proposed algorithm. We had incorporated the Random Forest algorithm to the dataset to make the required predictions. Here we had divided dataset into training and testing model i.e. 70% for training and 30% for testing. We have saved the prediction model of training dataset and applied the same on the testing data and then performed the prediction. We used some specific libraries to carry out the data manipulations in python programming language. The libraries that we used in python are pandas for data pre-processing, Matplotlib for data visualization and Scikit learn for invoking the machine learning algorithm on the dataset. The sensor values are fetched from cloud and remaining 13 values given by the patient are combined and predict the heart disease using machine learning algorithm i.e. Random Forest Algorithm. There are five predicting output labels which are No disease detected, Coronary artery disease, Angina, Silent Ischemia and Myocardial Infarction.

4. PROPOSED METHODOLOGY

We predict the disease by giving the input of 13 parameters shown in figure 2 and can view the 4 sensor readings via LCD. After reading the input parameters given by the patient and sensor readings from Firebase, the system will predict the disease. The patient can view the results in user interface which is shown in figure 4. The admin can view the results and sensor readings through Firebase which is shown in Figure 3. Following is the description of dataset taken from the UCI Machine Learning Repository.

Following are the snapshots of our proposed system which includes Web application, Firebase (Google Cloud)

Figure 3: Snapshot of Firebase

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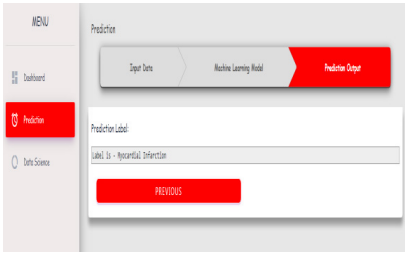

Figure 4: Disease predicted

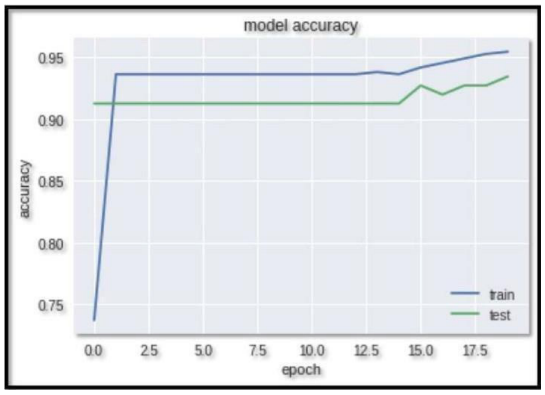

Figure 5: Accuracy

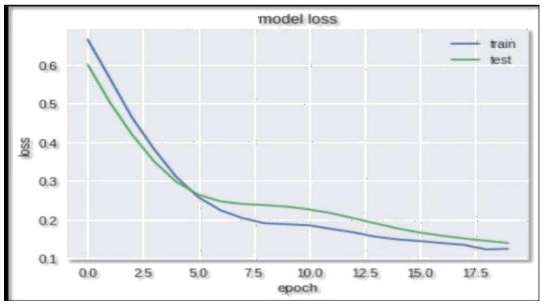

Figure 6: Loss

and also the accuracy of our model:

Loss is the cause of wrong prediction. The loss is greater if number of predictions made wrong are more. Whereas accuracy is the measure of the accurate predictions of the model. The accuracy and loss are inversely proportional to each other. So here as accuracy increases with epoch and hence the loss decreases.

5. CONCLUSION AND FUTURE WORK

By using our system, we concluded that we have successfully implemented the wireless sensor network which is sensing accurate health parameters with very minute error. In this way, patient can easily know his health parameters without going to hospital and reduces the traveling cost and time. Our system is very useful in rural areas where the medical facilities are lacking. After using our system, patient can consult to doctor and can take preventive measures to prevent that disease. Our model is giving 89% accuracy in predicting the heart disease which is great achievement. In future, we are likely to add more attributes which can contribute more to predict the heart disease well and try to increase the accuracy of model. We will also add more sensors which will help the model.

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