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NEW-FANGLED INTERNET OF THINGS ARCHITECTURE FOR REAL-TIME HEART ATTACK MENACE PREDICTION

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Abstract: In recent times the prevalence of heart attacks among the youth is adding, which lead to the reason for death everywhere. These heart-related issues are endorsed due to fast-paced lifestyles and food habits. Not only adult youth are also affecting by heart attack. Inactivity, stress, insomnia, smoking, drinking, diabetes, hypertension, and obesity add to this health risk. The main cause for the increase in the death rate ensues due to the delay in detecting the symptoms or lack of early diagnosis. This paper proposes architectural design and solution to predict heart attacks with machine learning algorithms. The symptoms of heart attack can be traced by means of integrating the IoT with machine learning algorithms and medical care systems. In addition, a real-time patient monitoring system is developed to observe heart disease in patients, which assists a person to track his/her health condition easily, economically, and effectively. The system also detects patient risk levels based on different heart-related parameters used for the prudence of abnormal heart function.
Keywords: Internet of Things (IoT), heart attack prediction system, machine learning, Android smartphone

INTRODUCTION

The IoT has come an essential part for each one and is used in all disciplines similar as education, business, finance, social networking and healthcare, etc. The healthcare sector has been espousing new technologies for providing better and smart healthcare services [1].

The human body is made up of many parts, and the heart is one of the vital organs. But if the heart does not pump blood correctly it leads to many of the other diseases. So, any technology that detects the chance of a heart attack early before much serious heart attack will help to save the life of many people.

The habit of mobile device usage, as well as wifi sensors is increasing day by day. This helps to solve the problem of the growing population. In the Indian population, the population of senior people is increasing along with rise in healthcare fees due to innovative technological solutions in hospitals. An optimal way to deal with the above problems is to switch fitness tracking from clinic structures to places where individual humans stay [2]. By using this

solution people can sit at their home and keep track of their health easily. This contributes them more autonomy while keeping track of their heart condition very well at lower prices.

The proposed approach is to devise a heart attack detection system that takes benefit of the IoT and machine learning along with the Android application, which allows patients to predict the chance of heart attack remotely by connecting to the internet. A widespread method designed to implement the system comprises, designing a machine learning model with diverse algorithms (SVM, KNN, and Random Forest) that can predict the chance of heart attack efficiently and choosing the algorithms that have good accuracy for prediction against real-time data. All the examination data (systolic BP, Diastolic BP, and Heart Rate) are gathered from the hardware device and subjective data (Age, Gender, Chest pain) are captured from the Android application.

Section II explains the different work carried out related to heart attack prediction. Section III depicts the proposed work related to heart attack prediction. Results of work and Future scope are explained in section IV and section V concludes the proposed work.

II. RELATED WORK

In [2], the Sensors used in the system include, body temperature sensor for measuring the temperature of the body, a position/gesture sensor, and sensor to measure blood oxygen saturation level and an ECG sensor. All sensors are coupled to NodeMCU. The processor integrated in this system has two components namely a microcontroller and a wi-fi module. Sensors collect the data using a microcontroller and send the data to the cloud using Wifi. The Thingspeak open-source cloud is used. A time delay of about 2-5 mins is observed between the client sending the data and the server receiving it. For sending the results GSM module combined with the microcontroller sends the message to each person. In [3], some of the myths related to heart attack and heart-related disease published on the website (http://www.webmd.com) are, a) Normal heart rate is 50-100 beats per min. Nevertheless if the heart rate is above 75 then there may be a chance of heart attack. b) Having an irregular heartbeat is not the main symptom of a heart attack. But having chest pain or problem breathing may also be a chance of a heart attack. In this research data is mainly alienated into three categories, personal data (age, gender) which is collected from front-end applications, periodic data (sugar, cholesterol) gathered from hardware devices and live data (blood pressure, heart rate) is also taken from hardware devices. KNN algorithm is used for prediction. In [4], the prediction algorithm used is KNN and Random forest. From the heat map, it is observed that Chest pain and maximum heart rate have a positive correlation with target attributes. In [5], the proposed system uses IoT, machine learning, and mobile applications. A variety of sensors are used, such as pulse sensors, BP sensors, and temperature sensors. Experimental data is gathered from a hardware device and subjective data is aquired from a mobile app. A mobile app is built for patients and doctors.

Different prediction algorithms have been selected, the most important of which is the support vector machine [7][8].

Support vector algorithm can be applied both for linear data in addition to non-linear data [11]. For non-linear data, it transforms from a 2D plane to a 3D plane, and the technique is called a Kernel trick. The input variable is separated into classes by a hyperplane. In [10], the proposed system is designed to ease the doctors to track the health condition of their regular patients. The sensors (pulse sensor and temperature sensor) are embedded in the patient's body to read data continuously on the patient [6][9]. A humidity sensor and temperature sensor are installed in the patient's home. After capturing all data, data is sent to the IoT cloud to the base station. From there doctors can get the data. By observing all the sensor readings, doctors can determine the health status of their patients.

III. PROPOSED SYSTEM

The main purpose of this proposed approach is to build an early and real-time heart attack prediction system for patients so that they can foresee the chance of heart attack by sitting at their homes. The dataset is collected; pre-processed to keep the relevant attributes. To foretell the chance of heart attack various ML algorithms are used such as SVM, KNN, and Random Forest. The precision of these algorithms is compared, and the most accurate one is considered in real-time prediction. A portable IoT model is designed which is used to accumulate the experimental data such as Systolic blood pressure, Diastolic blood pressure, and Pulse rate which will be transmitted to the database. The Android application is also built to gather personal information (Name, Age) and other subjective data (Chest pain type, Gender) which will also be stored in the database. After collecting data from the IoT model and Android application, all the data is merged and sent to a trained machine-learning model for prediction. Finally, the machine learning model envisages the chance of heart attack and the result will be notified to the patients through Android Application. Fig.1 shows the overview of the proposed system architecture.

DESIGN OF ALGORITHMS:

Different algorithms are used in developing machine learning models, they are

Support Vector Machine:

ML consists of two important categories namely; Classification and regression. The SVM algorithm can be applied for both problems. But mainly it is used for classification. The objective of SVM is to classify the instance into two groups such that the margin between the hyperplane and the widest point should be maximum. Hyperplane is a line that separated two classes and the widest point is called Support Vector. To solve the problem of nonlinear data, SVM uses a trick called the Kernel trick, where 2D instances are converted to 3 dimensions or higher dimensions so that all the classes can be separated easily.

K-Nearest Neighbor:

In the K-NN algorithm a data point is taken whose classification is not available, and then the total neighbor, K is defined [4]. The K number of data points whose Euclidian distance is lowest regarding the new data point is selected as K neighbors. Finally, the new data point is categorized into the class which is the same as the majority of neighbors among K neighbors.

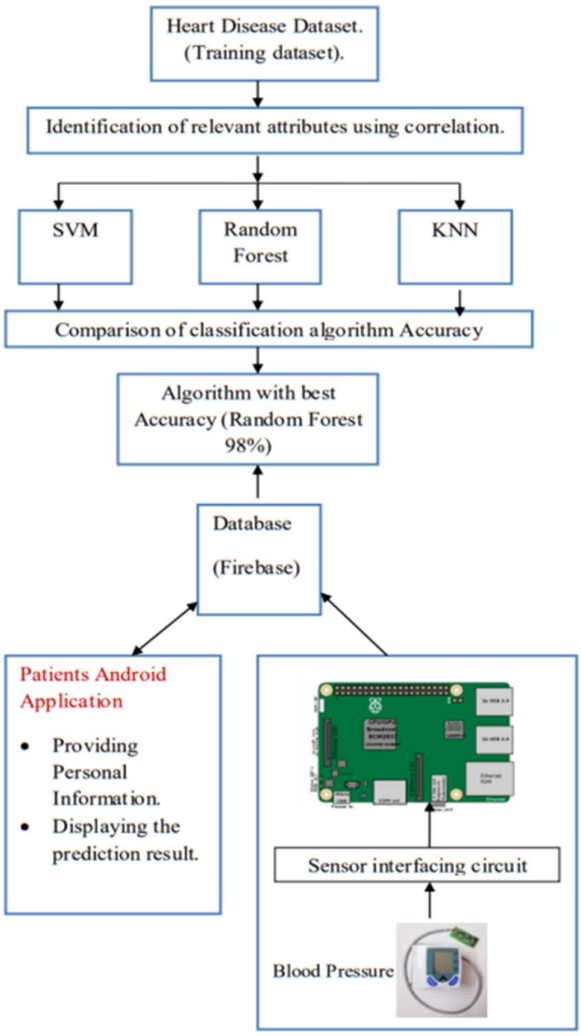

Fig 1. Proposed System Architecture

The value of K is non-parametric and the general rule is to select the K as,

$$K = \frac{\sqrt{N}}{2} \quad (1)$$

Where N is the total samples in the training dataset.

Random Forest:

Random Forest algorithm will work by creating multiple decision trees and decision trees predict the class as its output. The output of all decision trees is taken and the class which is the output of more-number of decision trees is taken as a result for the new instance which needs to be classified. For this algorithm, we need to define how many numbers of decision tree needs to be contracted as a part of the training
process. Random Forest is a bootstrap aggregating or bagging technique. This technique is used to decrease the variance in the results [4].

DESIGN OF IOT MODEL:

Proposed model contains different components. Namely,

Sunrom Blood Pressure machine: The purpose of this is to gather experimental data such as systolic BP, Diastolic BP, and pulse rate from the valetudinarian. This BP machine is a customized blood pressure recording machine that operates only through an external PCB but not with a battery. Output from the BP machine is serial output and sensor pinouts are,

TX-OUT – Transmit output, which outputs serial data. Connected to RXD pins of USB to TTL UART converter.
+5V - Regulated 5V input.
GND – Board common ground.

CP2102 USB 2.0 to TTL UART: This converter is used to convert the serial output from the BP machine into USB input for the microcontroller. This contains six pins out of which three pins are used. They are,

RXD – Receive input which is linked to the TX-OUT pin of the BP machine.

+5V - Output to power external circuit. This is coupled to +5V of the BP machine to power up the circuit.

GND – Board common ground which is attached to the ground of the BP machine.

Raspberry Pi 3B: The third-generation Raspberry Pi 3B microcontroller circuit, is larger than a regular microcontroller, so it is more of a microprocessor. In the proposed system, the Raspberry Pi 3B is used to send and receive data. The USB side of the CP2102 is connected to the USB port of the Raspberry Pi to get the value it needs. The data captured by the IoT model is forwarded to the database. Fig.2 shows the prototype of the IoT model.

Fig 2. Prototype of IoT model

DESIGN OF ANDROID APPLICATION:

Android application is implemented for valetudinarians who are using this system to afford their personal information such as Name, Age, Gender, and Chest Pain type. The application is used using Android Studio software.

Android application gets its first notification when experimental data is available from the IoT model and personal information needs to be provided. After providing personal information both data from the IoT model and Android Application are sent to machine learning for real-time prediction. Finally, when the result is ready from the proposed model, the android application is notified a second time stating that the result of the prediction is ready.

IV. RESULTS AND DISCUSSION

The results are to show that the entire module is working correctly without any failures. Heart attack prediction for the positive or negative category is made by various machine learning algorithms. The precision of all the algorithms is shown in Fig. 3. Hence, Random Forest is considered the best algorithm for future real-time prediction.

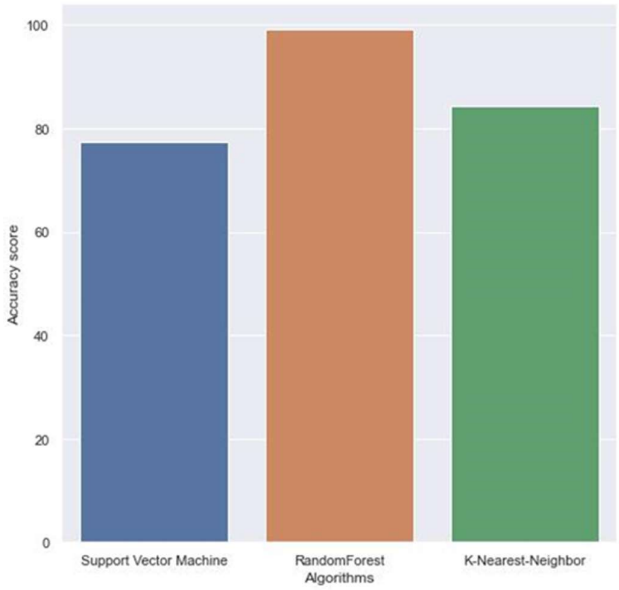

Fig3. Accuracy of ML Algorithms

Once the patients have stimulated the BP machine, then systolic BP, diastolic BP, and heart rate are collected. Once the data is gathered it is passed through the Raspberry Pi 3B and deposited in the database. The retrieval of experimental data from the IoT model is shown in Fig. 4.

After the acquisition of data from the IoT model and stored in the database, the Android application gets a Notification to fill in the necessary personal information, and entire personal information together with the experimental information from the IoT model is sent to trained machine learning model for prediction. The Notification for filling in personal information and data that was directed for prediction is shown in Fig. 5.

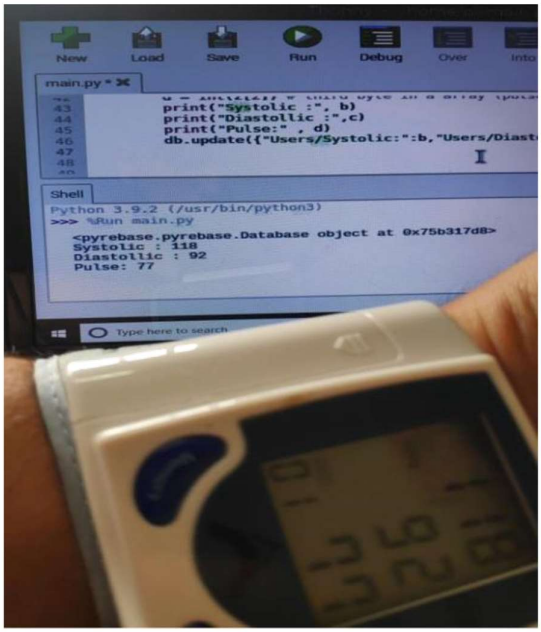

Fig 4. Retrieval of BP and Pulse rate

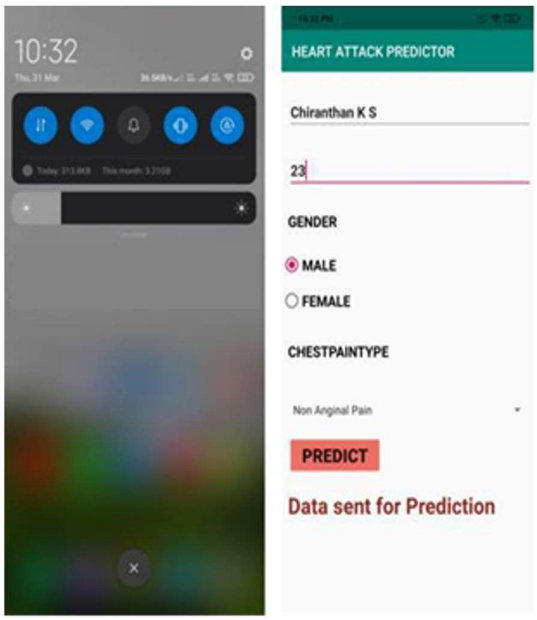

Fig 6. Notification of result

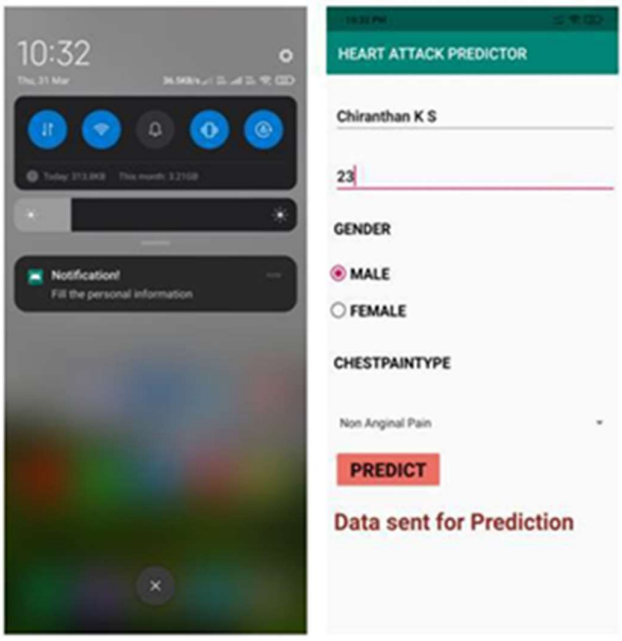

Fig 5. Notification to fill Personal Information

After providing personal data from Android Application, both the IoT model collected data and personal data are merged and sent to the machine learning model for prediction. Since Random Forest is considered the best algorithm for predicting heart attack, it will predict the chance of heart attack. The outcome will be notified to the patients through the Android application and will be displayed which is shown in Fig. 6.

V. CONCLUSION

This paper deliberates determining the chance of a heart attack by sitting at home even earlier before the actual attack happens which helps to save the life of many individuals. The classification algorithm used for the prediction is SVM, KNN, and Random forest, out of which Random forest evidenced to be the best algorithm for real-time classification. An IoT model is developed to get the experimental data such as BP and pulse rate. Android application is also developed to gather personal information. This system helps the patients as a preliminary system to predict the chance of heart attack. Patients will receive the final result of the prediction to the installed Android application.

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