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IoT Based Elderly Healthcare Monitoring System

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Abstract: Now a days continuous patient health monitoring is becoming a key concern for the doctors since it can help them save patient's life. So, the main objective is to design a patient monitoring system which can monitor various physiological data of patient who is remotely placed and make available this real time data to the doctor. The data is made available over the internet so that doctor can access this data from anywhere in the world. Remote patient monitoring reduces the need of doctor`s visit to the patient. In this entire system IOT plays a major role in providing many applications and services and Raspberry Pi used here is not just a sensor node but also a processor. It is a smart device which can sense, gather and publish this data over the internet. Paper proposes a generic health monitoring system with Heart Disease Prediction system (HDPS) using Neural network. The HDPS system predicts the likelihood of patient getting a heart disease. For prediction, the system uses sex, blood pressure, age, height, weight like medical parameters. as a step forward to the progress made in this department till now.
Keywords: IoT, HDPS, Cardiovascular disease,

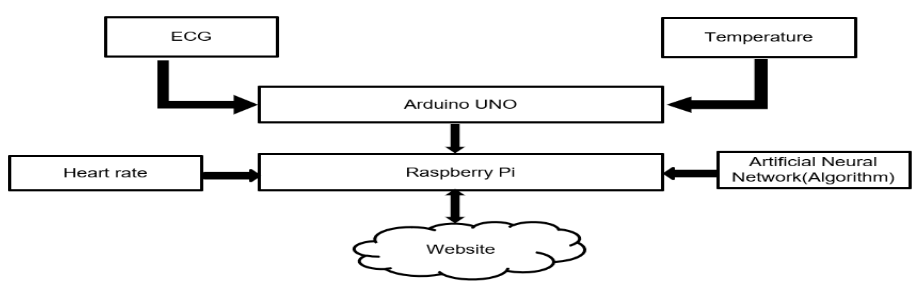
I. INTRODUCTION

The increased use of mobile technologies and smart devices in the area of health has caused great impact on the world. Health experts are increasingly taking advantage of the benefits these technologies bring, thus generating a significant improvement in health care in clinical settings. According to the constitutions of World Health Organization (WHO) the highest attainable standard of health is a fundamental right for an individual[1]. As we are truly inspired by this, we attempt to propose an innovative system that puts forward a smart patient health tracking system that uses sensors to track patient vital parameters and guess the chances of patient suffering from a cardiovascular disease in advance in terms of percentage and use internet to update the doctors so that they can help in case of any issues at the earliest preventing death rates. Patient Health monitoring using IoT is a technology to enable monitoring of patients outside of conventional clinical settings (e.g., in the home), which may increase access to care and decrease healthcare delivery costs. This can greatly improve a person's quality of life. This allows patients to maintain independence, avoid complications and minimize staff costs [10]. Moreover, Patients and their families are reassured that they are being supported in case of problems [10].

II. PROPOSED WORK

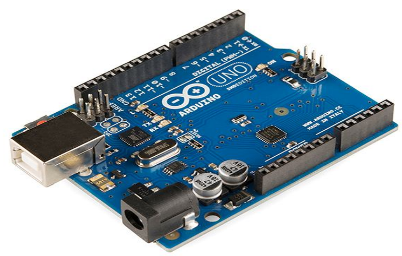
In this proposed work the vital parameters such as temperature, EEG and heart beat readings which are monitored using Arduino Uno. These sensors signals are sent to Arduino Uno via amplifier circuit and signal conditioning unit (SCU), because the signals level is low (gain), so amplifier circuit is used to gain up the signals and transmit the signals to the Arduino Uno. Here patients body temperature, EEG and heart rate is measured using respective sensors and it can be monitored in the screen of computer using Arduino Uno connected to a cloud database system as well as monitored anywhere in the world using internet source. The proposed method of patient monitoring system monitors patient's health parameters using Arduino Uno. The main goal of this proposed system is to guess the chances of a patient getting heart disease in terms of percentage using the artificial neural network. Then the server automatically sends data to the receiver system. Hence, it enables continuous monitoring of the patient's health parameters by the doctor. Any discrepancies in these parameter values can be detected at the earliest and hence necessary medications can be provided by the doctor immediately.

III.SYSTEM ARCHITECTURE



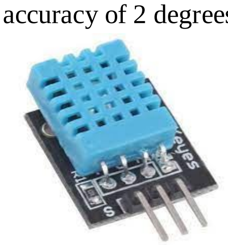
IV. HARDWARE

1) Arduino Board (ATmega 328P Microcontroller): This is a single chip microcontroller developed by Atmel in the Mega-AVER family. Atmel's 8-bit AVRRISC-based microcontroller has 32 kB ISP flash memory and read function during writing, 1 kB EEPROM, 2 kB SRAM, 23 general purpose I / O lines, 32 general purpose work registers, and three flexible timers. Combines / counter, comparison mode, internal and external interrupts, serial programmable USART. The device operates between 1.85.5 volts. This device delivers a throughput of about 1 MIPS per MHz The ATmega328 is widely used in many projects and autonomous systems that require a simple, low power and inexpensive microcontroller. Perhaps the most common implementation of this chip is the popular Arduino development platform: Arduino Uno and Arduino Nano models.[2][4]

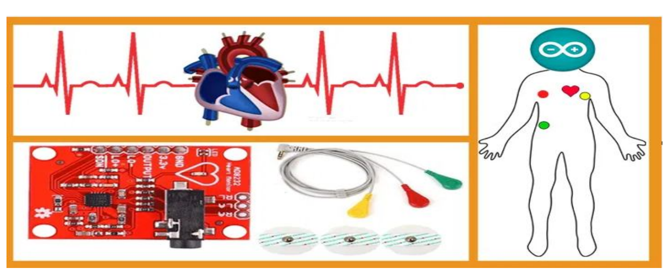


2) Sensors: The sensors used here are

a) The DHT11 sensor consists of a capacitive humidity detector and a thermistor for temperature measurement. Moisture detection capacitors have two electrodes with a moisture retention substrate as a dielectric. The IC measures and processes these modified resistance values and converts them into digital format. This sensor uses a thermistor with a negative temperature coefficient to measure temperature. This will reduce the resistance as the temperature rises. This sensor is usually made of semiconductor ceramic or polymer in order to obtain a higher resistance value even with the smallest temperature change. The DHT11 has a temperature range of 0 to 50 degrees Celsius and an accuracy of 2 degrees Celsius. [2][3] [7]



b) The ECG sensor AD8232 is a device for measuring and checking the electrical activity of the heart and stands for ECG. After measuring the activity of the heart, it is plotted or displayed depending on the function of the heart. Since the Raspberry Pi cannot analyze analog signals, the analog output of the ECG is captured by the Arduino Nano, converted to digital and sent to the Raspberry Pi. EKG measurement and drawing are noisy. The AD8232 sensor module is specially designed to act as an operational amplifier (op amp) used to amplify and acquire well-defined signals with PR and QT intervals. The module also has an LED that flashes each time the heart beats. The AD8232 module also has a 3.5mm audio / video jack for connecting a sensor cable. The sensor cable is a 3-wire cable with a biomedical pad on each head of each conductor. The holes in the AD8232 cannot be used directly. First, solder the male header pins before using. EKG is based on two basic things: PR interval and QR interval.[2][5]



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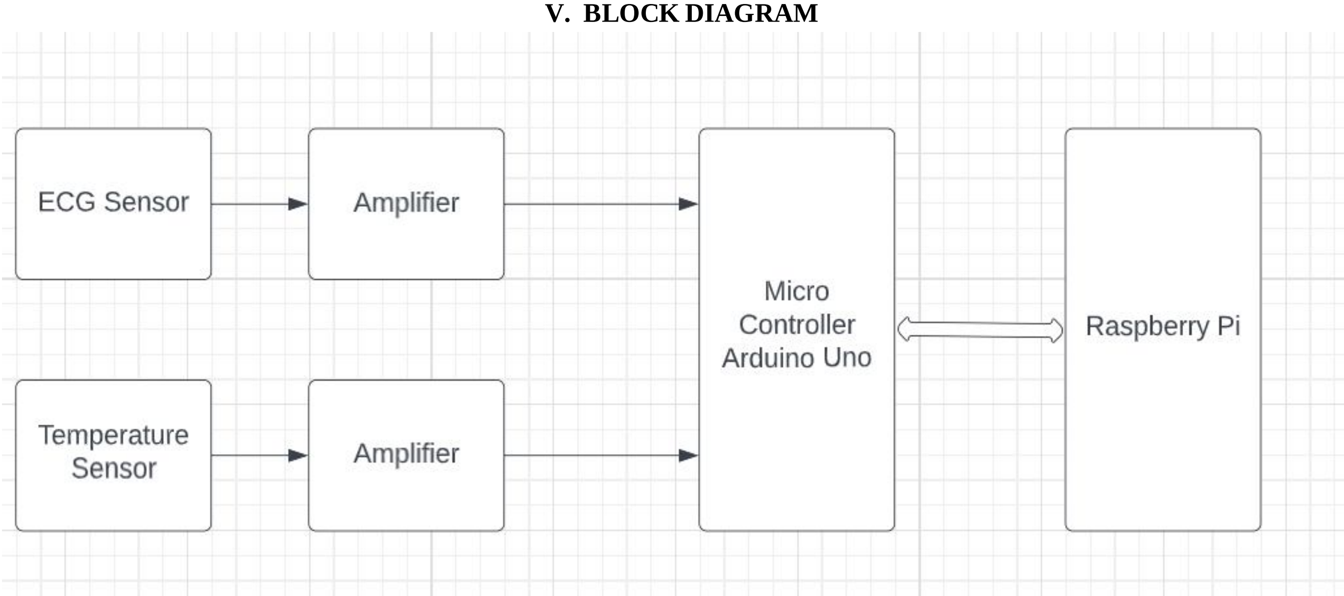
c) Biomedical Pads: Biomedical pads are disposable electrodes used to measure a patient's ECG, EMG, and EEG. These pads are circular and easy to attach to the human body. The dimensions of the biomedical pad are 24 mm x 1 mm.[2]

3) Raspberry Pi 3: The Raspberry Pi is an inexpensive credit card-sized computer that connects to your computer monitor or TV and uses a standard keyboard and mouse. It has a 64-bit quad-core 1.2GHz ARMv8 CPU and 1GB RAM. Use SD card for boot and save. It is equipped with Bluetooth 4.1, Bluetooth Low Energy, and wireless LAN. The main advantage of the Raspberry Pi is that it has a large number of applications. It also has a 4-pin stereo output and a composite video connector. Video processing applications are also possible on Raspberry Pi like video compression.[2][6][8].

V. BLOCK DIAGRAM



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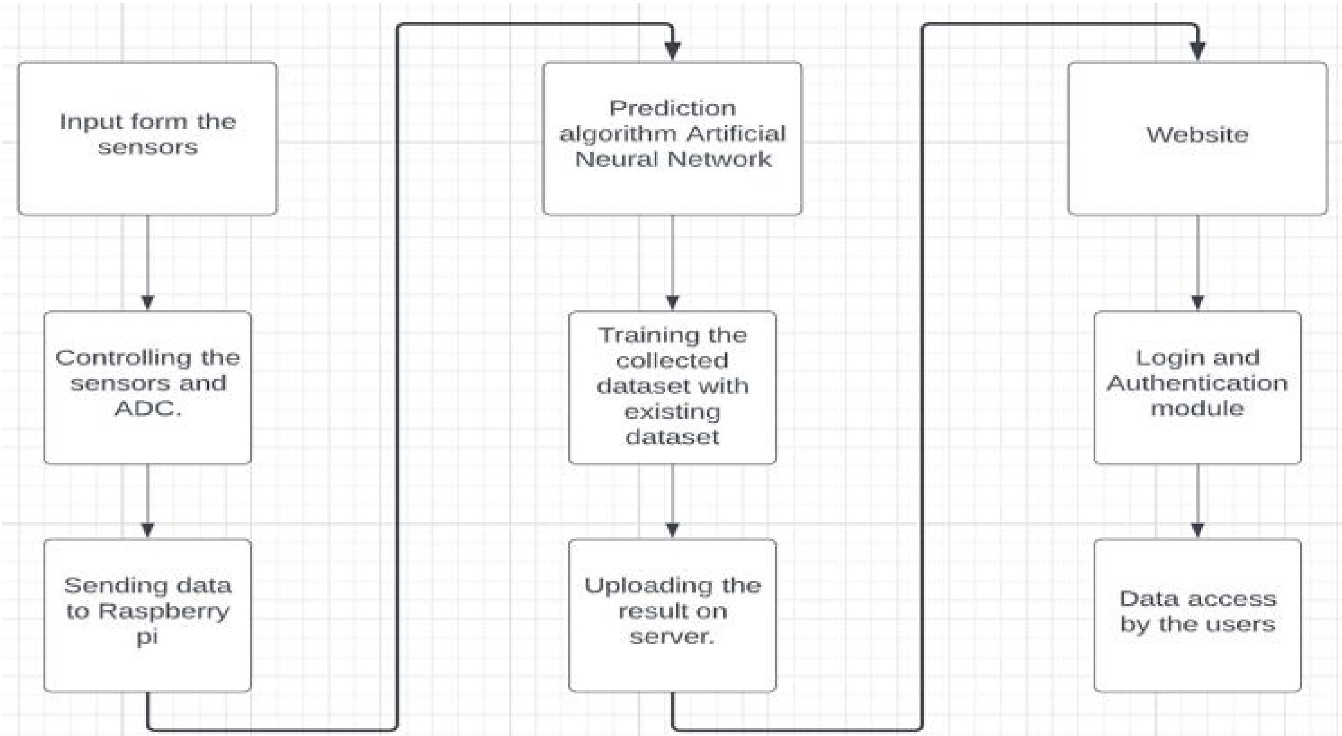
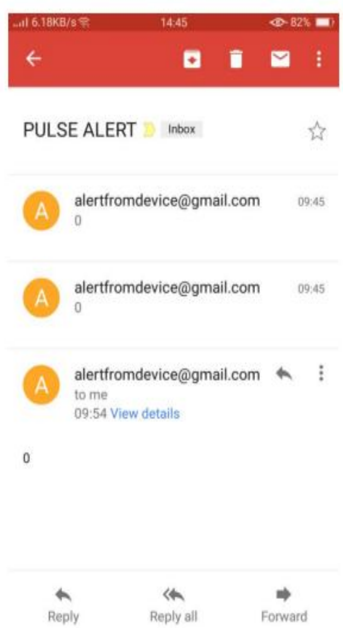
VI. DATA FLOW DIAGRAM



The health monitoring system consists of several sensors that are connected to the patient and send data through the processing device. In this project, the Raspberry Pi will be used as both a data aggregator and a processor. Patient and doctor smartphones act as surveillance systems. Sensor systems are used to obtain information or readings from patients, and the readings read are converted into signals. These signals are provided to the IoT module Raspberry Pi for processing. Signals are used in artificial neural network models to train and validate whether vital signs are normal or abnormal based on existing datasets. Pi then displays the information on the monitor and stores the information into the cloud. Doctors can access and retrieve this information on their phone / computer. The sensor values are read and displayed on the monitor and stored in the cloud for future use. When the blood pressure sensor output exceeds 120, an alarm email will be automatically sent to the patient to consult a doctor.



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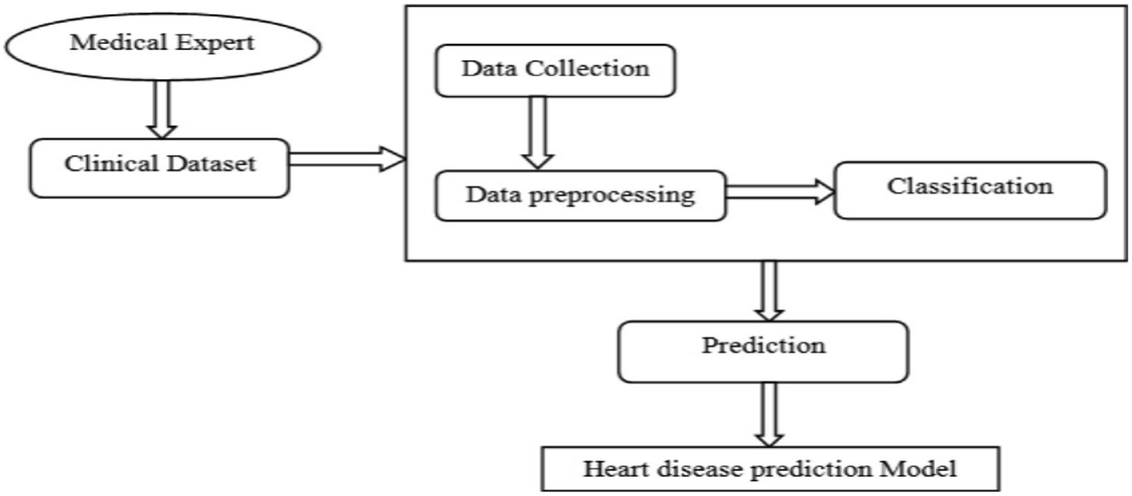
VII. DATA COLLECTION AND PREDICTION ARCHITECTURE



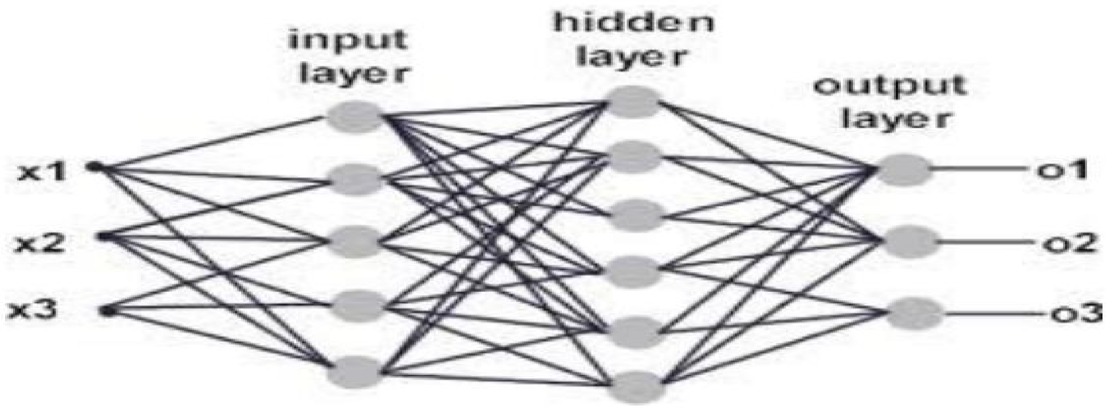
Data Pre-processing - Initially database contains some attributes, in this some value in the attributes are missing. That attribute's values are found and replaced by mean mode method. This process is called as Data Pre-processing. After Data pre-processing, data mining classification algorithms such as Neural Networks, Decision Trees, & Naive Bayes are used. A confusion matrix is created to compute the accuracy rate of classification. A confusion matrix shows two classes, Class A is said to be YES (patient has affected by heart disease) Class B is said to be NO (patient has not affected by heart disease). True Positive: True Records are classified. False Negative: False records are classified. False Positive: Number of tuples were classified as positive when they were false. True Negative: Number of tuples were classified as negative when they were true. In Existing System, Artificial neural network algorithm has higher accuracy when compared with decision tree algorithm or naive Bayes.

	a (has heart disease)	**b (no heart disease)**
a (has heart disease)	TP	FN
b (no heart disease)	FP	TN

VIII. ARTIFICIAL NEURAL NETWORK

Artificial neural networks can be represented as weighted directed graphs using artificial neurons that form nodes. It is a computer network based on the biological neural network that builds the structure of the human brain. Just as the human brain has neurons that are connected to each other, artificial neural networks have neurons that are connected to each other at different layers of the network [6]. ANN is widely used in various fields of medicine, especially in the medical application of cardiology [10]. ANN is widely used in diagnostics, electrical signal analysis, medical image inspection, and radiology. ANN has been used by many authors for modelling in medical and clinical research. In this study, a decision support system was developed to predict a patient's heart disease. The predictions are based on past heart disease databases. The system uses medical terms such as gender, blood pressure, height, and age as 13 input attributes to get better results. The technique used to develop the system is the Multilayer Perceptron Neural Network (MLPNN) with the backpropagation algorithm (BP).

Multilayer Perceptron Neural Network (MLPNN): MLPNN consists of an input layer, an output layer, and one or more hidden layers. Each layer consists of one or more nodes represented by small circles. Line between a node shows the flow of information from one node to another. The input layer receives signals from external nodes. The output of the input layer is provided by the hidden layer weighted connection link. Performs calculations and sends the results to the output layer over a weighted connection. The output of the hidden layer is passed to the output layer, which performs the calculations and produces the final result.



Steps:

1) Input data is provided to input layer for processing, which produces a predicted output.
2) The predicted output is subtracted from actual output and error value is calculated.
3) The network then uses a Backpropagation algorithm which adjusts the weights.
4) For weights adjusting it starts from weights between output layer nodes and last hidden layer nodes and works backwards through network.
5) When back propagation is finished, the forwarding process starts again.
6) The process is repeated until the error between predicted and actual output is minimized.

Backpropagation network It is the most widely used training algorithms in multi-tier and feedforward network. The name given is backpropagation to calculate the difference between the actual value and the predicted value is propagated backwards from the output node to the input node. Previous shift- This is done to improve the weights during processing.

Working of backpropagation algorithm is described in the following steps:

a) Provide training data to the network.
b) Compare the actual and desired output.
c) Calculate the error in each neuron.
d) Calculate the output of each neuron and how low it should be You need to adjust the higher power to match the power you need.
e) Next, set the weight.

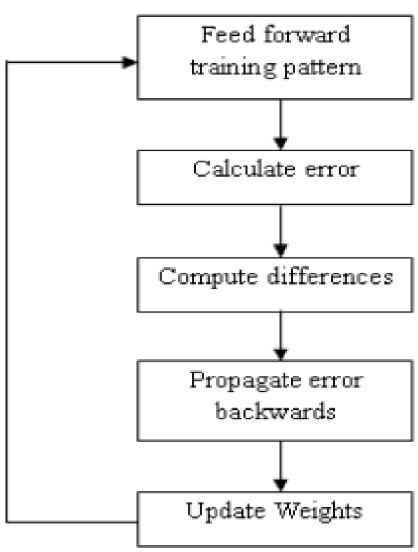


Fig- working of backpropagation network

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IX. TRAINING DATA SET ON ARTIFICIAL NEURAL NETWORK

```
data = pd.read_csv('arrhythmia.csv',header=None)
data.head(10)
```

1 Physical GPUs, 1 Logical GPUs

	0	1	2	3	4	5	6	7	8	9	...	270	271	272	273	274	275	276	277	278	279
0	75	0	190	80	91	193	371	174	121	-16	...	0.0	9.0	-0.9	0.0	0.0	0.9	2.9	23.3	49.4	8
1	56	1	165	64	81	174	401	149	39	25	...	0.0	8.5	0.0	0.0	0.0	0.2	2.1	20.4	38.8	6
2	54	0	172	95	138	163	386	185	102	96	...	0.0	9.5	-2.4	0.0	0.0	0.3	3.4	12.3	49.0	10
3	55	0	175	94	100	202	380	179	143	28	...	0.0	12.2	-2.2	0.0	0.0	0.4	2.6	34.6	61.6	1
4	75	0	190	80	88	181	360	177	103	-16	...	0.0	13.1	-3.6	0.0	0.0	-0.1	3.9	25.4	62.8	7
5	13	0	169	51	100	167	321	174	91	107	...	-0.6	12.2	-2.8	0.0	0.0	0.9	2.2	13.5	31.1	14
6	40	1	160	52	77	129	377	133	77	77	...	0.0	6.5	0.0	0.0	0.0	0.4	1.0	14.3	20.5	1
7	49	1	162	54	78	0	376	157	70	67	...	0.0	8.2	-1.9	0.0	0.0	0.1	0.5	15.8	19.8	1
8	44	0	168	56	84	118	354	160	63	61	...	0.0	7.0	-1.3	0.0	0.0	0.6	2.1	12.5	30.9	1
9	50	1	167	67	89	130	383	156	73	85	...	-0.6	10.8	-1.7	0.0	0.0	0.8	0.9	20.1	25.1	10

Fig- Importing Existing Data Set

```
import tensorflow.keras
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
# Neural network
model = Sequential()
model.add(Dense(16, input_dim=12, activation='relu'))
model.add(Dense(12, activation='relu'))
model.add(Dense(17, activation='softmax'))
```

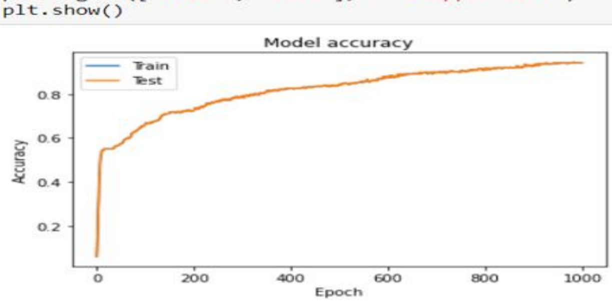
```
model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'])
```

```
history = model.fit(X_train, y_train, epochs=1000, batch_size=64)
5/5 [==============================] - 0s 2ms/step - loss: 0.1947 - accuracy: 0.9499
Epoch 992/1000
5/5 [==============================] - 0s 3ms/step - loss: 0.2128 - accuracy: 0.9484
Epoch 993/1000
5/5 [==============================] - 0s 3ms/step - loss: 0.2137 - accuracy: 0.9449
Epoch 994/1000
5/5 [==============================] - 0s 3ms/step - loss: 0.2276 - accuracy: 0.9529
Epoch 995/1000
5/5 [==============================] - 0s 3ms/step - loss: 0.2270 - accuracy: 0.9371
Epoch 996/1000
5/5 [==============================] - 0s 2ms/step - loss: 0.2073 - accuracy: 0.9473
Epoch 997/1000
5/5 [==============================] - 0s 3ms/step - loss: 0.2295 - accuracy: 0.9423
Epoch 998/1000
5/5 [==============================] - 0s 3ms/step - loss: 0.2260 - accuracy: 0.9380
Epoch 999/1000
5/5 [==============================] - 0s 3ms/step - loss: 0.2317 - accuracy: 0.9410
Epoch 1000/1000
5/5 [==============================] - 0s 3ms/step - loss: 0.2280 - accuracy: 0.9321
```

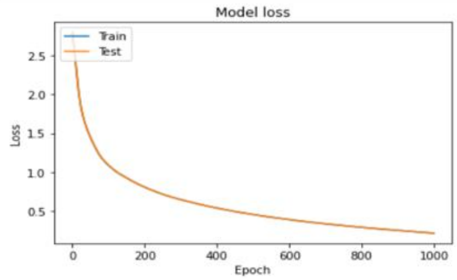
Fig-Training the Data set On Artificial Neural Network For 1000 Iterations.

After the training of the data using the artificial neural network the accuracy of the results are 93% which is a remarkably high accuracy and is in accordance with the accuracy of any medical equipment as the environment and testing conditions can be vary and can cause interference and noise in the data. The result signifies that the artificial neural network is working good in predicting the probability of a cardiovascular disease.

```
import matplotlib.pyplot as plt
plt.plot(history.history['accuracy'])
plt.plot(history.history['accuracy'])
plt.title('Model accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['Train', 'Test'], loc='upper left')
plt.show()
```

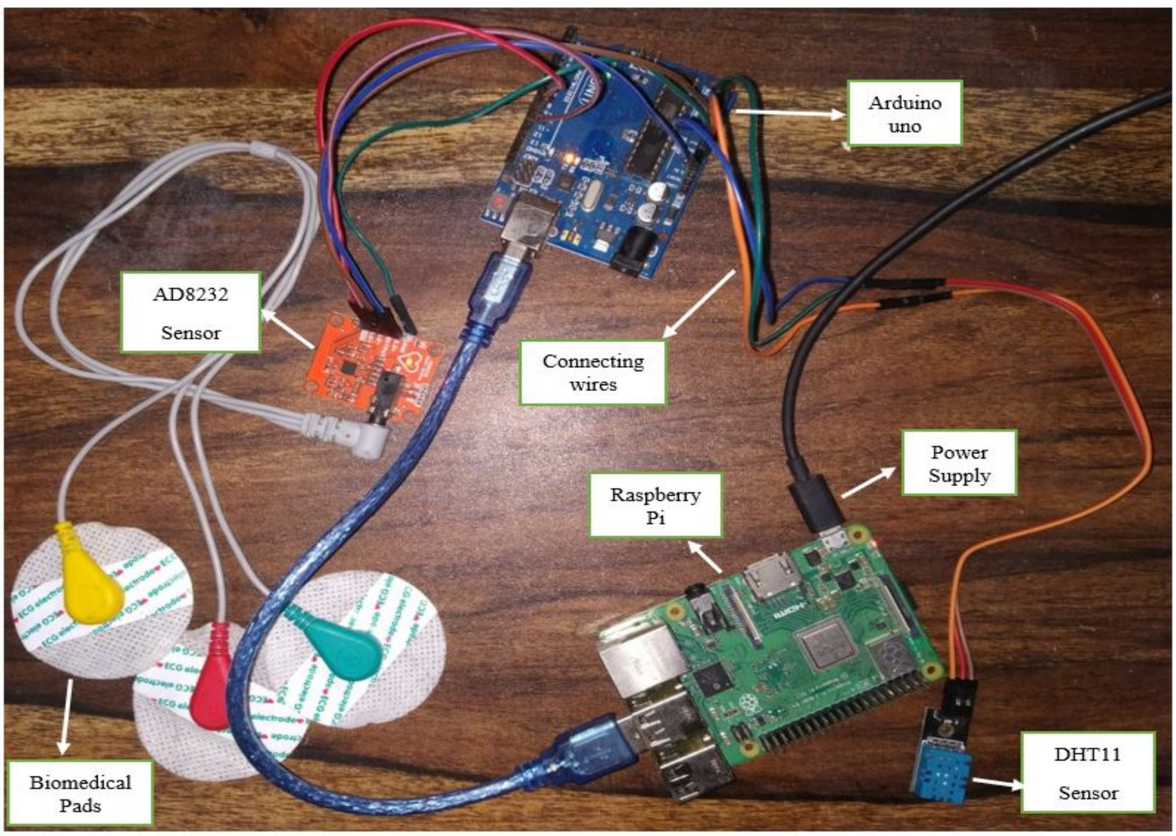


```
plt.plot(history.history['loss'])
plt.plot(history.history['loss'])
plt.title('Model loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['Train', 'Test'], loc='upper left')
plt.show()
```



X. EXPERIMENTAL SETUP

The figure shows an experimental setup of a system consisting of an electrocardiogram, a temperature sensor with accessories such as a biomedical pad and a sensor cable, an Arduino UNO, a Raspberry Pi 2, and a WIFI dongle. All connections between the sensor and the Arduino board, or between the Raspberry Pi and other devices (power) are clearly visible.



XI. RESULTS AND DISCUSSION

After providing all the genuine information, the doctor can go to a web page where they can see the patient's parameters and provide real-time feedback according to the patient's health needs. Sensor data is received on dynamic websites. All sensor data can be displayed in columns. Patients can also monitor the data to identify potential cardiovascular disease and consult a doctor if negative results are obtained. Information and data timing can also be found in the Information and Timing column. The data is received at dynamic web page after every two minutes from server site. Hence all the patients` health record is stored; which can be used for diagnosing and better remote healthcare.

XII. CONCLUSIONS

The proposed system highlights the shortcomings in our traditional healthcare system with the increasing aging population by providing affordable, safe, fast and portable systems using technically sound devices (Arduino, Raspberry Pi, sensors) and systems. It highlights and overcomes the shortcomings of traditional medical systems. Implementing artificial neural networks to predict cardiovascular disease helps patients identify abnormalities and determine if they need immediate medical attention. This system is a good tool for remote patient care, but in the future, we can make improvements to make it more efficient. Adding a video call between the patient and the doctor can make the system more patient-friendly. You can use the GSM / GPRS module to generate alerts when a patient's sensor data approaches thresholds. Adding health-related sensors will make your life more self-reliant and convenient. Addition of more health related sensor will make one’s life more independent and convenient. Causal Productions permits the distribution and revision of these templates on the condition that Causal Productions is credited in the revised template as follows: “original version of this template was provided by courtesy of Causal Productions (www.causalproductions.com)”.

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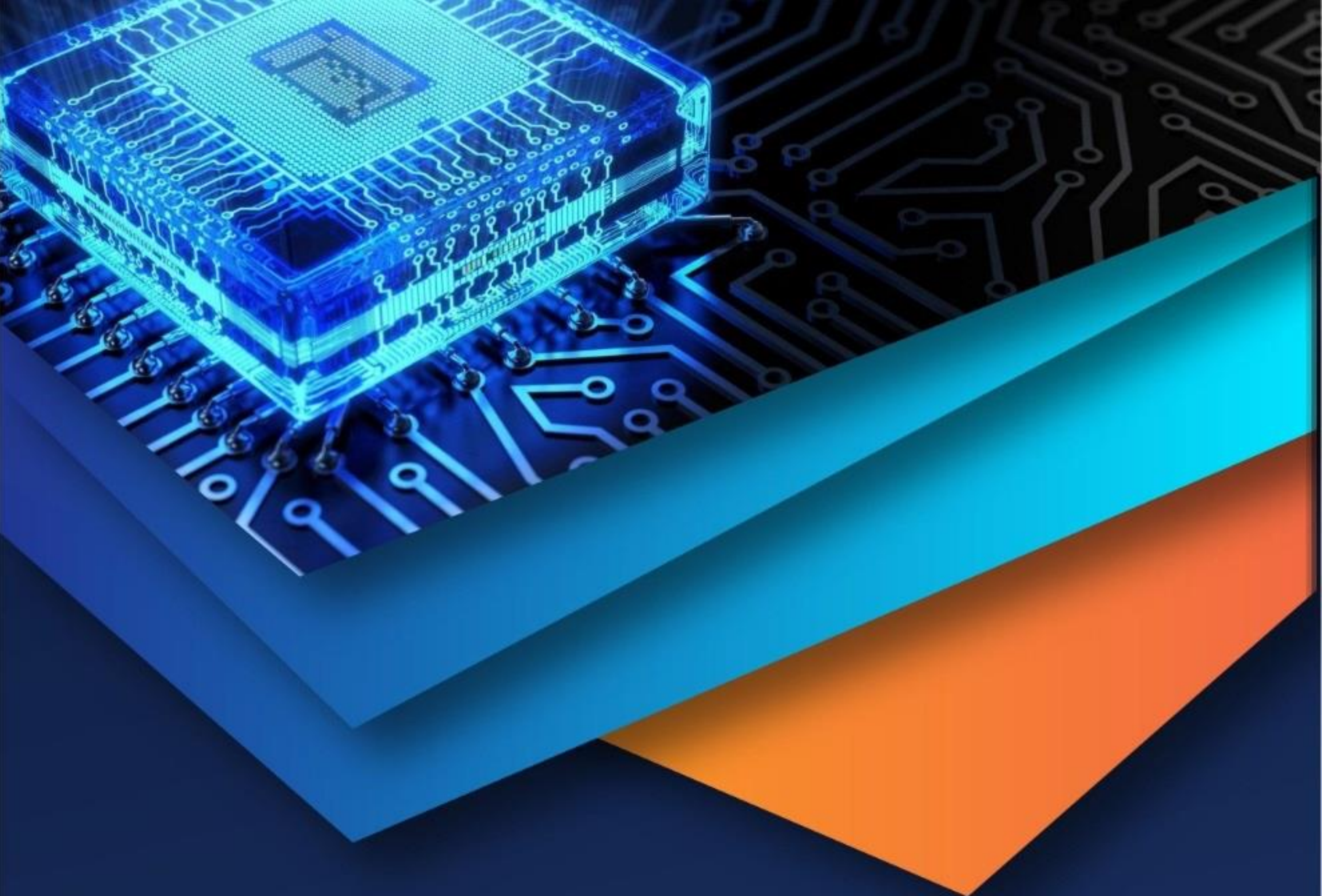

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