International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 1 Jan. 2023, pp: 752-757 www.ijaem.net ISSN: 2395-5252

Arduino Based Heart Disease Risk Prediction System

RV Joel*[1], Kvn Sai Suraj*[2], Vinay Sai Gorantla*[3], LVR Chaitanya Prasad*[4]

[1,2,3] Student,Department of Electronics and Communication Engineering, Sreenidhi Institute of Science and Technology, Hyderabad, India

[4] Assistant Professor, Department of Electronics and Communication Engineering, Sreenidhi Institute of Science and Technology, Hyderabad, India

Corresponding Author: Kvn Sai Suraj, Student, Department of Electronics and Communication Engineering, Sreenidhi Institute of Science and Technology, Hyderabad, India

Date of Submission: 12-01-2023 Date of Acceptance: 24-01-2023

ABSTRACT:Worldwide, heart disease is one of the main causes of death. Heart disease can be predicted and detected early, which can lead to better patient outcomes and lower healthcare expenditures. The electrocardiogram (ECG), which offers useful information about the electrical activity of the heart, is a frequently used diagnostic test for cardiac illness. A potent technique that can be used to evaluate and interpret ECG data and forecast the likelihood of developing cardiac disease is machine learning. This abstract outlines a study that uses ECG data and machine learning to estimate the likelihood of developing heart disease. The study's findings showed that utilizing ECG data, machine learning can precisely forecast the risk of heart disease. The model that performed the best had high sensitivity and specificity, as well as accuracy of over 80%. The study also discovered that specific ECG data characteristics, such as the QRS complex and the T wave, were particularly useful for predicting cardiac disease. The study emphasizes how machine learning could help with better heart disease early detection and prediction. When combined with machine learning, ECG data can offer useful insights into the electrical activity of the heart and aid in the identification of patients who are at high risk for developing heart disease. The results of this study can be utilized to create new, more precise cardiac disease diagnostic tools, as well as to enhance patient outcomes and save healthcare expenditures. In conclusion, this work shows how machine learning has the potential to enhance heart disease early detection and prediction. The study demonstrated the potential of this approach in improving patient outcomes and lowering healthcare costs by properly predicting the risk of heart disease using ECG data and machine learning methods.

KEYWORDS: Machine Learning, Electrocardiograph, Classification Algorithms, Decision Trees.

I. INTRODUCTION

A vital organ in the human body is the heart. It supplies blood to every bone and organ in our body. It is necessary for the brain and several other organs to operate properly; if they don't, the individual would die in a matter of minutes. Numerous heart-related disorders are becoming more common as a result of lifestyle changes, professional stress, and bad dietary habits. The leading cause of death worldwide is now heart diseases. 17.7 million people worldwide die from heart-related illnesses each year, making about 31% of all fatalities, according to the World Health Organization. Not just in India but around the world, heart-related illnesses are now the top cause of death. According to the 2016 Global Burden of Disease Report, which was published on September 15, 2017, heart disease killed 1.7 million people in India in that year. Patients' productivity is also hampered, and the cost of treating heart diseases is rising. According to estimates from the World Health Organization (WHO), India could spend up to $237 billion between 2005 and 2015 on treating heart- and cardiovascular-related disorders. Therefore, it is crucial to make precise estimates regarding ailments related to the heart. Researchers have suggested a number of web-based systems, however due to the high cost of the necessary equipment, those on low incomes were unable to use these. An android mobile phone-based system

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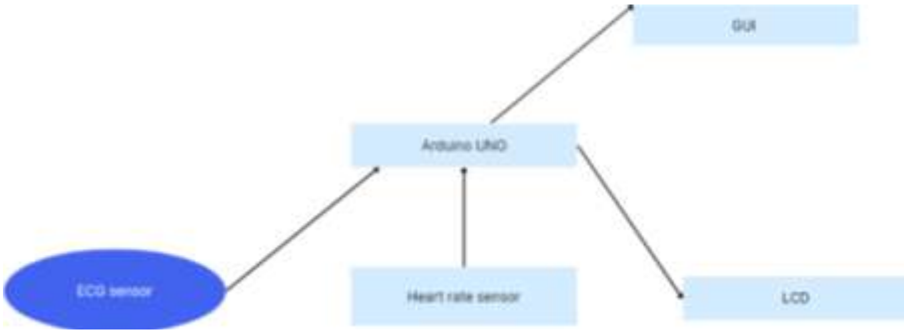
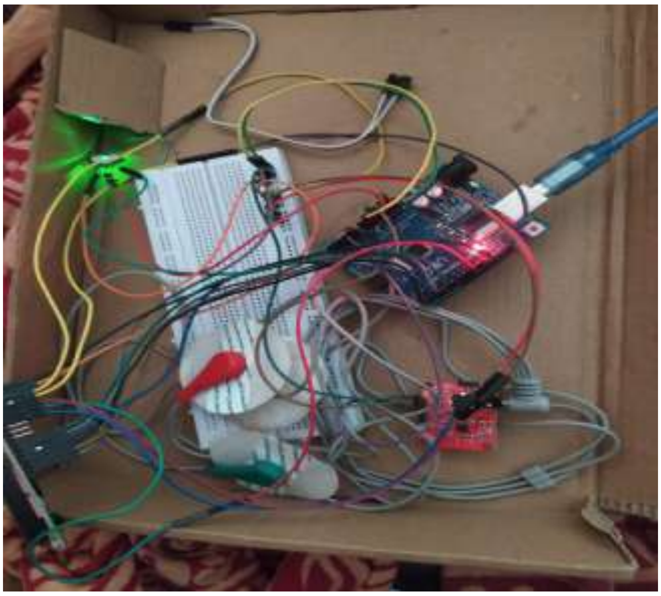
is used to receive and store the biomedical sensor data. The incapacity of design to immediately visualize the data, however, was the fundamental problem. As a result, the system proposed in this study both meets all of the requirements and offers economical solutions to the issue of real-time ECG monitoring and heart rate detection of a patient while detecting potential risks.

II. MODELLING OF ECG SENSOR WITH AURDINO





A) ECG Sensor

A built-in signal conditioning block for ECG and other biometric measurement applications is the AD8232. When there are noisy conditions present, like those brought on by movement or remote electrodeposition, it is made to extract, amplify, and filterless energy bio-potential signals. The output signal can be obtained using an embedded microcontroller or an ultralow power analog-to-digital converter (ADC). The AD8232 has a two-pole high-pass filtering capability for removing electrode half-cell potential and motion artefacts. This filter allows for both high-pass and large gain filtering in a first stage, saving both money and space thanks to its close coupling to the instrumentation amplifier design.

B) Arduino Uno

The Arduino Uno is an 8-bit microcontroller board based on the ATmega328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz crystal oscillator, a power jack, an ICSP header a USB connection and a reset button. It has everything required to hold up the Arduino; Basically, connect it to a Laptop with the help of USB cable or power it with an adapter or battery to get initiated. The Uno differs from all previous boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U

C) LCD Display

Liquid Crystal Display (LCD) is an electronic display technology with a vast array of real-time applications. The most fundamental part, a 16x2 LCD, is frequently used in many different machines, appliances, and circuits. These modules were chosen over multi-segment light emitting

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diodes with 7 segments and other configurations. Reasons include LCDs' low cost, ease of programming, and lack of limitations when it comes to displaying unique and even customised characters, animations, and other content. With a 16x2 LCD, there are 2 lines that can each display 16 characters. Each character on this LCD is shown in a 5 by 7 pixel matrix.

D) Pulse Sensor

The optical pulse sensor's basic operation is very straightforward and simple to comprehend. An optical pulse sensor emits 550 nm-wavelength green light. The photodetector of the pulse sensor uses light to penetrate the skin and measure the reflection. Photoplethysmogram is the name of this technique for light-based pulse detection. The sensor's operation can be broken down into two parts: measuring heart rate and measuring blood oxygen levels.

III. EXPERIMENTATION

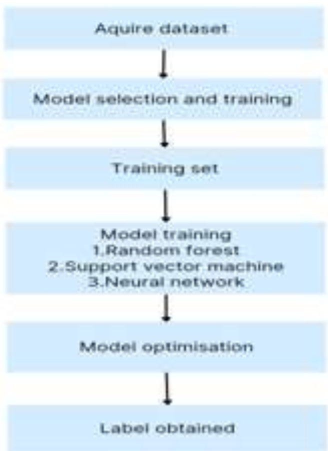
Here, system's hardware components and implementation. The hardware component provides a brief overview of the Ag/Cl electrodes and ECG module components of the ECG monitoring circuit system. Utilizing three-lead electrodes, the ECG module in this instance is receiving three inputs from the human body. For operational purposes, the ECG module (AD8232) has an instrumentation amplifier and a high pass filter. It produces a single output after processing the inputs. The Analog pins on the Arduino Uno Microcontroller are used to provide this output.

Here, a Liquid Crystal Display was connected to an Arduino Uno. with four data lines. The LCD received the transmitted data that was displayed. Using the potentiometer that is connected to the LCD, we can modify the brightness. The observed electronically pulses are collected and the data is further analysed using the machine learning algorithms.

Modelling and analysis:

Data mining and machine learning techniques are crucial for disease prediction. Computer learning Cardio-vascular illness is detected using algorithms like K Nearest Neighbor and Artificial Neural Networks (ANN). With the use of a machine learning algorithm, researchers are working quickly to create software that will assist physicians in making decisions on how to detect and diagnose cardiac disease. Various models are applied to classification techniques and labels are obtained for software development of the system.

The Hardware system developed is responsible for giving out the plausible Heart rate detection and ECG outputs. Here are the results observed at the Hardware end where we captured the numerical date for further processing. The ECG module produces a single analogue output that is given to the Arduino microcontroller after the system receives the three biometric input signals from the human body using three lead electrodes. The Arduino is then in charge of the remaining operations and it checks to see if all three input signals are received reliably. The system begins by obtaining readings from the ECG module. After doing so, the microcontroller checks to see if all three readings have begun to behave correctly. The reading of the ECG can be observed on the computer screen. And the Heart rate which is enabled by the implementation of pulse sensor integration to the project is observed on the LCD screen connected to the arduino module.



Software Modelling

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SOURCE CODE FOR THE AURDINO:

```
/*The circuit:
 * LCD RS pin to digital pin 12
 * LCD Enable pin to digital pin 11
 * LCD D4 pin to digital pin 5
 * LCD D5 pin to digital pin 4
 * LCD D6 pin to digital pin 3
 * LCD D7 pin to digital pin 2
 * LCD R/W pin to ground
 * LCD VSS pin to ground
 * LCD VCC pin to 5V
 * 10K resistor:
 * ends to +5V and ground
 * wiper to LCD VO pin (pin 3)
*/

// include the library code:
#include <LiquidCrystal.h>


// initialize the library by associating any needed LCD interface pin
// with the arduino pin number it is connected to
const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
#define USE_ARDUINO_INTERRUPTS true    // Set-up low-level interrupts for most acurate BPM math.
#include <PulseSensorPlayground.h>     // Includes the PulseSensorPlayground Library.
//  Variables
const int PulseWire = 0;       // PulseSensor PURPLE WIRE connected to ANALOG PIN 0
const int LED13 = 13;          // The on-board Arduino LED, close to PIN 13.
int Threshold = 550;           // Determine which Signal to "count as a beat" and which to ignore.
                               // Use the "Gettting Started Project" to fine-tune Threshold Value beyond default setting.
                               // Otherwise leave the default "550" value.

PulseSensorPlayground pulseSensor;  // Creates an instance of the PulseSensorPlayground object called "pulseSensor"

const int PIN_SPEAKER = 10;

void setup() {
  // set up the LCD's number of columns and rows:
  Serial.begin(9600);
  lcd.begin(16, 2);
  // Print a message to the LCD.
  lcd.print("HDRP JOELTECH");
  pulseSensor.analogInput(PulseWire);
  pulseSensor.blinkOnPulse(LED13);       //auto-magically blink Arduino's LED with heartbeat.
  pulseSensor.setThreshold(Threshold);

  // Double-check the "pulseSensor" object was created and "began" seeing a signal.
   if (pulseSensor.begin()) {
    Serial.println("We created a pulseSensor Object !");  //This prints one time at Arduino power-up,  or on Arduino reset.
  }

}

void loop() {
  // set the cursor to column 0, line 1
  // (note: line 1 is the second row, since counting begins with 0):
  lcd.setCursor(0, 1);
  // print the number of seconds since reset:
  //lcd.print(millis() / 1000);

 int myBPM = pulseSensor.getBeatsPerMinute();  // Calls function on our pulseSensor object that returns BPM as an "int".
    buzz();                          // "myBPM" hold this BPM value now.

if (pulseSensor.sawStartOfBeat()) {            // Constantly test to see if "a beat happened".
 //Serial.println("♥  A HeartBeat Happened ! "); // If test is "true", print a message "a heartbeat happened".

 lcd.print("BPM: ");
 // Print phrase "BPM: "
 if(myBPM<=100 && myBPM>=70)
 {lcd.print(myBPM); }
 else
 {lcd.print("<>"); }

 // Print the value inside of myBPM.


 //digitalWrite(PIN_SPEAKER,1);
 //delay(50);
 //digitalWrite(PIN_SPEAKER,0);
 //delay(50);

}
//Serial.print("\n");
//Serial.print(myBPM);
//Serial.print("|");
Serial.print(analogRead(A1));
Serial.print("\n");
```

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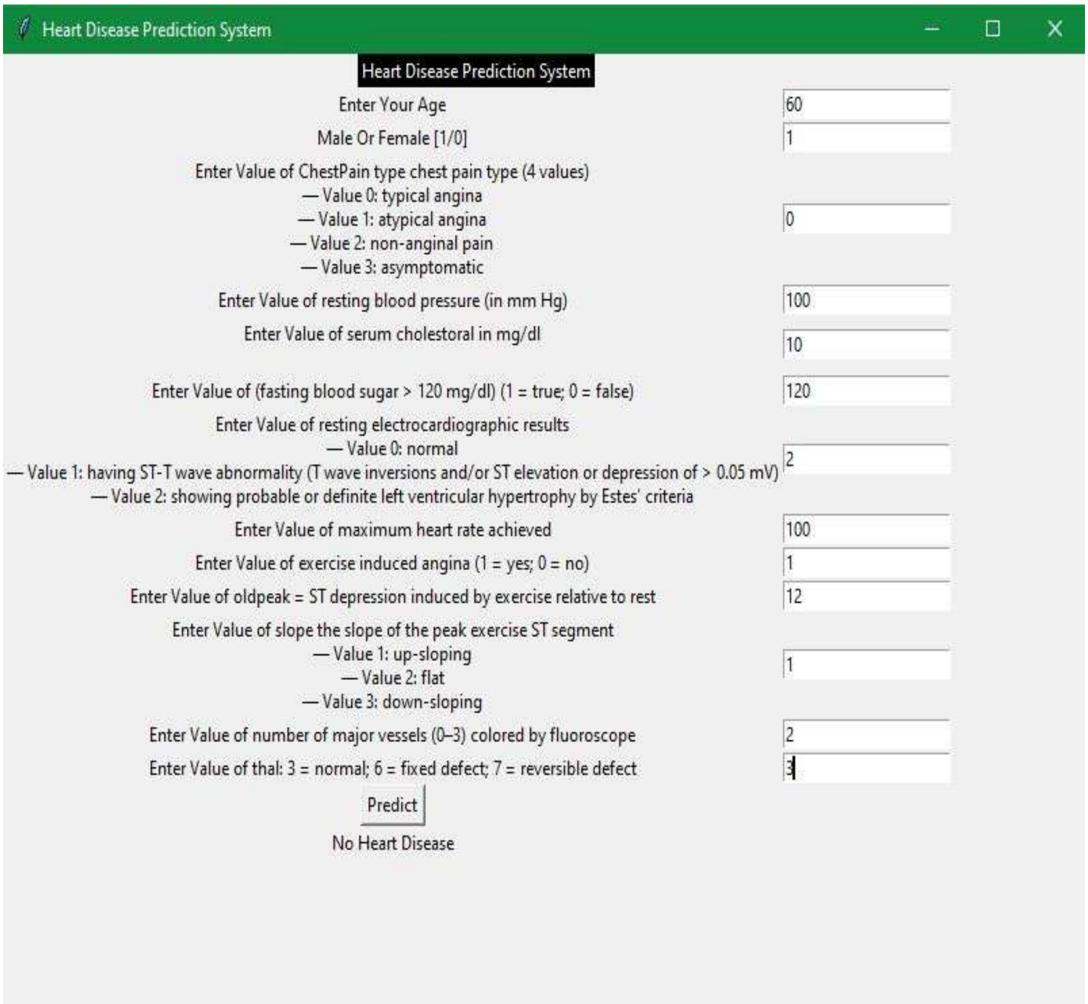
```
//delay(3000);                    // considered best practice in a simple sketch.

}
void buzz()
{
 tone(PIN_SPEAKER, 2000); // Send 1KHz sound signal...
 delay(50);       // ...for 1 sec
  noTone(PIN_SPEAKER);     // Stop sound...
  delay(50);
}
```

IV. OBESERVATIONS FROM THE TESTS

After collection of numerical data from the designed embedded system which consisted of a microcontroller module connected to ECG sensor and Pulse sensor, The data is now analyzed from the proposed software system. An intuitive graphical user interface is designed so as to ease the process of result observation. After inputting the required questionnaire in the graphic user interface, the result is observed from the computed algorithm. The analysis of the algorithm is implemented by integrating machine learning algorithm and computational statistics. This prediction system is reliable if followed all the specified conditions and giving the correct inputs to the interface.



V. CONCLUSION

Three ML classification modelling techniques have been combined to create a model for the detection of cardiovascular disease. By extracting the patient medical history that results in a fatal heart disease from a dataset that includes patients' medical history such as chest pain, sugar level, blood pressure, etc., this project predicts people with cardiovascular disease. Based on clinical information about a patient's prior heart disease diagnosis, this heart disease detection system helps the patient. The given model was created using the algorithms of KNN, Random Forest Classifier, and Logistic Regression. Our model has an accuracy rate of 87.5%. The likelihood that the model will correctly predict whether a given person has heart disease or not increases with the use of more training data. The results observed show that the hardware system implemented using low cost sensors and microcontroller were successful enough to capture the data required for further processing which analysed whether the patient is potent of any underlying heart conditions.

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