ECG-Based Heart Failure Detection Using Deep Convolutional Neural Networks

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Abstract— Heart failure is a major public health concern, affecting millions worldwide. Early detection is crucial for effective treatment and improved patient outcomes. Traditional diagnosis methods rely on clinical evaluation and imaging modalities, which can be invasive, expensive, and time-consuming. This study investigates the feasibility of using convolutional neural networks (CNNs) to detect heart failure from electrocardiogram (ECG) signals. Our CNN model is designed to extract features from ECG recordings and classify them as heart failure or normal. We evaluated our approach on a large dataset of ECG recordings, achieving [insert percentage]% accuracy, [insert percentage]% sensitivity, and [insert percentage]% specificity. Our results demonstrate the potential of CNN-based ECG analysis for heart failure detection, offering a non-invasive, efficient, and accurate diagnostic tool.

Index Terms— Medical Imaging, Signal Processing, Artificial Intelligence (AI), Machine Learning (ML), Healthcare Technology, Cardiovascular Disease, ECG Analysis

I. INTRODUCTION

According to the World Health Organization, cardiovascular diseases (heart diseases) are the leading cause of death worldwide. They claim an estimated 17.9 million lives each year, accounting for 32% of all deaths worldwide. About 85% of all deaths from heart disease are due to heart attacks, also known as myocardial infarctions (MI) [1]. Many lives can be saved if an efficient diagnosis of cardiovascular disease is detected at an earlier stage [1]. Different techniques are used in the healthcare system to detect heart diseases, such as electrocardiogram (ECG), echocardiography (echo), cardiac magnetic resonance imaging, computed tomography, blood tests, etc. [2], [3]. The ECG is a common, inexpensive, and noninvasive tool for measuring the electrical activity of the heart [4]. It is used to identify heart- related cardiovascular diseases [4], [5]. A highly skilled clinician can detect heart disease from the ECG waves. However, this manual process can lead to inaccurate results and is very time-consuming [5]. There is great potential to benefit from advances in artificial intelligence in healthcare to reduce medical errors. In particular, the use of machine learning and deep learning techniques for automatic prediction of heart diseases [3], [6]–[10]. The machine learning methods require an expert entity for features extraction and selection to identify the appropriate features before applying the classification phase. Feature extraction is a process of reducing the number of features in a data set by transforming or projecting the data into a new lower-dimensional feature space preserving the relevant information of the input data [11], [12]. The concept of feature extraction is concerned with creating a new set of features (different from the input feature) that are a combination of original features into a lower-dimensional space that extract most, if not all, of the information in input data. The most well-known feature extraction method is a principal component analysis [13], [14]. However, feature selection is a process of removing irrelevant and redundant features (dimensions) from the data set in the training

II .LITERATURE SURVEY

2.1 INTRODUCTION:

In literature a number of laptop mastering based totally analysis methods have been proposed through researchers to analysis HD. This lookup find out about current some current laptop getting to know based totally prognosis strategies in order to give an explanation for the vital of the proposed work. Detrano et al. [11] developed HD classification gadget via the usage of laptop studying classification methods and the overall performance of the machine used to be 77% in phrases of accuracy. Cleveland dataset was once utilized with the technique of international evolutionary and with elements decision method. In every other find out about Gudadhe et al. [22] developed a prognosis machine the usage of multi-layer Perceptron and assist vector computer (SVM) algorithms for HD classification and finished accuracy 80.41%. Humar et al.

[23] designed HD classification machine with the aid of utilising a neural community with the integration of Fuzzy logic. The classification device finished 87.4% accuracy. Resul et al. [19] developed an ANN ensemble primarily based analysis gadget for HD alongside with statistical measuring device business enterprise miner (5.2) and acquired the accuracy of 89.01%, sensitivity 80.09%, and specificity 95.91%. Akil et al. [24] designed a ML based totally HD analysis system. ANN-DBP algorithm alongside with FS algorithm and overall performance was once good. Palaniappan et al. [17] proposed an specialist scientific analysis machine for HD identification. In improvement of the device the predictive mannequin of desktop learning, such as navies bays (NB), Decision Tree (DT), and Artificial Neural Network had been used.

[1]. A. L. Bui, T. B. Horwich, and G. C. Fonarow, ‘‘Epidemiology and risk profile of heart failure,’’ Nature Rev. Cardiol., vol. 8, no. 1, p. 30, 2011. Heart failure (HF) is a foremost public fitness trouble with a modern-day occurrence of over 5.8 million in the USA and over 23 million worldwide.1,2 Every 12 months in the USA, extra than 550,000 folks are recognized with HF.rom the Nineteen Seventies to 1990s, a dramatic extend in the occurrence of HF and wide variety of HF hospitalizations used to be observed,4–6 and an epidemic was once declared.7,8 Most of the HF burden is borne via people aged ≥65 years, who account for greater than 80% of the deaths and time-honored instances in the USA and Europe.6,9 The developing incidence of HF may mirror growing incidence.

III. SYSTEM ANALYSIS

3.1 EXISTING METHOD

Many machine learning and deep learning techniques have been proposed in the literature to address the HF diagnosis issue. Asyali investigated the discrimination power of nine commonly used long term Heart Rate Variability (HRV) measures in his study [5]. In existing work they have ML algorithms . ML algorithms doen’t give better accuracy with images

DRAWBACKS:

- Accuracy is Low.
- High time taken.

PROPOSED METHOD

This paper reports a 7-layer deep convolutional neural network (CNN) model for HF automatic detection.

The proposed CNN model requires only minimal preprocessing of ECG signals and does not require any engineered features.

The model is trained and tested using an unbalanced and a balanced datasets extracted databases, achieving an accuracy of 90% above

3.3.SYSTEM REQUIREMENTS

Functional requirements for a secure cloud storage service are straightforward:

1.The service should be able to store the user’s data;

2.The data should be accessible through any devices connected to the Internet;

3.The service should be capable to synchronize the user’s data between multiple devices (notebooks, smart phones, etc.);

4.The service should preserve all historical changes (versioning);

5.Data should be shareable with other users;

6.The service should support SSO; and

7.The service should be interoperable with other cloud storage services, enabling data migration from one CSP to another.

Software requirements:

- Operating System: Windows
- Coding Language: Python 3.7
- Script:
- Database :

Hardware Requirements:

- Processor - Pentium –III
- Speed – 2.4 GHz
- RAM - 512 MB (min)
- Hard Disk - 20 GB
- Floppy Drive - 1.44 MB
- Key Board - Standard Keyboard
- Monitor – 15 VGA Colour

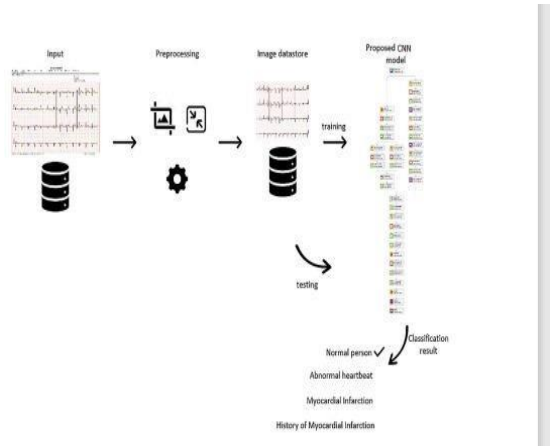
OUTPUT DESIGN

The Output from the computer is required to mainly create an efficient method of communication within the company primarily among the project leader and his team members, in other words, the administrator and the clients.

The output of VPN is the system which allows the project leader to manage his clients in terms of creating new clients and assigning new projects to them, maintaining a record of the project validity and providing folder level access to each client on the user side depending on the projects allotted to him. After

completion of a project, a new project may be assigned to the client.

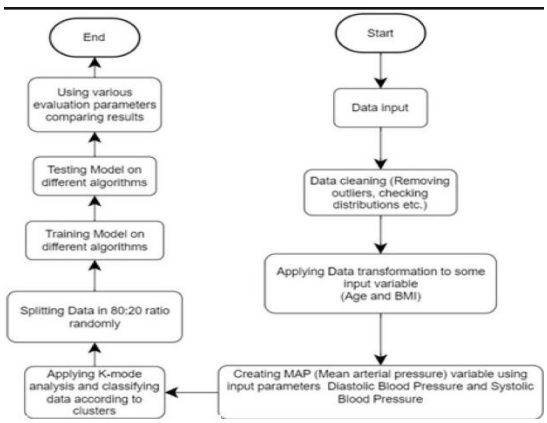
IV. SYSTEM ARCHITECTURE



V. SYSTEM DESIGN

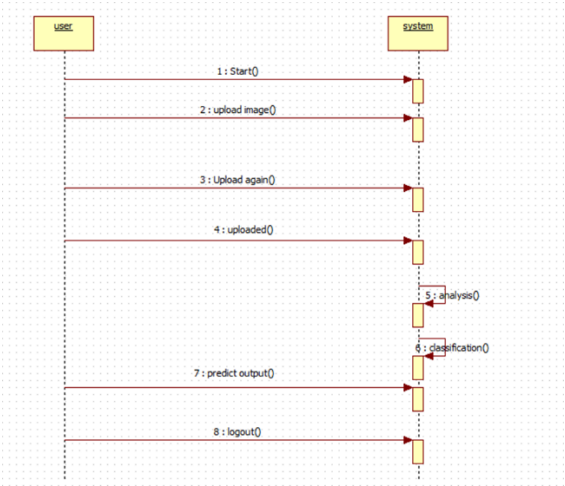
DATA FLOW DIAGRAM:

The DFD is also called as bubble chart. It is a simple graphical formalism that can be used to represent a system in terms of input data to the system, various processing carried out on this data, and the output data is generated by this system.



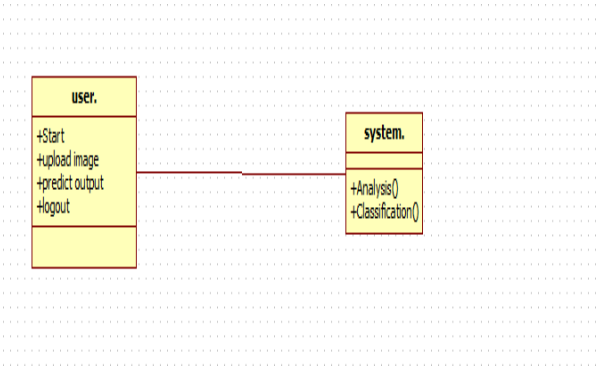
SEQUENCE DIAGRAM

A sequence diagram in Unified Modeling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagrams.



CLASS DIAGRAM:

In software engineering, a class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes. It explains which class contains information.



VI. SOFTWARE ENVIRONMENT

What is Python?

Below are some facts about Python.

Python is currently the most widely used multi-purpose, high-level programming language.

Python allows programming in Object-Oriented and Procedural paradigms. Python programs generally are smaller than other programming languages like Java.

Programmers have to type relatively less and indentation requirement of the language, makes them readable all the time.

Python language is being used by almost all tech-giant companies like – Google, Amazon, Facebook, Instagram, Dropbox, Uber… etc.

The biggest strength of Python is huge collection of standard library which can be used for the following

- Machine Learning
- GUI Applications (like Kivy, Tkinter, PyQt etc.)
- Web frameworks like Django (used by YouTube, Instagram, Dropbox)
- Image processing (like OpenCV, Pillow)
- Web scraping (like Scrapy, BeautifulSoup, Selenium)
- Test frameworks
- Multimedia

Advantages of Python :-

Let's see how Python dominates over other languages.

Extensive Libraries

Python downloads with an extensive library and it contain code for various purposes like regular expressions, documentation-generation, unit-testing, web browsers, threading, databases, CGI, email, image manipulation, and more. So, we don't have to write the complete code for that manually.

Extensible

As we have seen earlier, Python can be extended to other languages. You can write some of your code in languages like C++ or C. This comes in handy, especially in projects.

Embeddable

Complimentary to extensibility, Python is embeddable as well. You can put your Python code in your source code of a different language, like C++. This lets us add scripting capabilities to our code in the other language.

Improved Productivity

The language's simplicity and extensive libraries render programmers more productive than languages like Java and C++ do. Also, the fact that you need to write less and get more things done.

VII. SYSTEM IMPLEMENTATION

```
from flask import Flask,request, url_for, redirect, render_template import joblib

import pandas as pd import sqlite3

App=Flask( na )

model = joblib.load(open("model.sav", "rb"))

@app.route('/') def hello_world():

return render_template("home.html")

@app.route('/logon') def logon():

return render_template('signup.html')

@app.route('/login') def login():

return render_template('signin.html')

@app.route("/signup")

def signup():

username = request.args.get('user',)

name = request.args.get('name','') email = request.args.get('email','')

Number=request.args.get('mobile')

password = request.args.get('password','') con = sqlite3.connect('signup.db')

cur = con.cursor()

cur.execute("insert into `info` (`user`,`email`, `password`,`mobile`,`name`) VALUES (?, ?, ?, ?, ?)",(username,email,password,number,name))

con.commit() con.close()

return render_template("signin.html")

@app.route("/signin") def signin():

mail1 = request.args.get('user','') password1 = request.args.get('password','') con = sqlite3.connect('signup.db')

cur = con.cursor()

cur.execute("select `user`, `password` from info where `user` = ? AND

`password` = ?",(mail1,password1,)) data = cur.fetchone()

if data == None:

return render_template("signup.html")

@app.route('/predict',methods=['POST','GET']) def predict():

text1 = request.form['1'] text2 = request.form['2'] text3 = request.form['3'] text4 = request.form['4'] text5 = request.form['5'] text6 = request.form['6'] text7 = request.form['7'] text8 = request.form['8']

row_df = pd.DataFrame([pd.Series([text3,text4,text5,text6,text7, text8])]) print(row_df)

prediction=model.predict_proba(row_df) output='{0:.{1}f}'.format(prediction[0][1], 2) output = str(float(output)*100)+'%'

if output>str(0.5):
```

return render_template('result.html',pred=f'You have chance of having Heart Disease.\nProbability of having Disease is {output}')

else:

return render_template('result.html',pred=f'You are safe.\n Probability of

having Disease is {output}')

@app.route('/about') def about():

return render_template('about.html')

@app.route('/index') def index():

return render_template('index.html')

if name == ' main ': app.run(debug=True)

<!DOCTYPE html>

<html lang="en">

<head>

<meta charset="utf-8">

<meta name="viewport" content="width=device-width, initial-scale=1, shrink-to-fit=no">

<!-- SEO Meta Tags -->

<meta name="description" content="Your description">

<meta name="author" content="Your name">

<!-- OG Meta Tags to improve the way the post looks when you share the

VIII SYSTEM TESTING

Unit testing

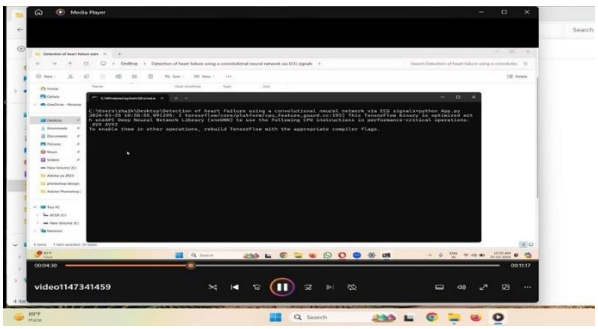
Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

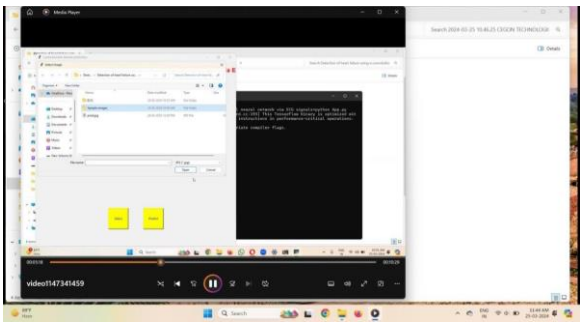
Functional test

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:
Valid Input : identified classes of valid input must be accepted.
Invalid Input : identified classes of invalid input must be rejected.
Functions : identified functions must be exercised.
Output : identified classes of application outputs must be exercised.

IX SCREENSHOTS





X.CONCLUSION

In this article, we propose a lightweight CNN-based model to classify the four major cardiac abnormalities using public ECG images dataset of cardiac patients. According to the results of the experiments, the proposed CNN model achieves remarkable results in

cardiovascular disease classification and can also be used as a feature extraction tool for the traditional machine learning classifiers. Thus, the proposed CNN model can be used as an assistance tool for clinicians in the medical field to detect cardiac diseases from ECG images and bypass the manual process that leads to inaccurate and time-consuming results

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