Cardiocare Ai: Predictive Risk Assessment For Acute Myocardial Infarction Using Machine Learning

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Abstract- *Acute Myocardial Infarction (AMI), or heart attack is a severe condition caused by reduced blood flow to the heart. Early detection is crucial to lower its global impact on health. This project presents CardioCare AI, a machine learning based model for predicting and assessing AMI risk. By analyzing data like cholesterol blood pressure, blood sugar, smoking habits, and family history, it identifies high risk individuals with great accuracy. Using advanced algorithms like XGBoost known for handling medical data effectively, the system detects patterns and relationships among clinical features. CardioCare AI focuses on non-invasive data to ensure its accessibility for widespread use. It provides healthcare professionals with actionable insights for early intervention, enabling preventive care and personalized treatments. The model integrates predictive analytics into daily medical practices to enhance diagnostic speed and reliability, addressing limitations of traditional methods. This innovative approach aims to improve patient outcomes reduce healthcare challenges, and support global cardiovascular disease prevention efforts. By offering a scalable solution, CardioCare AI represented.*

Keywords- AMI, XGBoost, AI, ML.

I. INTRODUCTION

Cardiovascular diseases remain the leading cause of mortality worldwide, with Acute Myocardial Infarction (AMI), or heart attack, ranking as one of the most critical conditions. Characterized by the sudden reduction or complete blockage of blood flow to the heart muscle, AMI poses a significant threat to global health leading to severe complications or death if not detected and treated promptly. Early risk assessment and intervention play a pivotal role in mitigating the devastating effects of this condition. However, traditional diagnostic methods often rely on invasive techniques or are implemented only after clinical symptoms manifest leaving a substantial gap in preemptive healthcare.This project, CardioCare AI Predictive Risk Assessment for Acute Myocardial Infarction Using Machine Learning, addresses this critical challenge by employing data-driven techniques to develop a robust and scalable predictive.

II. LITERATURE SURVEY

The prediction and diagnosis of heart disease have been a significant area of research, with various studies focusing on developing accurate and efficient models. A recent study published in IEEE (2024) introduced two deep learning-based cardiovascular disease detection networks, EnsCVDD-Net and BlCVDD-Net, which demonstrated improved prediction accuracy compared to traditional machine learning approaches.

Another study published in IEEE (2023) proposed a Clinical Decision Support System (CDSS) leveraging deep learning techniques for heart disease prediction. The system integrated multiple patient health indicators and electrocardiogram (ECG) features, achieving superior performance compared to conventional machine learning techniques.

Diagnosing coronary heart disease (CHD) remains a challenge due to the difficulty in accurately differentiating between various types of heart murmurs. A study published in IEEE (2021) emphasized the need for advanced, objective diagnostic techniques to distinguish between diastolic murmurs associated with CHD and those caused by valvular diseases.

Hybrid machine learning approaches have also been explored for heart disease prediction. A study published in IEEE (2019) proposed a Hybrid Random Forest with a Linear Model (HRFLM), which achieved high accuracy in predicting heart disease. The study demonstrated the potential of hybrid models in clinical settings, suggesting that such models can serve as valuable tools for early detection and prevention of cardiovascular conditions.

The integration of deep learning with the Internet of Medical Things (IoMT) has also been explored for heart disease prediction. A study published in IEEE (2020) proposed an Enhanced Deep Learning Assisted Convolutional Neural Network (EDCNN), which demonstrated superior accuracy and efficiency compared to traditional CNN models and other machine learning approaches.

These studies demonstrate the potential of machine learning and deep learning techniques in improving heart disease prediction and diagnosis. The use of ensemble and blending techniques, hybrid models, and IoMT integration can enhance predictive accuracy and efficiency, ultimately leading to better patient outcomes.

The proposed system consists of the following key Components:
Data Collection

- Effective data collection is crucial for training accurate machine learning models.
- Gathering comprehensive datasets relevant to the problem domain ensures that models learn from a diverse range of scenarios, enhancing their predictive capabilities.
- For the CardioCare AI project, collecting data on patient demographics, medical history and clinical features related to cardiovascular disease would be essential.

Training Layer

- The training layer involves developing and fine-tuning machine learning models using the collected dataset.
- Techniques such as cross-validation help evaluate model performance and prevent overfitting.
- In the context of CardioCare AI, training layers would focus on optimizing algorithms like XGBoost to predict acute myocardial infarction risk accurately.

Data Preprocessing

- Data preprocessing transforms raw data into a suitable format for modeling.
- This step includes handling missing values, encoding categorical variables and scaling/normalizing features.
- For CardioCare AI, preprocessing would ensure that clinical data is consistently formatted and encoded properly for XGBoost model implementation.

The literature survey highlights the need for continued research in developing accurate and efficient models for heart disease prediction and diagnosis. Future studies can focus on optimizing models for portable IoMT devices, enhancing scalability, and integrating advanced AI-driven analytics for more precise diagnostics.

III. METHODOLOGY

The CardioCare AI system leverages machine learning to predict acute myocardial infarction risk, utilizing patient data and XGBoost modeling to achieve high accuracy. By integrating data preprocessing and model optimization, the system enables healthcare professionals to access predictive analytics via an API, improving patient outcomes and reducing healthcare costs.

XGBoost

- XGBoost is a powerful gradient boosting algorithm known for its speed and performance.
- It can handle complex datasets and is particularly effective in handling missing data and outliers.
- In CardioCare AI, XGBoost would be utilized for its ability to learn intricate patterns in clinical data enhancing predictive accuracy.

EDA (Exploratory Data Analysis)

- EDA involves analyzing datasets to uncover patterns relationships and insights that inform model development.

Model Implementation

- Model implementation involves integrating trained models into a functional framework.
- In CardioCare AI, model implementation would enable seamless prediction of cardiovascular disease risk, supporting clinical decision-making.

API

- APIs facilitate interaction between the model and external applications, enabling data input and prediction output.
- A well-designed API ensures efficient model deployment and integration with existing systems.
- For CardioCare AI, APIs would allow healthcare professionals to access predictive analytics, enhancing patient care.

Model Input Data

- Model input data refers to the formatted and preprocessed data fed into the trained model for prediction. Ensuring input data quality and consistency is crucial for accurate predictions.

- In CardioCare AI, model input data would comprise patient-specific clinical information, used to predict cardiovascular disease risk.

Prediction Result

- Prediction results are the output of the model, providing insights into patient-specific risks.
- Accurate predictions enable healthcare professionals to make informed decisions, improving patient outcomes.
- In CardioCare AI, prediction results would indicate the likelihood of acute myocardial infarction, guiding preventive measures and treatment plans.

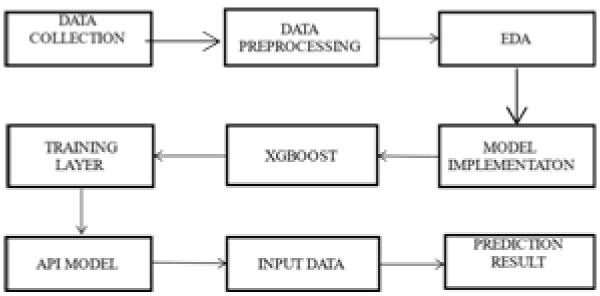

Figure 1:Block Diagram

IV. SOFTWARE DESCRIPTION FOR FLASK WITH MACHINE LEARNING MODEL

Flask is a lightweight and flexible Python web framework that is widely used for building web applications and REST APIs. In this project, Flask serves as the backend framework for deploying a heart disease prediction model, allowing users to interact with the machine learning algorithm through a web interface. The model, trained and saved using joblib, predicts the presence of heart disease based on input health parameters.

Purpose**:** To build a user-friendly web interface for heart disease prediction using a pre-trained machine learning model.

Supported Languages: Flask, HTML/CSS, Python, Joblib, SQLite, TensorFlow, XG-Boost.

Key Features:

- Lightweight and easy to deploy for small to medium-scale applications.
- Allows seamless integration of Python-based ML models.
- Includes routing, session management, and template rendering.
- Secure password hashing and user authentication using Argon2.
- Built-in SQLite database integration for user data management.

In this project, Flask is used to:

Host the Prediction Model:

- Load the heart_disease_model.pkl using Joblib.
- Receive user input from an HTML form and process it to predict heart disease.

Build the Frontend Interface:

- Render dynamic pages such as login, registration, prediction form, and result display.

User Authentication:

- Use Argon2 for password hashing and validation.
- Store and manage user data using SQLite through create_database.py.

Steps for Using Flask Application

Installing Flask and Dependencies

- Install Flask and other libraries using the following command:

pip install flask joblib pandas tensorflow argon2-cffi.

- Clone or download the project directory and navigate to it in the terminal.

Setting Up the Project Project Structure:

- app.py: Main script for running the Flask server.
- model.py: Contains the logic for predictions.
- templates/: Contains HTML files (login, register, predict, result).
- static/: Contains CSS for styling.
- users.db: SQLite database file for user data.

Running the Application

- Start the server: python app.py
- Open browser at: http://localhost:5000 Features Used in This Project

User Authentication:

- Registration and login with hashed passwords. Prediction Engine:
- Reads form data, preprocesses it, and predicts using the XGBoost model.

Frontend Presentation:

- Clear and modern interface with HTML templates and CSS styling.

Database Operations:

- Stores user details and prediction logs for future reference.

Outputs from the System Prediction Result:

- Displayed on the result page after form submission. Logged Records:
- Stored data for user history and model validation. User Accounts:
- Allows personalized access and secure sessions.

Advantages of the System

- High Performance: XGBoost offers fast and accurate predictions.
- User Friendly: Clean web interface allows easy use by medical professionals or patients.
- Secure and Modular: Uses secure hashing for credentials and modular Python codebase.
- Expandable: Ready for image input or advanced analytics via TensorFlow.

V. CONCLUSION

The CardioCare AI system offers a robust solution for predicting acute myocardial infarction risk by leveraging machine learning techniques and comprehensive patient data. By integrating data preprocessing, model training, and API deployment, the system provides accurate and actionable insights for healthcare professionals. This predictive capability enables early intervention and personalized care, ultimately enhancing patient outcomes and advancing cardiovascular health management.

REFERENCES

[1] Agyekum, F., A. A. Folson, B. Abaidoo, L. T. Appiah, Y. Adu-Boakye, H. Ayetey and I. K. Owusu, ‘‘Behavioural and nutritional risk factors for cardiovascular diseases among the Ghanaian population—A cross-sectional study,’’ BMC Public Health, vol. 24 no. 1, p. 194, Jan. 2024.

[2] Abubaker, M. B., and B. Babayigit, ‘‘Detection of cardiovascular diseases in ECG images using machine learning and deep learning methods,’’ IEEE Trans. Artif. Intell. vol. 4, no. 2, pp. 373–382, Apr. 2023.

[3] Chang, V., M. A. Ganatra, K. Hall, L. Golightly, and Q. A. Xu, ‘‘An assessment of machine learning models and algorithms for early prediction and diagnosis of diabetes using health indicators,’’ Healthcare Analytics, vol. 2, Nov. 2022, Art. no. 100118.

[4] Inam, M., Z. Samad, E. M. Vaughan, A. Almas, B. Hanif, A. M. Minhas, Z. Jarrar F. Z. Habib, S. Sheikh, D. Zhu, and S. S. Virani, ‘‘Global cardiovascular research: Gaps and opportunities,’’ Current Cardiology Rep., vol. 25, no. 12 pp.1831-1838 Dec. 2023.

[5] Jawalkar, A. P., P. Swetcha, N. Manasvi, P. Sreekala, S. Aishwarya, P. Kanaka DurgaBhavani, and P. Anjani, ‘‘Early prediction of heart disease with data analysis using supervised learning with stochastic gradient boosting,’’ J. Eng. Appl. Sci., vol. 70, no. 1, p. 122, Dec. 2023.

[6] Kumar, A., K. U. Singh, and M. Kumar, ‘‘A clinical data analysis based diagnostic systems for heart disease prediction using ensemble method,’’ Big Data Mining Analytics, vol. 6, no. 4, pp. 513–525, Dec. 2023.

[7] Kumar, Y., A. Koul, R. Singla, and M. F. Ijaz, ‘‘Artificial intelligence in disease diagnosis: A systematic literature review, synthesizing framework and future research agenda,’’ J. Ambient Intell. Humanized Comput., vol. 14 no.7, pp. 8459–8486, Jul. 2023.

[8] Nazir, S., S. Khan, H. U. Khan, S. Ali, I. García-Magariño, R. B. Atan, and M. Nawaz, ‘‘A comprehensive analysis of healthcare big data management analytics and scientific programming,’’ IEEE Access, vol. 8, pp. 95714 95733, 2020.

[9] Nicolucci, A., L. Romeo, M. Bernardini, M. Vespasiani, M. C. Rossi, M. Petrelli A.Ceriello, P. Di Bartolo, E. Frontoni, and G. Vespasiani, ‘‘Prediction of complications of type 2 diabetes: A machine learning approach,’’ Diabetes Res. Clin. Pract., vol. 190, Aug. 2022, Art. no. 110013.

[10] Rajalakshmi, R., P. Sivakumar, L. K. Kumari, and M. C. Selvi, ‘‘A novel deep learning model for diabetes mellitus prediction in IoT-based healthcare environment with

effective feature selection mechanism,'' J. Supercomput., vol. 80, no. 1, pp. 271–291, Jan. 2024.

[11] Rehman, S., E. Rehman, M. Ikram, and Z. Jianglin, ''Cardiovascular disease (CVD): Assessment, prediction and policy implications,'' BMC Public Health vol. 21, no. 1, pp. 1–14, Dec. 2021.

[12] Shen, Y., J. Zhu, Z. Deng, W. Lu, and H. Wang, ''EnsDeepDP: An ensemble deep learning approach for disease prediction through metagenomics,'' IEEE/ACM Trans. Comput. Biol. Bioinf., vol. 20, no. 2, pp. 986–998, Mar. 2023.