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CardioEdge – AI Powered Exercise Companion

Abstract: *The escalating global prevalence of heart diseases, particularly heart attacks, underscores a critical health concern that necessitates innovative solutions. Despite strides in healthcare, the current diagnostic methods exhibit limitations in accuracy and efficiency, while the vast reservoir of healthcare data remains underutilized. Traditional diagnostic methods lack precision, necessitating innovative solutions. This research introduces "CardioEdge - AI-Powered Exercise Companion," which addresses these challenges by harnessing the power of Computer Vision, Machine Learning, and Django. The platform made using Django predicts heart attack risk with an 85% accuracy rate and offers personalized exercise recommendations with real-time monitoring for proactive cardiovascular health management using computer vision. This solution addresses the crucial need for early, precise prediction, utilizing untapped healthcare data, and represents a significant step toward data-driven, user-friendly heart health management.*

Keywords: *Heart attack prediction, Machine Learning, Random Forest, Computer Vision, Django*

I. INTRODUCTION

Cardiovascular diseases, particularly heart attacks, constitute a pressing health concern, demanding innovative solutions. Heart attacks continue to be a significant global health concern, ranking high among the leading causes of mortality worldwide. It accounts for approximately 17.9 million deaths annually, representing nearly one-third of all global deaths, according to the reports of the World Health Organization (WHO) [1]. The imperative to identify at-risk individuals early and intervene proactively is of high importance. While technologies like deep learning and machine learning have shown promise in accurately predicting susceptibility to heart attacks, it remains a formidable challenge.

Apart from prediction, the well-established efficacy of preventive exercises in reducing heart attack risk must also be addressed. The consistent practice of physical exercise, effective stress control, and adherence to a nutritious diet have proven to substantially lower the chances of heart disease. Adopting a heart-healthy lifestyle, as supported by research, has the potential to slash the risk of heart attacks by 80%. Taking motivation from above, the research aims to tackle both aspects of this challenge – prediction and prevention. We propose to develop an innovative web platform using Django named 'CardioEdge' that seamlessly integrates Computer Vision and Machine Learning technologies to deliver a comprehensive solution for heart attack risk prediction and cardiovascular health management. The remaining part is structured as follows: Section II provides a summary of previous research and related work. Section III comprises the proposed solution. In Section IV, the working architecture of the platform is discussed, followed by results in Section V. In Section VI, the work's conclusion is presented

II. LITERATURE SURVEY

Recent studies in the field of cardiovascular health have explored the utilization of both deep learning and machine learning. In 2023, Chintan M. Bhatt et al. introduced a novel methodology that incorporated k-modes clustering and ML models, with the Multilayer Perceptron emerging as the top-performing algorithm, achieving 87.28% accuracy [2]. In the same year, Valle Harsha Vardhan et al. focused on predicting heart conditions, introducing an ensemble classifier for hybrid classification [3]. In 2022, Janaraniani N et

al. delved into the escalating prevalence of coronary artery disease (CAD) as the foremost factor influencing mortality on a global scale. The study underscored the value of human genetics research in enhancing the ability to identify individuals at higher risk for CAD. The paper delved into the utilization of artificial intelligence technologies to scrutinize raw clinical data for the evaluation of heart disease severity. The research further employed algorithms, such as Naive Bayes, Weighted Associative Rule Mining and Decision Tree, to predict various states of CAD in individuals. These algorithms underwent testing using clinical data sourced from the Cardiology department, encompassing noteworthy instances and distinctive cases. The paper concluded that the Decision Tree algorithm achieved the highest prediction accuracy of 99.5 percent, outperforming other algorithms with the fastest rate of exactness. The research highlighted the potential of AI technologies in predicting CAD severity and improving patient outcomes [4]. Similarly, in 2021, Harshit Jindal et al. engineered a system capable of forecasting heart disease through the utilization of KNN and Logistic Regression, showcasing commendable accuracy and potential cost reduction. [5]. In 2021, Lubna Riyaz et.al directed their attention to the widespread occurrence of cardiovascular diseases, acknowledging them as a foremost factor in global fatalities. The study highlighted the importance of a feasible, accurate, and reliable system to diagnose heart disease in a timely manner to prevent severe complications and heart attacks. The research reviewed the utilization of machine learning (ML) algorithms and techniques to various available heart disease datasets for automatic prediction, diagnosis, and treatment. The paper presented a comprehensive survey of various machine learning techniques and analyzed their performances in predicting, diagnosing, and treating various heart diseases. Some of the techniques surveyed in the paper included support vector machine (SVM), artificial neural network (ANN), Naïve Bayes (NB), K-nearest neighbor (KNN), and decision tree (DT). The paper additionally presented the mean accuracy of prediction for each technique, concluding that Artificial Neural Network (ANN) attained the highest average accuracy at 86.91%, while the C4.5 decision tree technique exhibited the lowest average accuracy of 74.0% [6].

In 2021, Jaydutt Patel et al. utilized data spanning ten years to make predictions about Chronic Heart Disease, assessing the effectiveness of Support Vector Machine (SVM), Decision Tree, Artificial Neural Network (ANN), and Naive Bayes. [7]. In 2017, Himanshu Sharma et al. directed their attention to the alarming statistics uncovered in a WHO survey, which highlighted that 17.5 million individuals succumbed to heart diseases annually, with a projected escalation to 75 million by 2030.The study highlighted the limitations of medical professionals in predicting heart attacks with only up to 67% accuracy. The paper emphasized the need for a support system for more accurate forecast of heart disease, given the current epidemic scenario. The research explored machine learning algorithms and deep learning as new avenues for precise prediction of heart attacks. The paper provided comprehensive information about state-of-the-art methods in machine learning and deep learning and offered an analytical comparison to assist new researchers working in this field. The algorithms Naïve Bayes, Decision Tree, Neural Network, SVM, and Deep Learning. [8]. Additionally, in 2016, Sonam Nikhar et al. compared Naïve Bayes and Decision Tree classifiers, with the Decision Tree outperforming [9]. In 2008, Sellappan Palaniappan et al.'s introduced a research paper outlining an Intelligent Heart Disease Prediction System that utilized Decision Trees, Naïve Bayes, and Neural Network algorithms. [10]. n 2006, the research by Kemal Polat et al. centered on introducing a new technique for heart disease diagnosis, involving the integration of AIRS and fuzzy weighted pre-processing in a hybrid approach. The study emphasized that AIRS had demonstrated effective performance in several problems, including machine learning benchmark problems and medical classification issues such as breast cancer, liver disorders and diabetes classification. The paper examined the robustness of the method using classification accuracy, k-fold cross-validation method, and confusion matrix. The results showed a promising classification accuracy of 96.30%, which was very promising compared to previously reported classification techniques [11]. This body of work collectively underscores the evolving landscape of employing ML in cardiovascular health, emphasizing its potential for accurate prediction and timely intervention.

III. PROPOSED SOLUTION

Our innovative solution involves the seamless integration of Computer Vision and Machine Learning into an intuitive web platform developed using Django. This platform is designed to accurately predict an individual's risk of a heart attack by leveraging essential health parameters, sourced from the UCI Machine Learning Repository. Our predictive model,

employing the Random Forest algorithm, achieves an impressive accuracy rate of 85%. The dataset used for training and testing is carefully curated to ensure the reliability of our predictions. Moreover, our platform goes beyond mere risk assessment; it provides personalized exercise recommendations tailored to each user. For individuals with a lower risk of a heart attack, the platform suggests curated YouTube videos for various exercises. Conversely, for those identified at a higher risk, or if specific parameters indicate elevated risk, our Computer Vision model comes into play. This advanced model monitors users in real-time as they engage in six specific yogic and aerobic exercises aimed at strengthening the core and minimizing the risk of heart attacks. The Computer Vision model is designed not only to be activated when overall chances are high but also when specific parameters indicate an increased risk. This nuanced approach ensures that users receive tailored exercise recommendations based on their unique health profile. By merging data-driven insights with targeted exercise strategies, our solution aims to empower users to proactively manage their cardiovascular health. The integration of cutting-edge technologies not only facilitates accurate risk predictions but also provides users with a practical and interactive approach to minimize their risk factors. Through this holistic approach, we aspire to contribute to the reduction of heart attack incidences and promote overall cardiovascular well-being among users.

A. Features of CardioEdge

The platform incorporates various features, which are listed below:

- Heart Attack Risk Prediction: CardioEdge employs Machine Learning algorithms to accurately assess an individual's risk of a heart attack based on essential health parameters such as age, sex, blood pressure, cholesterol levels, etc.
- Personalized Exercise Recommendations: Based on the heart attack risk prediction, the platform offers tailored exercise recommendations aimed at strengthening the core and mitigating heart attack risk. These recommendations include a mix of yogic and aerobic exercises.
- Real-time Video Feed and Analysis: CardioEdge features a real-time video feed that allows users to follow along with exercise routines. The platform also performs real-time analysis of the user's exercise postures using Computer Vision technologies.
- Posture Detection for Exercises: The platform implements functionalities for yogic and aerobic exercise posture detection, ensuring that users are performing the exercises correctly and effectively.
- Analytics Based on Exercises Performed: CardioEdge provides analytics based on the exercises performed by the user, offering insights into the effectiveness of the exercise routine and areas for improvement.
- Secure User Authentication and Authorization: The platform uses Django for website development, which includes built-in protection against most types of CSRF attacks and uses the PBKDF2 algorithm with a SHA-256 hash to securely store user passwords.
- Session Management: CardioEdge uses Django's built-in session management system that stores session data on the server-side, ensuring the security and integrity of user sessions.
- Cross-Site Scripting (XSS) Protection: The platform uses the X-Frame-Options middleware to prevent the site from being rendered inside a frame, providing protection against certain types of XSS attacks.
- SQL Injection Protection: Django's query sets are protected from SQL injection since their queries are constructed using query parameterization.
- HTTPS Support: CardioEdge supports HTTPS, ensuring secure communication between the user's browser and the server.

Through these key features, CardioEdge aims to empower users to proactively manage their cardiovascular health, reduce the incidence of heart attacks, and enhance overall well-being.

IV. WORKING ARCHITECTURE

The Fig 1 illustrates the working of the website that combines user authentication, heart attack prediction, and personalized content delivery based on the prediction results. The first block is "User Authentication," where the system verifies the identity

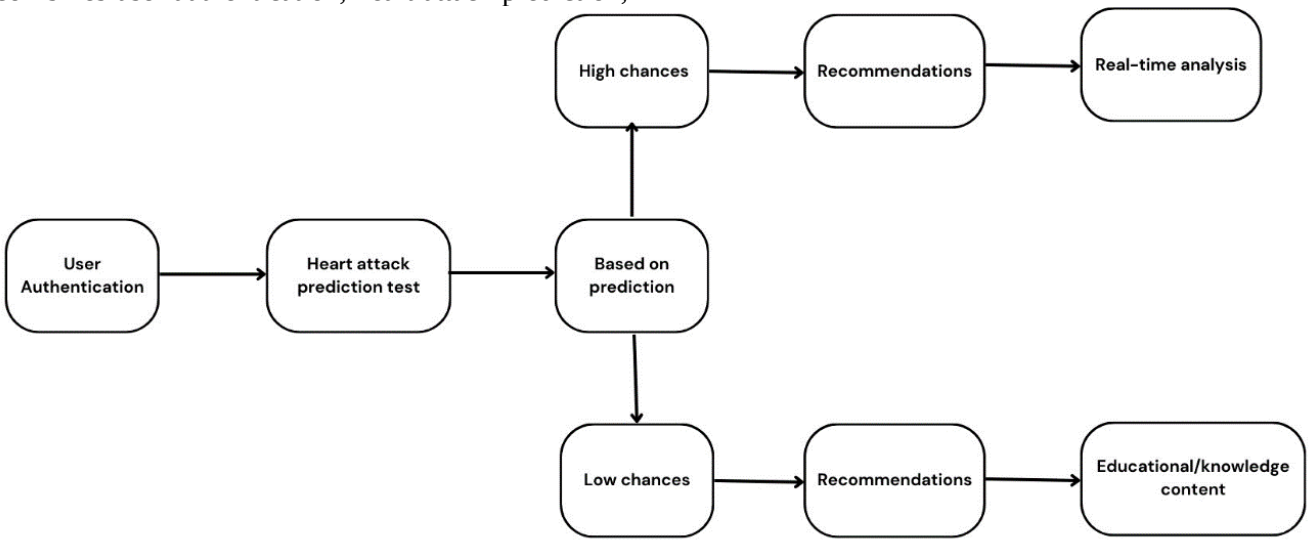

Fig 1: Working Architecture of Cardio Edge

of the user. This involves entering a username and password if the user is authenticated, and if not, then user needs to create an account on the website. The second block is "Heart Attack Prediction." Once the authentication is done, user will be authorized to take heart attack prediction test wherein the system predicts the likelihood of a heart attack based on the following user's health parameters:

- Age: In this, users are required to their age.
- Sex: Users are required to specify their gender.
- Chest Pain Type: There are four type of chest pains that are taken into consideration: Typical Angina, Atypical Angina, Non-anginal Pain and Asymptomatic.
- Resting Blood Pressure: Users are required to enter their resting blood pressure in mmHg unit.
- Cholesterol: Users are required to enter their cholesterol level in the mg/dL unit.
- Fasting Blood Sugar: If the fasting blood sugar level is greater than 120 mg/dL, the user needs to select 'true'; otherwise, they should select 'false'.

The block "Based on Prediction" represents the decision point where the system branches into two nodes based on the prediction results.

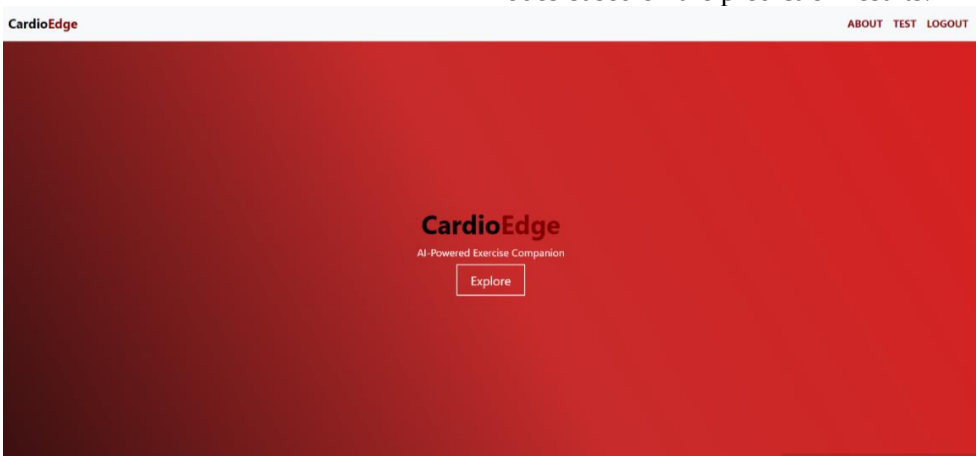

Fig 2: Home page of CardioEdge

The first node is "High Chances." If the system predicts high chances of a heart attack, this node is activated. It is further connected to the block "Recommendations," which provides personalized recommendations to the user. It represents different exercise poses, including "Warrior II pose," "Natraj pose," "Tree pose," "Lunges," "High Knees," and "Ripple Counter." These exercise poses are recommended based on the user's health parameters and are designed to help mitigate heart attack risk through targeted physical activity. The block "Real-time Analysis" is connected to the "High Chances" node. This block represents the continuous monitoring and analysis of the user's health parameters and adherence to the recommendations provided.

The analysis could involve tracking changes in health parameters, evaluating the effectiveness of the recommendations, and making adjustments as needed. The second node is "Low Chances." If the system predicts low chances of a heart attack, this node is activated. It is further connected to the block "Recommendations," which provides general recommendations for maintaining a heart-healthy lifestyle.

The block "Educational/Knowledge Content" is connected to the "Low Chances" node. This block represents the delivery of educational materials and knowledge content to the user. The content could include information about heart health, preventive measures, and tips for maintaining a healthy lifestyle. Fig 2 shows the home page of CardioEdge and Fig 3 shows the questionnaire page for the users.

V. RESULT

The implementation of the CardioEdge platform yielded promising outcomes in addressing the dual challenge of heart attack prediction and prevention. Leveraging the Random Forest algorithm, the platform achieved an impressive 85% accuracy in assessing individuals' risk of a heart attack based on essential health parameters. Additionally, the integration of advanced features, including real-time video feed, Computer Vision, and Machine Learning functionalities, empowered users to proactively manage their cardiovascular health, offering personalized exercise recommendations and fostering a sense of control over well-being.

The platform's capabilities extend to supporting healthcare practitioners in making informed decisions, contributing to the enhancement of overall healthcare services. CardioEdge demonstrates significant potential as a comprehensive solution, showcasing positive results in accuracy, personalized recommendations, and advanced functionalities for heart attack risk prediction and prevention.

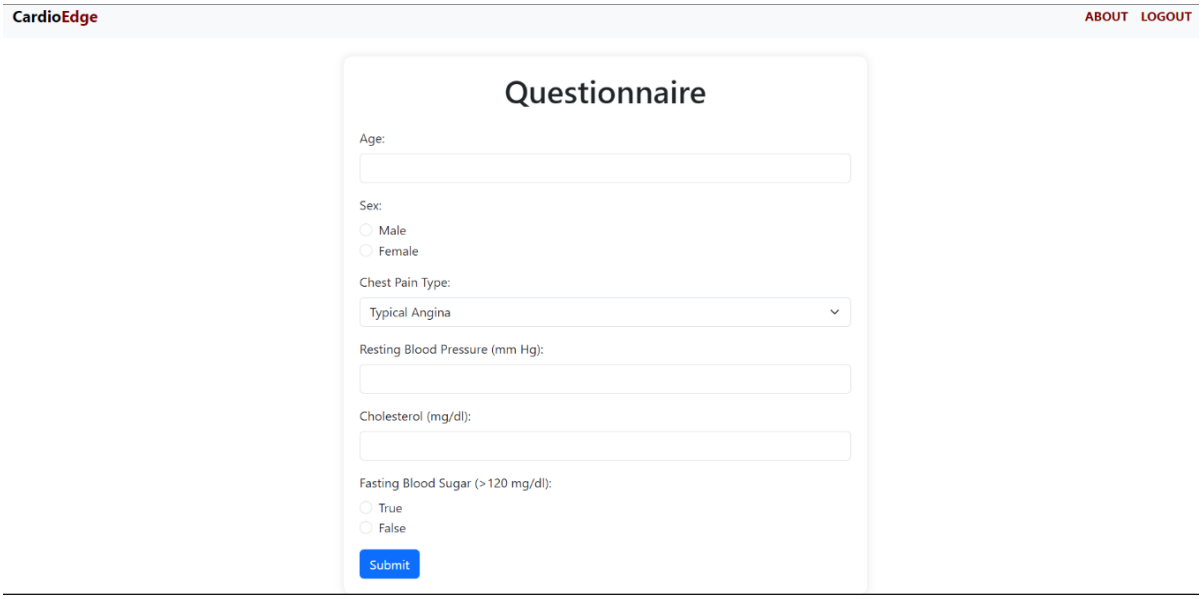

Fig 3: Prediction questions for the use

VI. CONCLUSION

In conclusion, the CardioEdge platform stands as a promising advancement in the realm of cardiovascular health management, effectively addressing the challenges of heart attack prediction

and prevention. The platform's notable achievements in accurately assessing heart attack risks, offering personalized exercise recommendations, and providing advanced functionalities showcase its potential impact on both individual well-being and healthcare services. By seamlessly integrating Machine Learning and Computer Vision technologies within a user-friendly web platform.

CardioEdge not only empowers users to take proactive control of their cardiovascular health but also supports healthcare practitioners with valuable tools for informed decision-making. The positive outcomes observed in our study underscore the platform's potential to significantly contribute to reducing the incidence of heart attacks and improving overall cardiovascular well-being. As we move forward, the CardioEdge initiative represents a crucial step towards leveraging technology for the enhancement of preventive healthcare strategies and the promotion of heart-healthy lifestyles.

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