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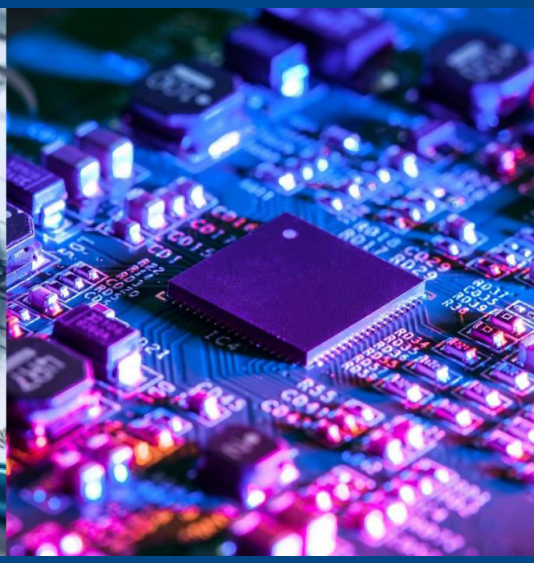

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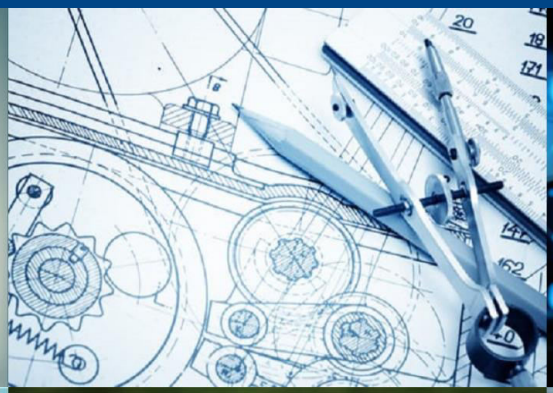

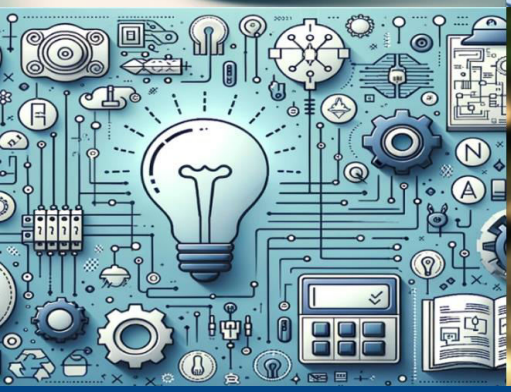

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Early Detection and Prevention Risk of Developing Heart Disease

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ABSTRACT: Diabetes is often referred to as a condition with far-reaching consequences, as it impacts multiple organs throughout the body. Detecting and managing diabetes at an early stage is vital to prevent long-term complications. One of the most serious health risks associated with diabetes is the development of cardiovascular diseases. This project introduces a novel approach named Optimal Scrutiny Boosted Graph Convolutional LSTM (O-SBGC-LSTM), which builds upon the SBGC-LSTM framework by incorporating the Eurygaster Optimization Algorithm (EOA) to fine-tune hyperparameters for better accuracy in early prediction and prevention of diabetes-related complications. The proposed model is designed to extract meaningful features from both spatial and temporal data, and it effectively captures interactions between these dimensions. Its hierarchical temporal structure expands the receptive fields of the upper LSTM layers, enabling improved learning of complex patterns while reducing computational overhead. Performance evaluations have consistently shown that the O-SBGC-LSTM outperforms traditional machine learning models across various benchmarks. In addition to prediction, this system leverages fuzzy inference rules and recommendation tables to provide proactive and personalized guidance, emphasizing that preventive care remains more effective than reactive treatment.

I. INTRODUCTION

Chronic diseases such as Type 2 Diabetes Mellitus (T2DM) continue to pose serious public health challenges across the globe. One of the most significant and life-threatening complications associated with T2DM is Coronary Heart Disease (CHD), a condition characterized by the narrowing or blockage of coronary arteries due to plaque buildup. The prevalence of CHD is notably higher among diabetic patients, owing to long-term metabolic disruptions, insulin resistance, and persistent inflammation, all of which contribute to endothelial dysfunction and atherosclerosis. This dual burden of T2DM and CHD not only affects patients' quality of life but also places a considerable strain on healthcare systems. Therefore, early detection and personalized prevention strategies are essential in mitigating risks and managing disease progression effectively.

In response to these challenges, we propose a hybrid deep learning-based system that facilitates early prediction and prevention of CHD specifically in individuals diagnosed with T2DM. The proposed system is engineered to integrate multiple analytical layers, each addressing a critical stage in the clinical data pipeline. It begins with preprocessing raw data, followed by advanced feature extraction and classification to uncover complex patterns within the dataset. The core of the model is a newly introduced technique termed **O-SBGC-LSTM**, which combines an Enhanced Optimization Algorithm (EOA) with a Self-Balancing Gated Convolutional Long Short-Term Memory (SBGC-LSTM) network. This hybrid architecture is designed to effectively learn both temporal sequences and spatial dependencies within the data, offering superior accuracy compared to conventional deep learning models.

To further enhance the clinical value of the system, fuzzy inference techniques are employed. These techniques simulate human-like reasoning by incorporating imprecise and uncertain input values—such as dietary habits, exercise frequency, medication adherence, and personal health history—into the decision-making process. This is particularly beneficial in real-world medical settings where patient data may be incomplete or noisy. Using minimal yet critical inputs collected through Internet of Things (IoT)-enabled wearable devices or health monitoring trackers, the fuzzy system can provide individualized lifestyle and treatment recommendations. These may include suggestions for dietary modifications, physical activity plans, medication dosages, and blood sugar monitoring routines—all tailored to the patient's risk profile and current health status.

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Clinical insights from physicians underscore that maintaining blood glucose levels within a healthy range is fundamental to reducing the likelihood and severity of CHD complications in diabetic patients. Our system not only assists in detecting the disease at an early stage but also equips both patients and healthcare providers with actionable information to intervene proactively. This dual functionality—prediction and prevention—represents a shift from reactive to proactive care.

Federated learning will be adopted to ensure patient privacy while allowing the system to learn from diverse, distributed datasets, thereby enhancing the model's generalizability across different populations and healthcare settings. Ongoing integration with clinical guidelines will be maintained through collaboration with medical professionals, while scalability and interoperability with electronic health records (EHRs) will support widespread adoption.

Experimental validation of the proposed system was carried out using a publicly available cardiovascular dataset hosted on Kaggle. The system demonstrated a robust testing accuracy of 95.2%, highlighting its reliability and potential for real-world deployment. Additionally, a risk contribution analysis module was developed to quantify the influence of each clinical and lifestyle-related feature on a patient's likelihood of developing CHD. This component provides valuable interpretability to the model, empowering clinicians to identify high-impact risk factors and personalize treatment strategies more effectively.

In summary, the proposed hybrid deep learning framework presents a comprehensive solution to one of the most pressing healthcare issues—predicting and preventing coronary heart disease in diabetic patients. By combining state-of-the-art machine learning algorithms, fuzzy logic, and IoT-enabled data collection, this system lays the foundation for a smart, scalable, and patient-centric approach to chronic disease management. It not only enhances the accuracy of disease prediction but also delivers practical guidance for prevention, thereby improving long-term health outcomes and quality of life for individuals living with T2DM.

II. LITERATURE REVIEW

In their 2023 paper, M. Sachdev and A. Misra examined the heterogeneity of dietary practices in India and its implications for the prevention and control of Type 2 Diabetes (T2D). They highlighted the considerable regional variation in Indian diets, which are predominantly carbohydrate-based. The study observed a nutritional shift from traditional coarse grains to refined grains, particularly in urban areas where consumption of fats, sugars, and processed foods is on the rise. In contrast, rural populations continue to rely on cereals and legumes. Despite being non-vegetarian, most Indians consume relatively little meat. The paper stressed how reduced dietary diversity and nutritional imbalance are contributing to rising T2D cases and called for focused dietary policies and lifestyle interventions to manage diabetes effectively.

In their 2022 paper, P. Nagaraj and P. Deepalakshmi proposed an intelligent fuzzy inference rule-based expert recommendation system (IFIR_PDDM) for predictive diabetes diagnosis. This system leverages fuzzy membership functions and decision rule extraction techniques to handle uncertainties in medical data. The Mamdani fuzzy inference approach is employed to generate personalized recommendations based on parameters such as blood glucose levels and lifestyle factors. Rules used in the system are validated by healthcare experts to ensure clinical reliability. Evaluated with the PIMA Indian Diabetes dataset, the model demonstrated efficient diagnostic support and provided actionable suggestions for lifestyle adjustments in diet, physical activity, and medication.

In their 2022 paper, J. J. Joseph, P. Deedwania, T. Acharya, D. Aguilar, D. L. Bhatt, D. A. Chyun, et al. presented a scientific statement on the comprehensive management of cardiovascular risk factors in adults with Type 2 Diabetes. The paper emphasized the importance of integrating blood pressure, lipid, and glucose control while promoting lifestyle interventions such as physical activity and balanced nutrition. The authors also highlighted the efficacy of new antihyperglycemic medications in reducing risks of stroke and heart failure. Additionally, they discussed the role of social determinants and health equity in patient outcomes. The guidelines offer a holistic approach combining pharmacological and behavioral strategies for effective cardiovascular care in diabetic patients.

In their 2022 paper, R. K. Jha, S. K. Henge, S. K. Mandal, A. Sharma, S. Sharma, A. Sharma, et al. developed a neural fuzzy hybrid rule-based inference system to predict the probability of heart attacks. Utilizing over 13,000 fuzzy logic rules and integrating neural computation, the model mimics clinical decision-making processes for high predictive

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accuracy. Tested on the Cleveland heart disease dataset from the UCI repository, the system achieved a 94% accuracy rate. It includes modules for dynamic rule learning and error correction, making it suitable for future adaptation in real-time health monitoring applications. The study demonstrates the potential of combining fuzzy logic and neural networks in medical diagnostics.

III. METHODOLOGY OF PROPOSED SURVEY

User Interface Design

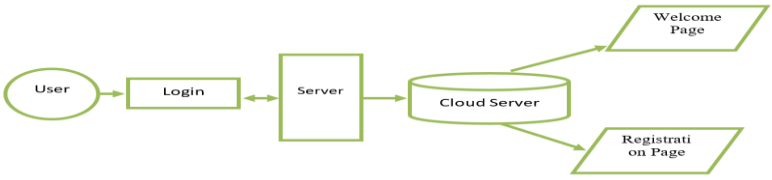

Fig: 1 User Interface Design Diagram

To connect with server user must give their username and password then only they can able to connect the server. If the user already exits directly can login into the server else, user must register their details such as username, password, Email id, City and Country into the server. Database will create the account for the entire user to maintain upload and download rate

Admin:

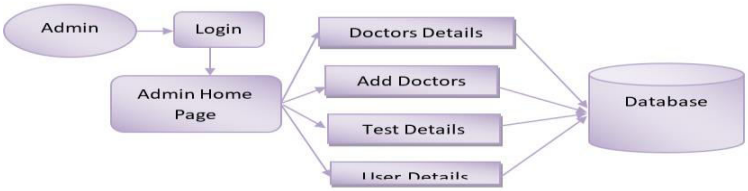

Fig: 2 Admin Diagram

This is the second module of our project no registration for admin only for login with help of admin name & password. Dataset is a collection of related sets of information that is composed of separate elements. Admin having some options like Add Doctor Details, View User Details, View Feedback, View Doc Details & View Test reports also.

User:

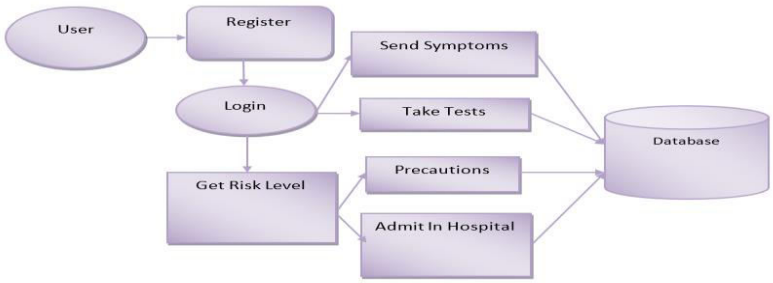

Fig: 3 User Diagram

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Users register with details like age and sex, then log in to submit symptoms, which are sent to the hospital for a doctor's appointment. After consultation and required tests, the system assesses risk: high-risk cases are advised for admission, while low-risk cases follow prescribed precautions and medication. The system suggests suitable doctors and allows users to give feedback and view doctor profiles.

Hospital:

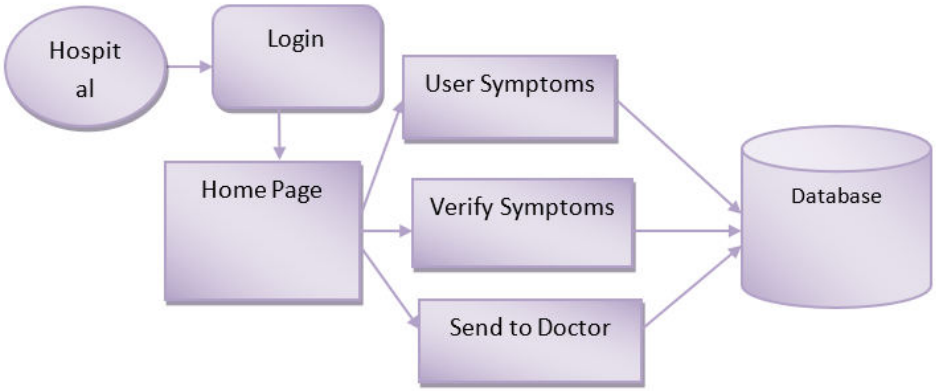

Fig: 4 Hospital Diagram

This is the fourth module of our project no registration for hospital only for login with help of hospital name & password. After login verify user's symptoms then provide appointment with doctor. Then according to doctors reports if user wants to admit then provide the admission in the hospital otherwise provide medicine details. And take care of details, reports, and admission details of the user.

Doctor Diagram:

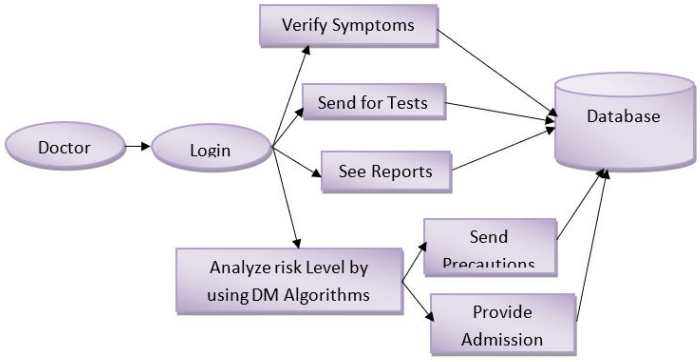

Fig: 5 Doctor Diagram

This is fifth module in our project in this module based on doctor information it works. Admin already adding some doctors based on name & password login in to application. Then First doctor register in administration staff then the particular doctor authorized to this organization. After that every time login in to hospital then checks the patient's condition and doctor checks patient medical reports. Then check the risk level and then based on the risk level doctor will provide some suggestions to hospital staff (either admission or medication details).

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IV. IMPLEMENTATION

Admin Login Page:

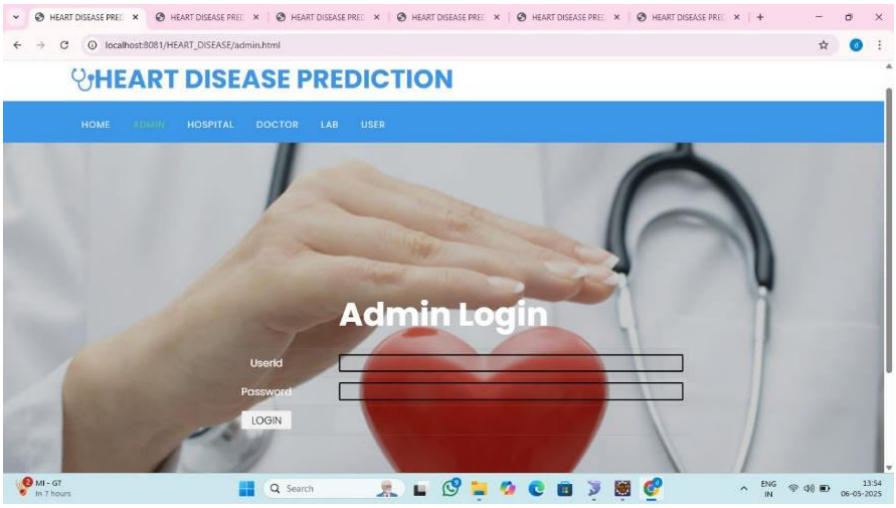

Fig: 6 Admin Login Page

To access the administrative functionalities of the "HEART DISEASE PREDICTION" system, administrators must enter their "Userid" and "Password" into the respective fields and then click the "LOGIN" button.

Doctor Registration:

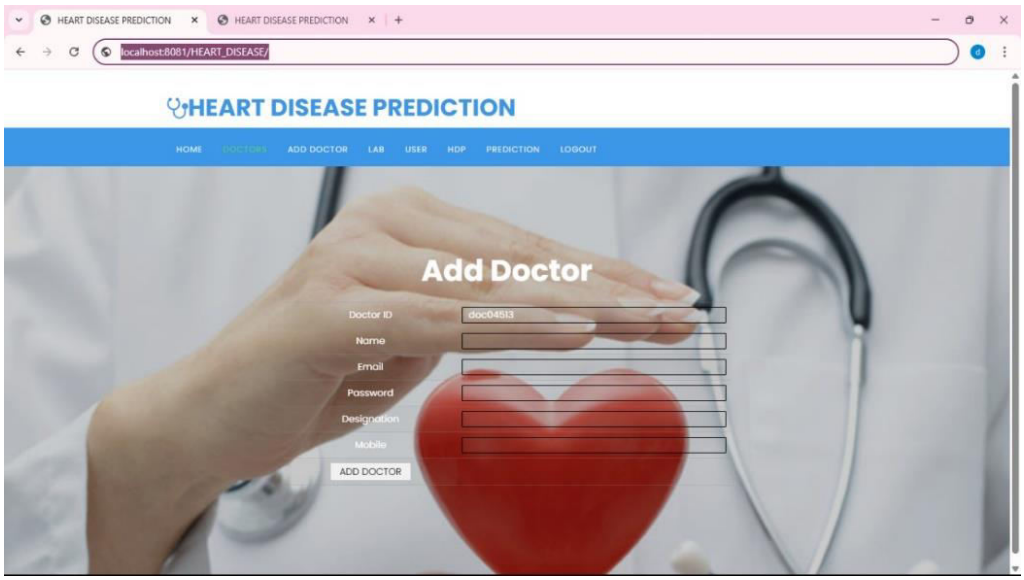

Fig: 7 Doctor Registration

As an administrator on the "Add Doctor" page of the "HEART DISEASE PREDICTION" system, you need to input the details for a new doctor. This involves filling in the "Doctor ID", "Name", "Email", "Password", "Designation", and "Mobile" fields. Once all the necessary information has been entered, click the "ADD DOCTOR" button to complete the addition of the doctor to the system.

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User Registration:

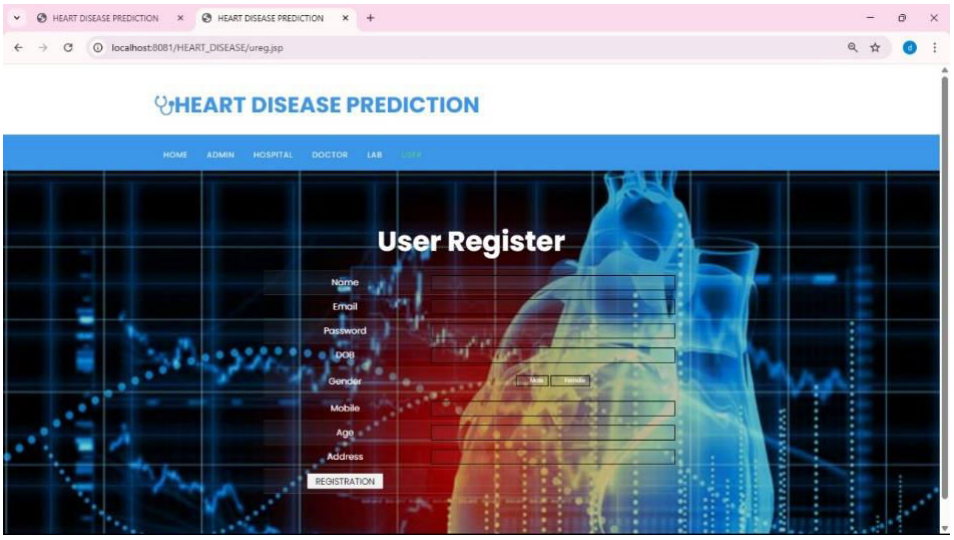

Fig: 8 User Registration

To register as a user on the "User Register" page of the "HEART DISEASE PREDICTION" system, you need to provide your details in the following fields: "Name", "Email", "Password", "DOB" (Date of Birth), "Gender", "Mobile", "Age", and "Address". After accurately filling in all the required information, click the "REGISTRATION" button to complete your user registration.

Upload Symptoms Page

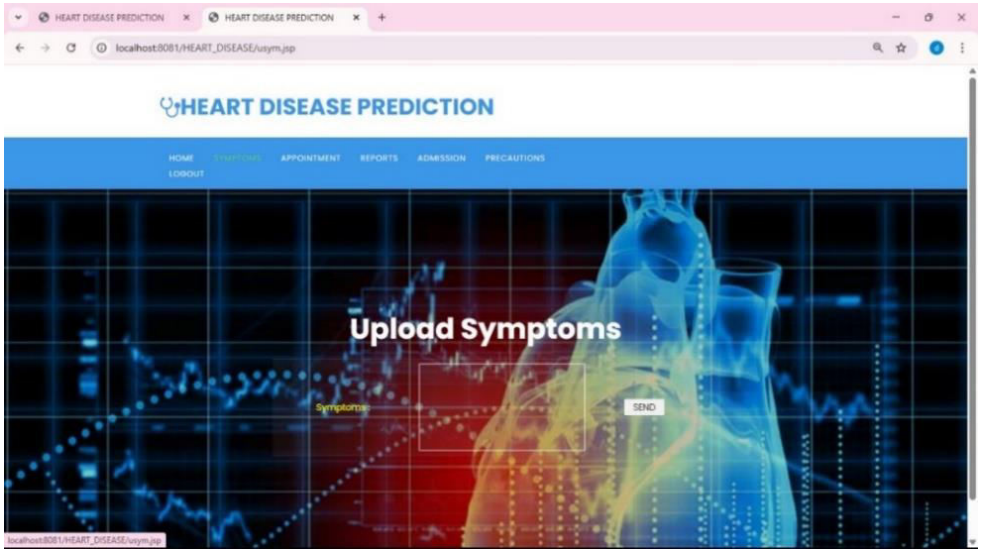

Fig: 9 Upload Symptoms Page

As a user on this page of the "HEART DISEASE PREDICTION" system, you can upload your symptoms. To do so, type your symptoms into the "Symptoms" input field. After entering your symptoms, click the "SEND" button to submit them. From this page, you also have navigation options including HOME, SYMPTOMS, APPOINTMENT, REPORTS, ADMISSION, PRECAUTIONS, and LOGOUT.

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Doctors Appointment Page:

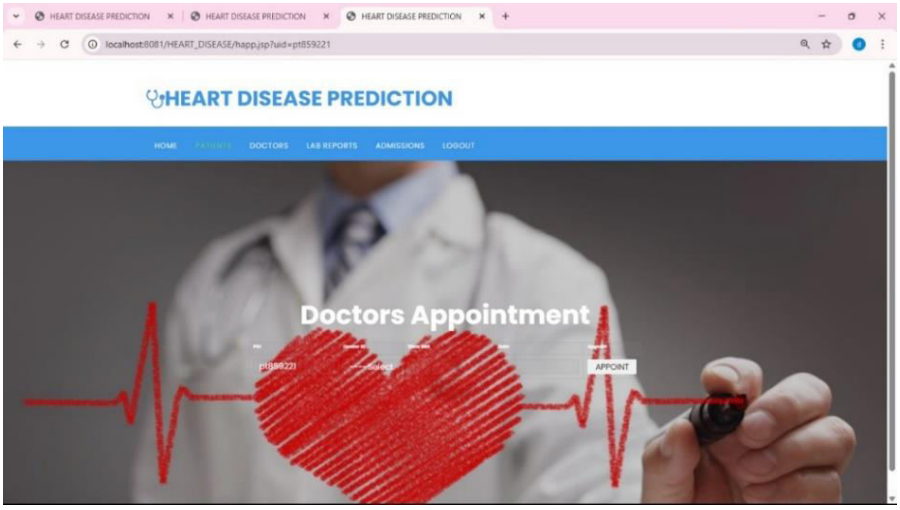

Fig: 10 Doctors Appointment Page

As a hospital staff member on the "Doctors Appointment" page of the "HEART DISEASE PREDICTION" system, you manage patient appointments. To process an appointment, you will need to input the relevant patient or appointment identifier into the provided field (currently showing "p859221" as an example). Once the correct ID is entered, click the "APPOINT" button to proceed. This page also provides navigation options specific to hospital management: HOME, PATIENTS, DOCTORS, LAB REPORTS, ADMISSIONS, and LOGOUT.

Doctor Login Page:

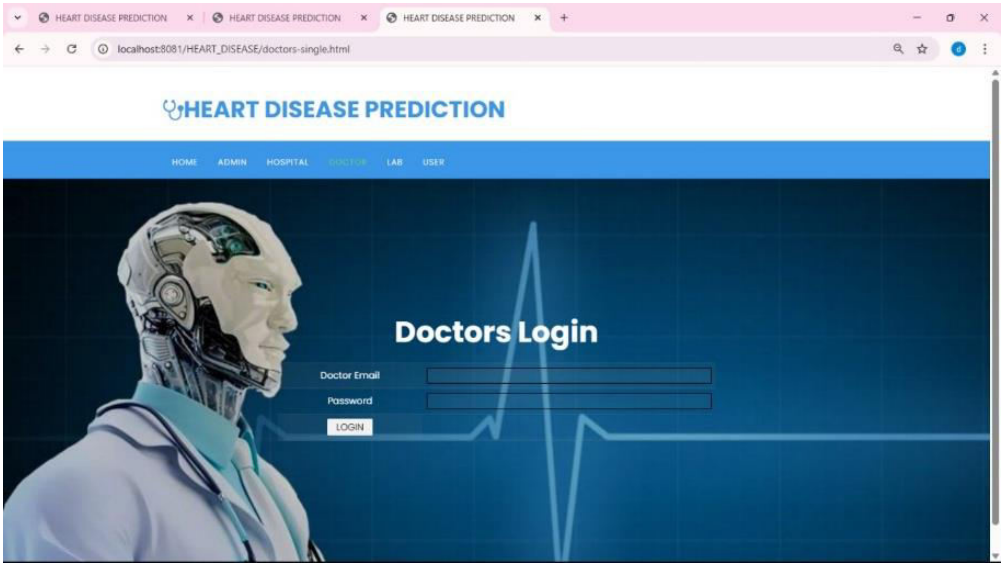

Fig: 11 Doctor Login Page

To login as a doctor on the "Doctors Login" page of the "HEART DISEASE PREDICTION" system, you need to enter your "Doctor Email" into the first field and your "Password" into the second. After providing both credentials, click the "LOGIN" button to gain access to your doctor-specific functionalities. The navigation bar also provides options to access HOME, ADMIN, HOSPITAL, DOCTOR, LAB, and USER sections of the system

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Patient Details Page:

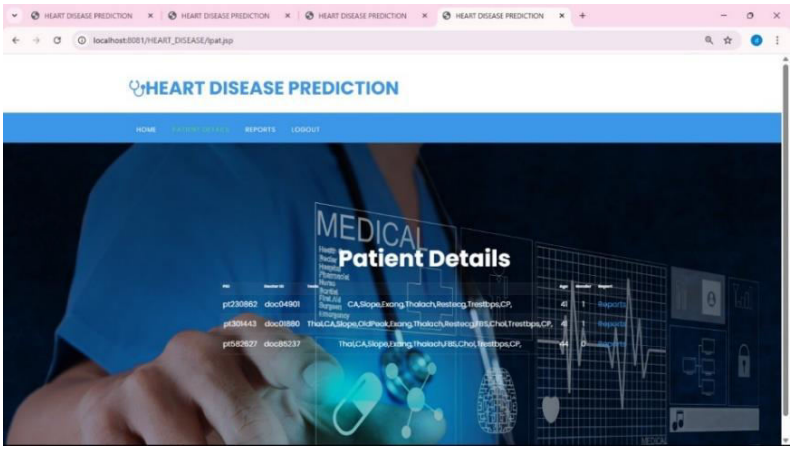

Fig: 12 Patient Details Page

From the lab login side of the "HEART DISEASE PREDICTION" system, the "Patient Details" page allows lab personnel to view comprehensive information about patients. This page presents details such as patient IDs (e.g., "pt290662"), associated doctor IDs (e.g., "doc04901"), and a string of relevant medical parameters or test results. Crucially, lab personnel can access specific patient reports by clicking on the "Reports" option next to each patient's entry. The navigation bar on this page also provides options to go to HOME, PATIENT DETAILS, REPORTS, and to LOGOUT from the system.

Lab Person Login:

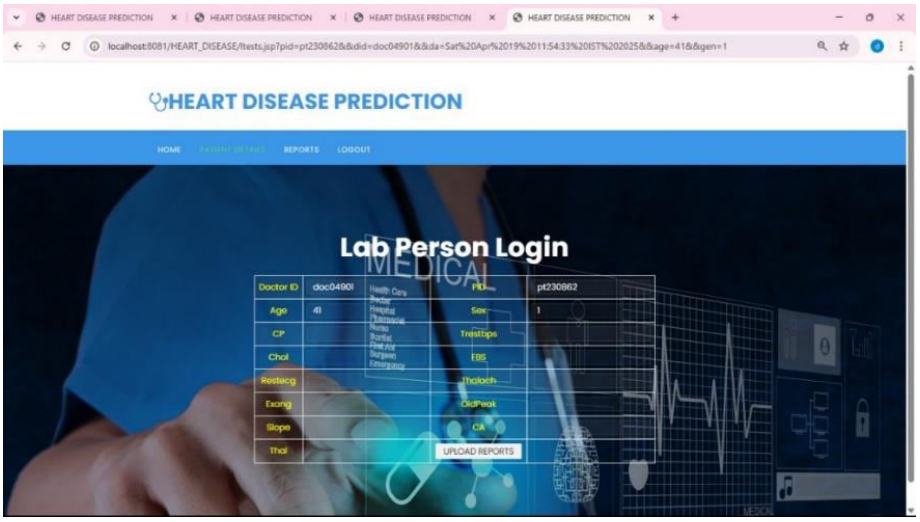

Fig: 13 Lab Report Page

From the lab login side of the "HEART DISEASE PREDICTION" system, this page allows lab personnel to view and manage patient test results. It displays detailed medical parameters for a specific patient, including their "Doctor ID" (e.g., "doc04901"), "Patient ID" (e.g., "pt230862"), Once the necessary tests are conducted or results are ready, lab personnel can click the "UPLOAD REPORTS" button to submit the data. The navigation bar provides options to go to HOME, PATIENT DETAILS, REPORTS, and to LOGOUT from the system.

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Heart Disease Prediction Page:

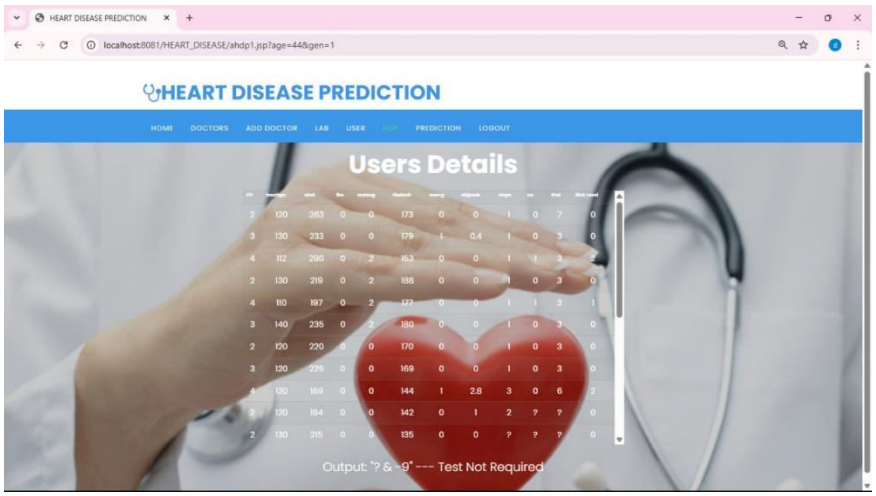

Fig: 14 Heart Disease Prediction Page

The page on the admin side of the "HEART DISEASE PREDICTION" system displays a table of medical parameters along with the prediction output indicating if a heart disease test is required. This section is managed by the admin. The top navigation bar includes options such as HOME, DOCTORS, ADD DOCTOR, LIST, USER, VIEW, PREDICTION, and LOGOUT.

IV. CONCLUSION AND FUTURE WORK

In our 2025 study, we proposed a novel neural network-based method for predicting the status of Coronary Heart Disease (CHD), utilizing a scrutiny mechanism integrated with the Eurygaster Optimization Algorithm (EOA) to derive adaptive weights for a hybrid framework. Our model extracts unique and shared embeddings from node topology, attributes, and their interactions, with the O-SBGC LSTM architecture capturing critical node-level information. This significantly enhanced the model's performance.We also incorporated a fuzzy inference system to assist clinicians by generating treatment suggestions based on CHD severity, thus aiding in diagnosis, prevention, and recurrence management. For future enhancement, we proposed integrating wearable IoT devices for real-time monitoring, developing mobile applications with multilingual and voice-enabled support, and adopting AI chatbots to assist elderly users. Additionally, migrating to cloud infrastructure and implementing blockchain will ensure secure, scalable, and accessible healthcare delivery.

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