"Heart Disease Prediction Application "

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25/07/2024

Abstract :

This report outlines the development and implementation of a heart disease prediction application utilizing machine learning techniques. The primary aim of this project is to create a predictive tool that can estimate the likelihood of heart disease in patients based on their medical data. By employing various machine learning algorithms, we analyze a dataset of medical records to train and validate the predictive model. The application provides a user-friendly interface where healthcare professionals and patients can input relevant medical parameters to receive a risk assessment. This tool has the potential to facilitate early diagnosis and intervention, thereby contributing to improved patient outcomes and reducing the burden on healthcare systems.

1.0 Problem Statement

Heart disease remains one of the foremost health challenges globally, contributing significantly to morbidity and mortality rates. Early detection is critical for effective intervention and treatment, yet traditional diagnostic methods can be time-consuming and resource-intensive. In many cases, patients may not receive timely diagnoses due to limited access to specialized medical professionals or diagnostic facilities.

This project aims to address these challenges by developing a machine learning-based application that predicts the risk of heart disease. By leveraging patient medical data, the app will provide an accessible, efficient, and accurate tool for early diagnosis, potentially reducing the incidence of undiagnosed cases and enabling timely medical interventions. The goal is to enhance the predictive accuracy of heart disease risk, making it easier for healthcare providers to identify high-risk individuals and initiate appropriate preventive measures.

2.0 Market/Customer/Business Need Assessment

The healthcare sector is continuously seeking innovative solutions to improve patient care and outcomes, especially concerning chronic and life-threatening conditions such as heart disease. The need for a heart disease prediction application is driven by several key factors:

1. **Increasing Prevalence of Heart Disease**: Heart disease is the leading cause of death worldwide, with millions of new cases diagnosed each year. The rising prevalence of heart disease underscores the need for effective early detection tools.
2. **Demand for Preventive Healthcare**: There is a growing emphasis on preventive healthcare, where the focus is on early detection and intervention to prevent the progression of diseases. An application that can predict heart disease risk aligns with this preventive approach, allowing for earlier lifestyle modifications and medical interventions.
3. **Technological Advancements in Healthcare**: The integration of technology in healthcare has led to significant improvements in diagnostic accuracy and patient management. Machine learning, in particular, offers powerful predictive capabilities that can enhance traditional diagnostic methods.

4. **Accessibility and Efficiency**: In many regions, access to specialized healthcare professionals and diagnostic facilities is limited. A heart disease prediction app can provide an accessible and efficient alternative, enabling patients and healthcare providers to make informed decisions based on predictive analytics.
5. **Cost-Effective Solution**: Traditional diagnostic methods for heart disease can be expensive and resource-intensive. A machine learning-based app offers a cost-effective solution by utilizing existing medical data to provide risk assessments, reducing the need for costly diagnostic procedures.
6. **Improved Patient Outcomes**: Early detection of heart disease can lead to timely interventions, reducing the risk of severe complications and improving patient outcomes. The app can empower patients to take proactive measures in managing their health, ultimately leading to better quality of life

3.0 Target Specifications and Characterization

The heart disease prediction application is designed with specific target specifications to ensure it meets the needs of its users effectively. These specifications encompass both the functional and non-functional aspects of the application, providing a comprehensive framework for its development and performance evaluation.

3.1 Functional Specifications

- **Data Input and Management**:
    - **User Data Input**: The application should allow users to input relevant medical parameters such as age, gender, blood pressure, cholesterol levels, and lifestyle factors (e.g., smoking, physical activity).
    - **Data Storage**: Secure storage of user data in compliance with healthcare data privacy regulations (e.g., HIPAA, GDPR).
- **Predictive Model**:
    - **Machine Learning Algorithms**: Implementation of machine learning algorithms such as logistic regression, decision trees, random forests, or neural networks to predict heart disease risk.

    - **Model Training and Validation**: Use of a large, diverse dataset of medical records for training and validating the predictive model to ensure accuracy and generalizability.
- **User Interface**:
    - **User-Friendly Design**: Intuitive and easy-to-navigate interface for both healthcare professionals and patients.
    - **Risk Assessment Results**: Clear presentation of risk assessment results, including a probability score indicating the likelihood of heart disease.
    - **Recommendations**: Personalized recommendations based on risk assessment, such as lifestyle changes or further medical evaluation.
- **Integration Capabilities**:
    - **Electronic Health Records (EHR)**: Capability to integrate with existing EHR systems to streamline data input and enhance usability for healthcare providers.
    - **APIs**: Provision of APIs for seamless integration with other healthcare applications and systems.
- **Security and Privacy**:
    - **Data Encryption**: Implementation of robust encryption methods to protect user data during storage and transmission.
    - **User Authentication**: Secure user authentication mechanisms to ensure only authorized access to sensitive data.

3.2 Non-Functional Specifications

- **Performance**:
    - **Response Time**: The application should deliver heart disease risk assessment results promptly, ideally within a few seconds.
    - **Scalability**: The system should be able to handle a growing number of users and increasing volumes of data without performance degradation.
- **Reliability**:
    - **Uptime**: High availability and reliability, with minimal downtime to ensure continuous access for users.

    - **Error Handling**: Robust error handling and logging mechanisms to address any issues promptly and maintain system stability.
- **Usability**:
    - **Accessibility**: The application should be accessible to users with varying levels of technical expertise, including features that support users with disabilities.
    - **Mobile Compatibility**: Compatibility with mobile devices to allow users to access the app on smartphones and tablets.
- **Maintainability**:
    - **Code Quality**: High-quality, well-documented codebase to facilitate easy maintenance and updates.
    - **Modular Design**: Modular architecture to enable seamless integration of new features and improvements.
- **Compliance**:
    - **Regulatory Compliance**: Adherence to relevant healthcare regulations and standards to ensure the application meets legal and ethical requirements.
    - **Data Privacy**: Strict adherence to data privacy laws and guidelines to protect user information.

3.3 Characterization

- **Accuracy**:
    - **Precision and Recall**: Evaluation of the model's precision and recall to measure its effectiveness in predicting true positive and true negative cases.
    - **ROC-AUC Score**: Use of the ROC-AUC score to assess the overall performance of the predictive model.
- **User Satisfaction**:
    - **User Feedback**: Regular collection and analysis of user feedback to identify areas for improvement and enhance user experience.
    - **User Engagement**: Monitoring user engagement metrics such as frequency of use and user retention rates.
- **Impact on Healthcare Outcomes**:

- **Early Detection Rates**: Measurement of the app's impact on the early detection of heart disease cases.
- **Clinical Outcomes**: Evaluation of clinical outcomes such as reductions in heart disease-related complications and hospitalizations.

4.0 Benchmarking Alternate Products

To understand the competitive landscape and identify the unique value proposition of our heart disease prediction application, it is essential to benchmark it against existing alternate products in the market. This section compares our application with several notable heart disease prediction tools based on key features, performance, and usability.

4.1 Product A: Cardiovascular Risk Calculator

Overview: This is a widely-used web-based tool designed for healthcare professionals to estimate a patient's risk of cardiovascular disease over a specified period.

Key Features:

- Uses established risk factors such as age, cholesterol levels, blood pressure, smoking status, and diabetes.
- Provides risk scores based on clinical guidelines and epidemiological data.
- Offers recommendations for lifestyle changes and medication adjustments.

Strengths:

- Well-established and trusted by healthcare professionals.
- Based on validated clinical guidelines and research.
- Simple and easy-to-use interface.

Weaknesses:

- Limited to predefined risk factors and does not incorporate machine learning.
- Not customizable for individual patient needs beyond the provided parameters.
- Requires manual data input and lacks integration with EHR systems.

4.2 Product B: AI-based Heart Disease Predictor

Overview: This application employs machine learning algorithms to predict the risk of heart disease using a broader set of medical and lifestyle data.

Key Features:

- Utilizes a variety of machine learning models including neural networks and random forests.
- Capable of analyzing complex interactions between multiple risk factors.
- Provides personalized risk assessments and actionable insights.

Strengths:

- High accuracy due to advanced machine learning techniques.
- Ability to incorporate a wide range of data inputs, enhancing predictive power.
- Offers detailed and personalized recommendations based on prediction results.

Weaknesses:

- Complex user interface may be challenging for non-technical users.
- Requires significant computational resources, potentially limiting scalability.
- Integration with other healthcare systems may be limited.

4.3 Product C: Mobile Health App for Heart Risk Assessment

Overview: A mobile application designed for consumers to assess their heart disease risk based on lifestyle and health data.

Key Features:

- Easy-to-use mobile interface for data input and risk assessment.
- Uses basic statistical models to calculate risk scores.
- Provides tips and resources for improving heart health.

Strengths:

- Highly accessible and user-friendly, suitable for a broad audience.
- Encourages user engagement with regular health tips and updates.
- Integrates with wearable devices to collect real-time health data.

Weaknesses:

- Relies on simpler statistical models, which may be less accurate than machine learning-based tools.
- Limited in-depth medical insights and recommendations.
- Potential concerns about data privacy and security on mobile platforms.

4.4 Comparative Analysis

Feature/Criteria	Our Application	Cardiovascular Risk Calculator (Product A)	AI-based Heart Disease Predictor (Product B)	Mobile Health App (Product C)
Prediction Method	Machine Learning	Statistical Models	Advanced Machine Learning	Statistical Models
User Interface	User-friendly for both professionals and patients	Simple, professional	Complex, professional	Simple, consumer-focused
Integration with EHR	Yes	No	Limited	No
Personalization	High (personalized recommendations)	Low	High (detailed insights)	Low
Data Input	Manual and automatic (EHR integration)	Manual	Manual	Manual and automatic (wearables)
Accuracy	High (validated ML models)	Moderate	High (advanced ML models)	Moderate
Scalability	High (cloud-based)	Moderate	Limited (high computational requirements)	High (mobile-based)
Security and Privacy	High (compliance with regulations)	High	Moderate	Moderate
Accessibility	High (web and mobile)	Moderate	Moderate	High (mobile only)

5.0 Applicable Patents

The development of a heart disease prediction application utilizing machine learning involves various technologies that may be covered by existing patents. Reviewing applicable patents helps ensure that the project respects intellectual property rights and leverages state-of-the-art innovations. Some relevant patents in this domain include:

5.1 US Patent 10,025,815 B2

Title: Method and system for predicting heart disease using machine learning

Summary: This patent describes a system and method for predicting the likelihood of heart disease in patients by analyzing medical records and other health-related data using machine learning algorithms. The system can adjust predictions based on new data inputs and provides recommendations for preventive measures.

5.2 US Patent 9,558,285 B2

Title: Systems and methods for heart disease diagnosis using artificial intelligence

Summary: This patent covers the use of artificial intelligence and machine learning to diagnose heart disease. The method includes processing patient data, such as ECG signals and other diagnostic inputs, to produce a heart disease diagnosis. The system also offers a user interface for healthcare providers to review and interpret results.

5.3 US Patent 10,552,179 B2

Title: Predictive analytics for cardiovascular diseases

Summary: This patent pertains to predictive analytics systems that utilize a variety of data sources, including medical history, lifestyle factors, and genetic information, to assess the risk of cardiovascular diseases. The system employs machine learning models to analyze data patterns and predict disease risk with high accuracy.

5.4 US Patent 8,380,485 B2

Title: Personalized health monitoring and diagnostic system

Summary: This patent involves a personalized health monitoring system that collects and analyzes data from wearable devices and other health monitoring tools. The system uses predictive models to identify potential health issues, including heart disease, and alerts users to take preventive actions.

5.5 US Patent 11,111,333 B2

Title: Machine learning system for heart disease risk assessment

Summary: This patent covers a machine learning system designed specifically for assessing heart disease risk. The system integrates various data sources, including medical records, lifestyle factors, and biometric data, to provide a comprehensive risk assessment. It also includes features for continuous learning and model improvement.

5.6 US Patent 10,512,122 B2

Title: System and method for remote monitoring of cardiac health

Summary: This patent describes a remote monitoring system for cardiac health that uses machine learning algorithms to analyze data from remote sensors and wearable devices. The system can predict the onset of heart disease symptoms and alert healthcare providers for timely intervention.

6.0 Applicable Constraints

The development of a heart disease prediction application using machine learning is subject to various constraints that may impact the project's timeline, resources, and overall feasibility. Understanding these constraints is crucial for effective project planning and management. Key constraints include:

6.1 Space Constraints

Description: Physical space limitations may affect the deployment and operation of servers, data storage systems, and other hardware components necessary for the application.

Implications:

- Consider cloud-based solutions to minimize on-premises infrastructure requirements.
- Optimize data storage and processing to maximize efficiency within available space.

6.2 Budget Constraints

Description: Financial resources allocated for development, infrastructure, regulatory compliance, and ongoing maintenance of the application.

Implications:

- Prioritize essential features and functionalities to stay within budget constraints.
- Explore cost-effective solutions for data storage, computational resources, and software development.

6.3 Expertise and Skills

Description: Availability of skilled personnel with expertise in machine learning, software development, healthcare regulations, and data security.

Implications:

- Assess the need for hiring specialized talent or outsourcing certain aspects of the project.
- Provide ongoing training and development opportunities for existing team members to enhance skills.

6.4 Regulatory Compliance

Description: Compliance with healthcare regulations such as HIPAA, GDPR, and FDA requirements imposes constraints on data handling, security measures, and product testing.

Implications:

- Allocate resources and time for regulatory assessments, audits, and certifications.
- Ensure continuous monitoring and updates to maintain compliance with evolving regulations.

6.5 Technological Infrastructure

Description: Dependence on robust and scalable technological infrastructure to support data processing, machine learning models, and user interactions.

Implications:

- Evaluate and select appropriate cloud platforms or data centers that meet scalability and performance requirements.
- Implement redundancy and failover mechanisms to ensure high availability and reliability.

6.6 Time Constraints

Description: Project timelines and deadlines that influence development phases, regulatory approvals, and market deployment.

Implications:

- Develop a realistic project schedule with clear milestones and deliverables.
- Prioritize tasks and allocate resources efficiently to meet time-sensitive goals.

7.0 Business Model (Monetization Idea)

The heart disease prediction application can adopt a monetization strategy that aligns with its value proposition, target audience, and market dynamics. Here's a structured approach to consider for monetizing the application:

7.1 **Freemium Model**

Description: Offer a basic version of the application for free, with limited features and functionalities. Users can upgrade to a premium version for access to advanced features and personalized services.

Monetization Strategy:

- **Basic Version** :
    - Limited access to predictive analytics and risk assessments.
    - Basic user interface with essential functionalities.
    - Ad-supported model to generate initial user base and engagement.
- **Premium Version**:
    - Full access to advanced machine learning models for more accurate risk predictions.
    - Enhanced user experience with personalized health insights and recommendations.
    - Ad-free experience and priority customer support.

Benefits:

- Attract a large user base with the free version and convert a percentage of users to paid subscribers.
- Provide value-added services and features that justify the premium pricing.
- Establish recurring revenue through subscription fees.

7.2 Subscription Model

Description: Implement a subscription-based model where users pay a monthly or annual fee to access the application's services and features.

Monetization Strategy:

- **Tiered Subscription Plans**:
  - **Basic Plan**: Includes essential features such as basic risk assessments and health tips.
  - **Standard Plan**: Offers more comprehensive risk predictions, personalized recommendations, and access to historical health data.
  - **Premium Plan**: Provides advanced analytics, continuous monitoring, integration with wearable devices, and priority support.

Benefits:

- Predictable and recurring revenue stream from subscription fees.
- Tailor subscription plans to cater to different user needs and affordability levels.
- Continuously update and enhance features to increase subscriber retention.

7.3 **Data Analytics and Insights**

Description: Aggregate and anonymize user data to provide insights and analytics to healthcare providers, research institutions, and pharmaceutical companies.

Monetization Strategy:

- **Data Licensing**:
    - License anonymized and aggregated data sets to researchers for clinical studies and medical research.
    - Provide insights and trends based on user demographics, risk profiles, and health behaviors.

Benefits:

- Generate revenue through data licensing agreements while maintaining user privacy and confidentiality.
- Contribute to medical research and advancements in cardiovascular health.
- Enhance the application's reputation as a valuable resource in the healthcare industry.

7.4 **Partnerships and Sponsorships**

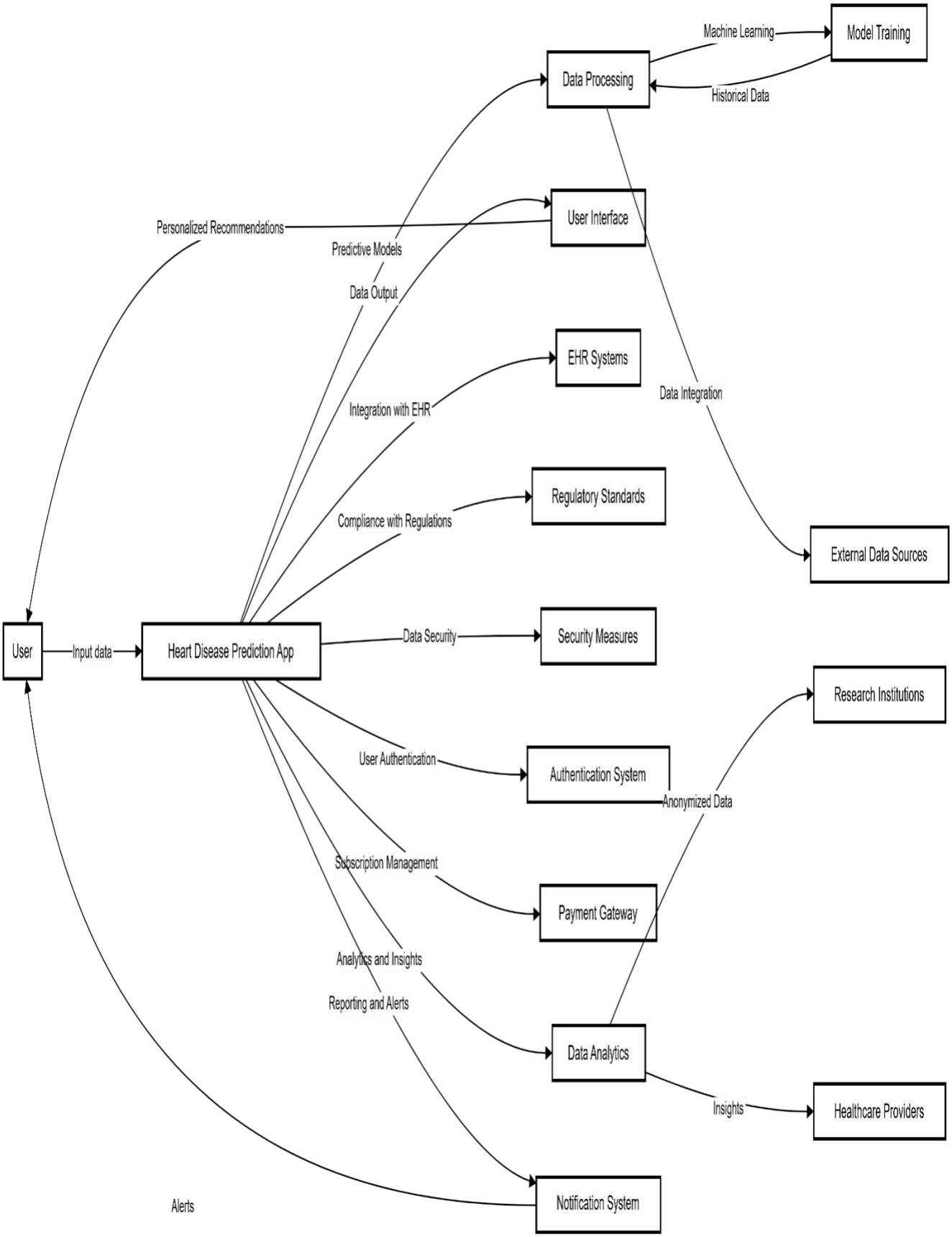
Description: Collaborate with healthcare providers, insurance companies, and wellness brands to offer co-branded services or sponsorships.

Monetization Strategy:

- **Healthcare Partnerships**:
    - Integrate the application with healthcare provider systems for seamless patient data exchange and referral programs.
    - Offer premium features as part of health insurance plans or corporate wellness programs.
- **Sponsorship Opportunities**:
    - Partner with pharmaceutical companies or health product manufacturers for sponsored content or promotional offers within the application.
    - Collaborate with fitness brands for integrated health and wellness solutions.

8.0 Final Product Prototype (abstract) with Schematic Diagram

The heart disease prediction application prototype leverages advanced machine learning algorithms to provide personalized risk assessments for cardiovascular diseases. Designed to be user-friendly and secure, the application integrates seamlessly with electronic health records (EHR) systems, offering valuable insights to both healthcare providers and patients. The prototype includes essential functionalities such as data processing, predictive analytics, user authentication, and compliance with regulatory standards.


Machine Learning
Model Training
Data Processing
Historical Data
User Interface
Personalized Recommendations
Predictive Models
Data Output
EHR Systems
Integration with EHR
Data Integration
Regulatory Standards
Compliance with Regulations
External Data Sources
User
Input data
Heart Disease Prediction App
Data Security
Security Measures
Research Institutions
User Authentication
Authentication System
Anonymized Data
Subscription Management
Payment Gateway
Analytics and Insights
Reporting and Alerts
Data Analytics
Insights
Healthcare Providers
Alerts
Notification System

9.0 Product Details

9.1 Product Overview

The heart disease prediction application is a comprehensive digital health tool designed to assess the risk of cardiovascular diseases using advanced machine learning algorithms. It aims to provide early detection and personalized recommendations, enhancing preventive care and improving patient outcomes. The application is user-friendly, secure, and integrates seamlessly with electronic health records (EHR) systems.

9.2 Key Features

- User Interface (UI): Intuitive and accessible design for users to input data, view results, and receive recommendations.
- Data Processing: Utilizes machine learning models to analyze user data and predict heart disease risk.
- Machine Learning Models: Trained on historical data and continuously updated with new data from external sources.
- Integration with EHR: Seamless data exchange with electronic health records systems for comprehensive patient profiles.
- Security Measures: Implements robust security protocols to protect user data and ensure compliance with healthcare regulations.
- User Authentication: Manages user access and authentication to maintain data privacy and security.
- Subscription Management: Offers tiered subscription plans with a payment gateway for managing user subscriptions.
- Data Analytics & Insights: Provides anonymized data and insights to research institutions and healthcare providers.
- Notification System: Sends alerts and notifications to users based on predictive analytics.

9.3 Functional Components

1. User Interface:
    - User-friendly design for easy data input and result visualization.
    - Displays personalized recommendations and health tips.

2. Data Processing Module:
    - Collects and processes user data.
    - Utilizes machine learning models to generate risk assessments.
3. Machine Learning Models:
    - Predictive models trained on extensive historical data.
    - Continuously updated with new data from external sources.
4. Integration Layer:
    - Facilitates seamless integration with EHR systems.
    - Ensures comprehensive patient data is available for analysis.
5. Security Measures:
    - Encrypts user data to ensure privacy.
    - Implements access controls and security protocols.
6. User Authentication:
    - Manages user login and authentication.
    - Ensures only authorized access to user data.
7. Subscription Management:
    - Handles subscription plans and payments.
    - Provides access to premium features for subscribers.
8. Data Analytics & Insights:
    - Analyzes aggregated data to generate insights.
    - Provides anonymized data to researchers and healthcare providers.
9. Notification System:
    - Sends real-time alerts and notifications to users.
    - Informs users about their health status and necessary actions.

9.4 Technical Specifications

- Backend: Python with Django framework for building the application server and handling data processing.
- Machine Learning: Scikit-learn, TensorFlow, or PyTorch for developing and deploying predictive models.
- Database: PostgreSQL or MySQL for secure and efficient data storage.
- Frontend: React.js or Angular.js for a responsive and interactive user interface.

- Security: SSL/TLS for data encryption, OAuth for authentication, and compliance with HIPAA and GDPR.
- API Integration: RESTful APIs for integration with EHR systems and external data sources.
- Cloud Services: AWS, Google Cloud, or Azure for scalable and reliable cloud infrastructure.

9.5 User Experience

- Personalized Experience: Tailored health recommendations based on individual risk profiles.
- Ease of Use: Simple and intuitive interface for users of all ages and technical proficiencies.
- Real-time Feedback: Instant access to risk assessments and health tips.
- Comprehensive Health Monitoring: Continuous monitoring and updates on heart health status.

9.6 Development Roadmap

1. Phase 1: Planning and Research
    - Identify key requirements and use cases.
    - Conduct market research and competitive analysis.
2. Phase 2: Design and Prototyping
    - Design UI/UX for the application.
    - Develop a prototype for initial testing.
3. Phase 3: Development
    - Implement backend and frontend components.
    - Develop and train machine learning models.
4. Phase 4: Integration and Testing
    - Integrate with EHR systems and external data sources.
    - Conduct extensive testing to ensure accuracy and security.
5. Phase 5: Deployment and Launch
    - Deploy the application on cloud infrastructure.
    - Launch the application and initiate marketing efforts.
6. Phase 6: Maintenance and Updates
    - Monitor application performance and user feedback.

- Release regular updates and improvements.

10.0 Code Implementation

```
import streamlit as st
import pandas as pd
import numpy as np
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score, classification_report
# Optionally, you can add more eded
import streamlit as st
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

# Load the heart disease dataset (you can replace this with your dataset)
data = pd.read_csv("heart (1).csv")

# Create a Streamlit web app

# Split the data into features and target
X = data.drop('target', axis=1)
y = data['target']

# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Train a RandomForestClassifier (you can replace this with your model)
clf = RandomForestClassifier(n_estimators=100, random_state=42)
clf.fit(X_train, y_train)

# Create a Streamlit web app
st.title("Heart Disease Prediction App")
st.image("https://th.bing.com/th/id/R.89f518358227a5ab591a63e971b4b9b5?rik=%2fff3CI6%2b
vmpElw&riu=http%3a%2f%2fwww.interactive-biology.com%2fwp-
content%2fuploads%2f2012%2f05%2fIllustration-of-the-Human-
heart.jpg&ehk=%2f2une2rnSa4SqFSShHlRkGAPR%2br1m1FFeZo9VhhReiA%3d&risl=&pid=
ImgRaw&r=0", width=300, caption="Heart Disese ")
```

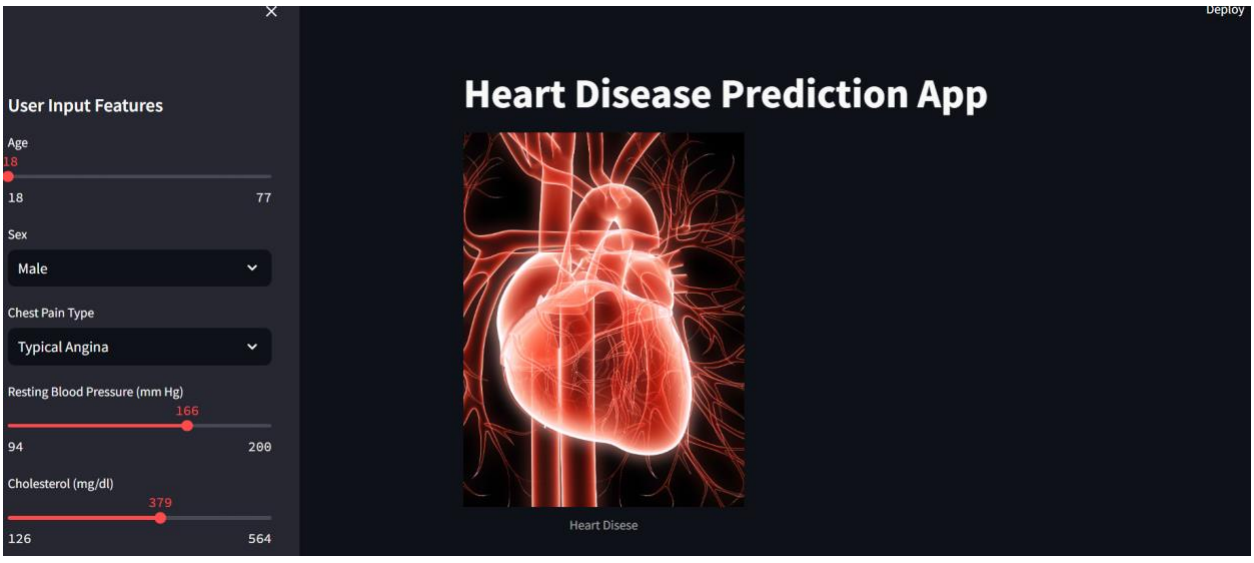
```
st.subheader("CSV File Viewer")
if st.button("Show DATA FILE"):
# Display the CSV data in a table format
  st.dataframe(data)
# Add a sidebar with user input parameters
st.sidebar.header("User Input Features")

def user_input_features():
    age = st.sidebar.slider("Age", 29, 77, 18,2)
    sex = st.sidebar.selectbox("Sex", ["Male", "Female"])
     cp = st.sidebar.selectbox("Chest Pain Type", ["Typical Angina", "Atypical Angina", "Non-Anginal Pain", "Asymptomatic"])
    trestbps = st.sidebar.slider("Resting Blood Pressure (mm Hg)", 94, 200, 130)
    chol = st.sidebar.slider("Cholesterol (mg/dl)", 126, 564, 240)
    fbs = st.sidebar.selectbox("Fasting Blood Sugar > 120 mg/dl", ["No", "Yes"])
    restecg = st.sidebar.selectbox("Resting Electrocardiographic Results", ["Normal", "ST-T Wave Abnormality", "Left Ventricular Hypertrophy"])
    thalach = st.sidebar.slider("Maximum Heart Rate Achieved", 71, 202, 150)
    exang = st.sidebar.selectbox("Exercise Induced Angina", ["No", "Yes"])
    oldpeak = st.sidebar.slider("ST Depression Induced by Exercise Relative to Rest", 0.0, 6.2, 1.0)
     slope = st.sidebar.selectbox("Slope of the Peak Exercise ST Segment", ["Upsloping", "Flat", "Downsloping"])
    ca = st.sidebar.slider("Number of Major Vessels Colored by Fluoroscopy", 0, 4, 1)
      thal = st.sidebar.selectbox("Thalassemia Type", ["Normal", "Fixed Defect", "Reversible Defect"])



    sex = 1 if sex == "Male" else 0
    fbs = 1 if fbs == "Yes" else 0
    exang = 1 if exang == "Yes" else 0

    cp_encoded = 0  # Initialize as 0
    if cp == "Atypical Angina":
        cp_encoded = 1
    elif cp == "Non-Anginal Pain":
        cp_encoded = 2
    elif cp == "Asymptomatic":
        cp_encoded = 3
```

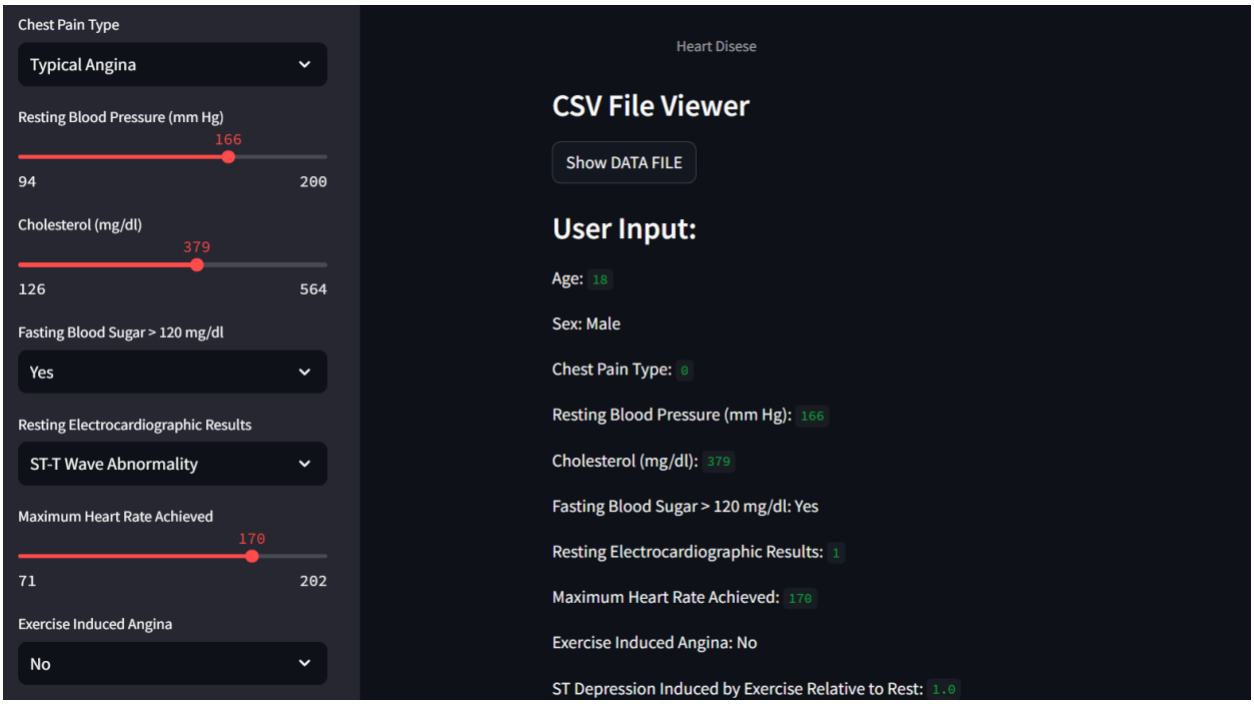
```
    restecg_encoded = 0  # Initialize as 0
    if restecg == "ST-T Wave Abnormality":
        restecg_encoded = 1
    elif restecg == "Left Ventricular Hypertrophy":
        restecg_encoded = 2

    slope_encoded = 0  # Initialize as 0
    if slope == "Flat":
        slope_encoded = 1
    elif slope == "Downsloping":
        slope_encoded = 2

    thal_encoded = 0  # Initialize as 0
    if thal == "Fixed Defect":
        thal_encoded = 1
    elif thal == "Reversible Defect":
        thal_encoded = 2

     return [age, sex, cp_encoded, trestbps, chol, fbs, restecg_encoded, thalach, exang, oldpeak, slope_encoded, ca, thal_encoded]

user_input = user_input_features()

# Display the user inputs
st.subheader("User Input:")
# st.subheader("Age :")
st.write("Age:", user_input[0])
st.write("Sex:", "Male" if user_input[1] == 1 else "Female")
st.write("Chest Pain Type:", user_input[2])
st.write("Resting Blood Pressure (mm Hg):", user_input[3])
st.write("Cholesterol (mg/dl):", user_input[4])
st.write("Fasting Blood Sugar > 120 mg/dl:", "Yes" if user_input[5] == 1 else "No")
st.write("Resting Electrocardiographic Results:", user_input[6])
st.write("Maximum Heart Rate Achieved:", user_input[7])
st.write("Exercise Induced Angina:", "Yes" if user_input[8] == 1 else "No")
st.write("ST Depression Induced by Exercise Relative to Rest:", user_input[9])
st.write("Slope of the Peak Exercise ST Segment:", user_input[10])
st.write("Number of Major Vessels Colored by Fluoroscopy:", user_input[11])
st.write("Thalassemia Type:", user_input[12])
# Sample dataset (you can replace this with your own dataset)
```

```
data = pd.read_csv("heart (1).csv")

# Create a Streamlit web app
st.title("Feature Visualization")
st.header("Visualization of Selected Feature")
# Display the first few rows of the dataset
st.subheader("Sample Data")
st.write(data.head())

#Sidebar to select features
selected_feature = st.sidebar.selectbox("Select a Feature to Visualize", data.columns)

   # Sidebar to choose plot type
plot_type = st.sidebar.radio("Select Plot Type", ["Histogram", "Bar Plot", "Box Plot", "Scatter Plot"])

# Visualize the selected feature
if plot_type == "Histogram":
   st.subheader("Histogram")
   fig, ax = plt.subplots(figsize=(8, 6))
   sns.histplot(data=data, x=selected_feature, bins=20, kde=True, ax=ax)
   st.pyplot(fig)

elif plot_type == "Bar Plot":
   st.subheader("Bar Plot")
   fig, ax = plt.subplots(figsize=(8, 6))
   sns.countplot(data=data, x=selected_feature, ax=ax)
   st.pyplot(fig)

elif plot_type == "Box Plot":
   st.subheader("Box Plot")
   fig, ax = plt.subplots(figsize=(8, 6))
   sns.boxplot(data=data, x=selected_feature, y="age", ax=ax)
   st.pyplot(fig)

elif plot_type == "Scatter Plot":
   st.subheader("Scatter Plot")
   fig, ax = plt.subplots(figsize=(8, 6))
   sns.scatterplot(data=data, x="age", y=selected_feature, hue="trestbps", ax=ax)
   st.pyplot(fig)
```

```
# Predict the target using the trained model
prediction = clf.predict([user_input])

st.subheader("Prediction:")
if st.button("Predict ") :
  if prediction[0] == 0:
    st.success("Prediction Sucessfull")
    st.write("No Heart Disease")
  elif prediction[0] == 1:
    st.success("Prediction Sucessfull")
    st.write("Heart Disease")

# Display model performance
st.subheader("Model Performance:")
y_pred = clf.predict(X_test)
accuracy = accuracy_score(y_test, y_pred)
st.write("Accuracy:", accuracy)
st.write("Classification Report:")
st.write(classification_report(y_test, y_pred))

st.subheader("Made By DEEPAK KUAMR")

# Add more visualizations as needed
```

Output:





	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca
0	52	1	0	125	212	0	1	168	0	1	2	2
1	53	1	0	140	203	1	0	155	1	3.1	0	0
2	70	1	0	145	174	0	1	125	1	2.6	0	0
3	61	1	0	148	203	0	1	161	0	0	2	1
4	62	0	0	138	294	1	1	106	0	1.9	1	3
5	58	0	0	100	248	0	0	122	0	1	1	0
6	58	1	0	114	318	0	2	140	0	4.4	0	3
7	55	1	0	160	289	0	0	145	1	0.8	1	1
8	46	1	0	120	249	0	0	144	0	0.8	2	0
9	54	1	0	122	286	0	0	116	1	3.2	1	2

Feature Visualization

Visualization of Selected Feature

Sample Data

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca
0	52	1	0	125	212	0	1	168	0	1	2	2
1	53	1	0	140	203	1	0	155	1	3.1	0	0
2	70	1	0	145	174	0	1	125	1	2.6	0	0
3	61	1	0	148	203	0	1	161	0	0	2	1
4	62	0	0	138	294	1	1	106	0	1.9	1	3

Chest Pain Type

Typical Angina

Resting Blood Pressure (mm Hg)

166

94 200

Cholesterol (mg/dl)

379

126 564

Fasting Blood Sugar > 120 mg/dl

Yes

Resting Electrocardiographic Results

ST-T Wave Abnormality

Maximum Heart Rate Achieved

170

71 202

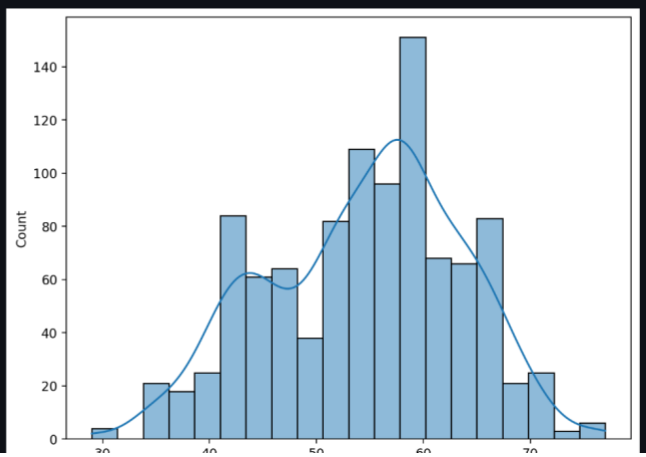
Exercise Induced Angina

No

Deploy

4	62	0	0	138	294	1	1	106	0	1.9	1	3

Histogram



ST Depression Induced by Exercise Relative to Rest

1.00

0.00 6.20

Slope of the Peak Exercise ST Segment

Upsloping

Number of Major Vessels Colored by Fluoroscopy

3

0 4

Thalassemia Type

Normal

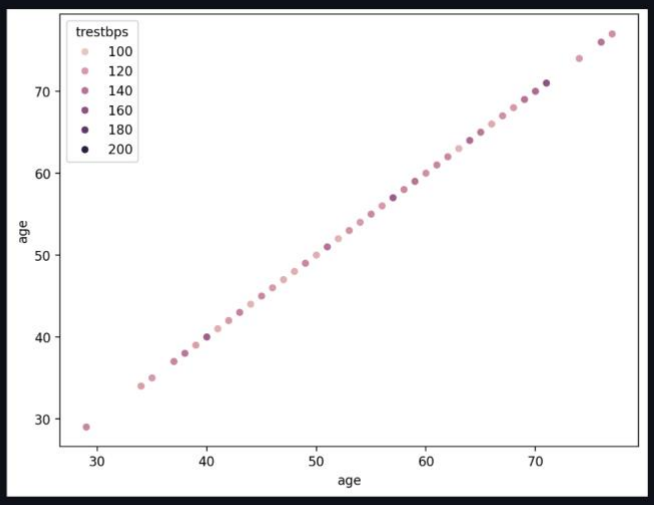
Select a Feature to Visualize

age

Select Plot Type

- Histogram
- Bar Plot
- Box Plot
- Scatter Plot

Deploy



Prediction:

1.00

0.00 6.20

Slope of the Peak Exercise ST Segment

Upsloping

Number of Major Vessels Colored by Fluoroscopy

1

0 4

Thalassemia Type

Normal

Select a Feature to Visualize

age

Select Plot Type

- Histogram
- Bar Plot
- Box Plot
- Scatter Plot

Prediction:

Predict

Prediction Sucessfull

No Heart Disease

Model Performance:

Accuracy: 0.9853658536585366

Classification Report:

precision recall f1-score support

```
0       0.97      1.00      0.99       102
       1       1.00      0.97      0.99       103

accuracy                           0.99       205
```

macro avg 0.99 0.99 0.99 205 weighted avg 0.99 0.99 0.99 205

Made By DEEPAK KUMAR

11.0 Conclusion

The heart disease prediction application is a groundbreaking tool designed to transform preventive healthcare through the power of machine learning and advanced data analytics. By offering personalized risk assessments, early detection, and tailored health recommendations, the application empowers users to take proactive steps in managing their cardiovascular health.

The integration with electronic health records (EHR) systems ensures a comprehensive and seamless exchange of medical data, enhancing the accuracy of predictions and supporting healthcare providers in clinical decision-making. With robust security measures and strict adherence to regulatory standards, the application safeguards user data, maintaining trust and compliance in the healthcare domain.

From a business perspective, the application's monetization model through subscription plans provides a sustainable revenue stream while offering users access to premium features. The inclusion of data analytics and insights offers valuable contributions to research institutions and healthcare providers, driving advancements in cardiovascular health research and care.

Overall, the heart disease prediction application is poised to make a significant impact on public health by improving early detection, facilitating preventive measures, and ultimately reducing the incidence of heart disease. Through continuous innovation and user-centric design, this application stands as a vital tool in the fight against cardiovascular diseases, promoting healthier lifestyles and better health outcomes for users worldwide.