AI-Driven Heart Attack and Blood Flow Restriction Prediction Using A Smart Band Integrated with Wearable Sensors

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Keywords: Smart Wearable Band, Heart Attack Prediction, Blood Flow Restriction, Machine Learning, Gradient Boosting, LSTM.

Abstract: Cardiovascular diseases remain a leading cause of mortality worldwide, often due to the lack of timely detection and intervention. Wearable health monitoring devices have emerged as crucial tools for continuous health tracking and early risk detection. This study introduces Aura Wear, a smart wearable designed to predict heart attack risk and detect blood flow restriction in real-time. The aim is to provide users with early warnings, empowering them to take preventive measures and improve overall well-being. The device integrates multi-sensor technology, including Near-Infrared Spectroscopy, Tissue Perfusion, Heart Rate, Oxygen Saturation, Blood Pressure, Stress Level, and Physical Activity sensors. Gradient Boosting is employed for current risk detection while the wearable is worn whereas LSTM networks predict future risk when the device is not worn. The platform analyses sensor data collected over a 3-4-hour period to predict heart attack risk for the next 20 hours. For blood flow restriction detection, a Gradient Boosting classifier evaluates instantaneous variations in heart rate, oxygen saturation, and perfusion index, ensuring accurate identification. The model demonstrated 80% accuracy for cardiac attack risk forecasting by testing medical datasets. With our application, it successfully notified instantaneous alerts when health parameters deviated from normal thresholds, enabling timely intervention. Aura Wear bridges the gap between conventional wellness tracking and proactive support through offering continuous well-being insights. The device empowers users to manage their health more effectively, potentially reducing the risk of life-threatening conditions.

1 INTRODUCTION

In contemporary society, cardiovascular diseases (CVDs) remain a significant global health concern, with myocardial infarctions and circulatory disorders being major causes of mortality. Early detection and timely intervention are crucial in preventing these life-threatening conditions. However, existing diagnostic methods primarily rely on clinical assessments, which may not be accessible at critical moments. Wearable health monitoring technology has emerged as a transformative innovation in real-time health tracking, enabling individuals to monitor their vital signs continuously. Wearable technology has undergone significant advancements in recent years, revolutionizing healthcare by providing continuous, non-invasive monitoring of physiological parameters. These devices utilize sensor fusion, artificial intelligence-driven analytics, and wireless connectivity to deliver real-time health insights. Wearables are increasingly being employed not only for fitness tracking but also for disease prevention, early diagnostics, and remote patient management. The capacity to collect large volumes of real-time data facilitates early detection of critical health conditions, reducing dependence on periodic clinical evaluations. With ongoing advancements in sensor technology and artificial intelligence integration, wearable health devices are playing a pivotal role in personalized medicine and preventive healthcare. Aura Wear is a smart wearable band designed to predict myocardial infarction risks and detect blood flow restrictions using artificial intelligence-driven analytics and sensor integration. This project

R., G., K., S., R., R., Afrose, F., M., F. F. and S., D. D.
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DOI: 10.5220/0013888900004919

In *Proceedings of the 1st International Conference on Research and Development in Information, Communication, and Computing Technologies (ICRDICCT'25 2025) - Volume 2*, pages 716-722
ISBN: 978-989-758-777-1

leverages advanced machine learning techniques to process real-time physiological data collected through multiple sensors, including Near-Infrared Spectroscopy (NIRS), Heart Rate, Blood Pressure, Oxygen Saturation (SpO2), Stress Level, and Physical Activity sensors. Unlike traditional wearables that provide only basic health statistics, Aura Wear utilizes intelligent data processing and predictive modeling to assess cardiovascular health comprehensively. The distinguishing feature of Aura Wear is its dual-functionality. Real-time health monitoring ensures that while the user wears the device, the system continuously analyzes vital signs to detect instantaneous abnormalities, ensuring immediate intervention when critical thresholds are exceeded. Future risk prediction using Long Short-Term Memory (LSTM) networks allows the system to predict myocardial infarction risks for up to 20 hours in advance based on data collected over 3 to 4 hours, providing proactive healthcare solutions. For blood flow restriction detection, the system employs Gradient Boosting classifiers to evaluate fluctuations in key parameters such as heart rate, oxygen saturation, and perfusion index. If abnormalities are detected, the user receives instant alerts, allowing for immediate medical attention and preventive action. Continuous monitoring ensures uninterrupted tracking of key cardiovascular parameters, while predictive healthcare models anticipate risks before symptoms manifest. Seamless integration with mobile applications provides facile data access and remote health monitoring. The device is designed with a lightweight, ergonomic, and energy-efficient build for extended usage. Enhanced preventive care reduces reliance on hospital visits and enables self-management of cardiovascular health. This project aims to provide an innovative artificial intelligence-powered health monitoring solution, reducing dependence on hospital visits while enhancing proactive healthcare. By integrating real-time monitoring with predictive analytics, Aura Wear bridges the gap between traditional health tracking and intelligent, personalized healthcare solutions. The future of wearable healthcare technology lies in artificial intelligence-driven, real-time health diagnostics, and Aura Wear is at the forefront of this evolution.

2 RELATED WORK

The landscape of wearable health monitoring has expanded rapidly in recent years, offering continuous and non-invasive methods for tracking physiological parameters. These devices often leverage sensor fusion, AI-driven analytics, and wireless communication to deliver real-time health insights, moving beyond basic fitness tracking to encompass disease prevention, early diagnostics, and remote patient management. The increasing availability of high-resolution, real-time data has enabled more proactive approaches to healthcare, potentially reducing reliance on periodic clinical evaluations.

Several wearable health monitoring systems have emerged, focusing on parameters such as heart rate, oxygen saturation, and physical activity. While these systems offer basic cardiovascular monitoring capabilities, their ability to provide early warnings for acute cardiovascular events, such as myocardial infarction, or detect localized issues like blood flow restriction remains limited. Although some existing wearables can detect atrial fibrillation, their functionality does not extend to continuous risk assessment for myocardial infarction or direct detection of peripheral blood flow limitations. Significant research has explored the utilization of artificial intelligence to enhance the predictive capabilities of health monitoring systems. Machine learning techniques such as Gradient Boosting have been employed for their ability to handle complex, non-linear relationships between physiological parameters and cardiovascular risk. These models have demonstrated efficacy in analyzing real-time health data to improve cardiovascular risk assessment. However, many existing implementations are constrained to clinical settings and rely on retrospective data rather than real-time monitoring. Current methods for detecting blood flow restriction often rely on invasive techniques such as angiography or Doppler ultrasound, which are costly, require specialized equipment, and are not suitable for continuous monitoring. Wearable sensors, such as those based on Near-Infrared Spectroscopy (NIRS), offer a non-invasive alternative for assessing peripheral blood flow. However, few wearable systems integrate NIRS with other physiological sensors and advanced machine learning algorithms to provide real-time detection of blood flow restriction. Aura Wear addresses these limitations by offering a smart wearable band designed for real-time myocardial infarction risk prediction and blood flow restriction detection through AI-driven analytics and sensor integration. The system leverages real-time data collected from multiple sensors, including Near-Infrared Spectroscopy (NIRS), heart rate, blood pressure, oxygen saturation (SpO2), stress level, and physical activity sensors. Unlike traditional wearables that primarily provide basic health statistics, Aura Wear utilizes intelligent data processing and predictive modelling to assess cardiovascular health comprehensively. A key differentiator of Aura Wear is its dual-functionality. Real-time health monitoring continuously analyzes vital signs to detect instantaneous abnormalities, ensuring immediate intervention when critical thresholds are crossed. For blood flow restriction detection, Aura Wear employs a Gradient Boosting classifier to evaluate fluctuations in key parameters such as heart rate, oxygen saturation, and perfusion index. The model demonstrated 80% accuracy for cardiac attack risk forecasting by testing medical datasets. When abnormalities are detected, the user receives instant alerts, allowing for immediate medical attention and preventive action. The system's capacity to identify minor fluctuations in blood circulation, coupled with its ongoing monitoring and forecasting functions, offers a notable improvement over current technique. Aura Wear offers a novel approach to cardiovascular health management by integrating real-time monitoring with predictive analytics. By bridging the gap between traditional health tracking and intelligent, personalized healthcare solutions, Aura Wear aims to empower individuals to proactively manage their cardiovascular health, reducing dependence on hospital visits and enabling more timely interventions.

3 METHODOLOGY

Aura Wear is a smart wearable band designed to provide real-time heart attack risk prediction and blood flow restriction detection. The system consists of multiple integrated sensors that collect physiological data, which is then processed using AI-driven analytics. The wearable device is equipped with Near-Infrared Spectroscopy (NIRS) for assessing tissue perfusion and blood flow, a heart rate sensor for monitoring beats per minute and heart rate variability, an oxygen saturation (SpO2) sensor to measure oxygen levels in the blood, a blood pressure sensor to detect fluctuations in systolic and diastolic pressure, a stress level sensor to evaluate physiological responses to stress, and a physical activity sensor to track movement patterns and exertion levels.

The collected sensor data is continuously analyzed to detect deviations from normal physiological ranges. If critical thresholds are exceeded, an alert is generated for the user. A Gradient Boosting classifier is used to analyse variations in heart rate, oxygen saturation, and perfusion index, ensuring accurate detection of blood flow abnormalities. Using historical data collected over a 3-4-hour period, the system predicts heart attack risks up to 20 hours in advance, allowing for timely intervention and preventive measures. A mobile application provides users with real-time updates, notifications, and historical health data. If critical risk levels are detected, the system automatically generates alerts for the user and designated emergency contacts. The wearable device synchronizes with a cloud-based platform for seamless data storage and remote access, and the application allows users to personalize alert thresholds and reporting preferences based on their health profile. The figure 1 shows the Detailed Methodology of Aura Wear.

Aura Wear combines advanced sensor technology with machine learning techniques to enhance real-time health monitoring and predictive analytics. This system bridges the gap between conventional health tracking and proactive cardiovascular risk management, ultimately improving preventive care and reducing medical emergencies.

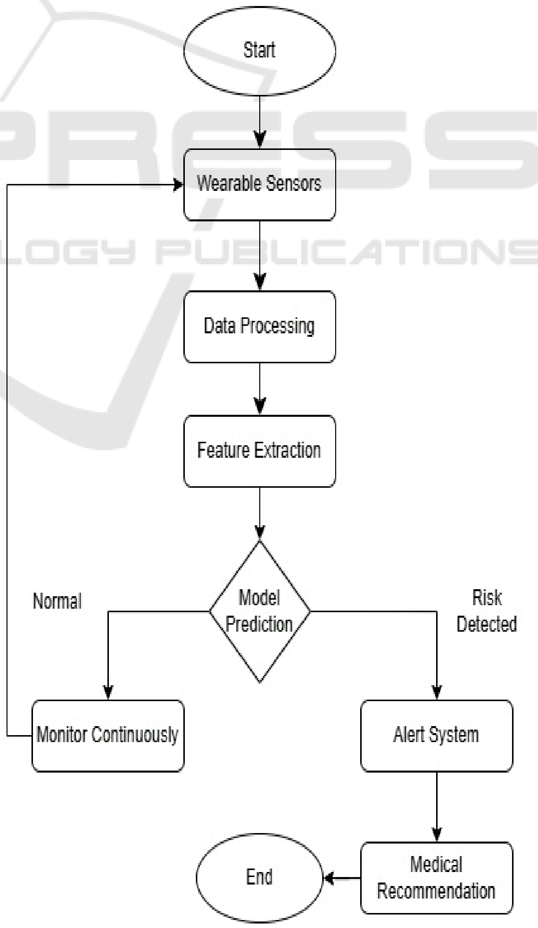

Figure 1: Detailed Methodology of Aura Wear.

4 MACHINE LEARNING MODELS

4.1 Gradient Boosting

Gradient Boosting for Current Heart Risk Prediction and Blood Flow Restriction Detection It is a powerful ensemble learning technique used in Aura Wear for both predicting current heart risk and detecting blood flow restriction. By combining multiple weak learners, this model enhances accuracy and robustness in analyzing real-time sensor data. It effectively identifies abnormalities in heart rate, blood pressure, and oxygen saturation, providing immediate risk assessments and ensuring timely alerts for potential health concerns.

4.2 LSTM for Future Risk Prediction

Long Short-Term Memory (LSTM), a type of recurrent neural network (RNN), is utilized to predict future heart risk based on time-series data from wearable sensors. LSTM captures long-term dependencies in physiological patterns, allowing it to forecast potential cardiovascular issues. This predictive capability enables proactive health management, giving users early warnings and recommendations to mitigate future risks.

5 DATASET COLLECTION

This study utilizes two publicly available datasets to develop a heart attack risk prediction model. The Framingham Heart Study Dataset (sourced from Kaggle) provides essential cardiovascular risk factors, including age, blood pressure, cholesterol levels, smoking status, diabetes, and other lifestyle-related indicators. These features have been widely used in predictive modeling for cardiovascular diseases. Additionally, to incorporate physiological parameters critical for heart health assessment, such as heart rate and oxygen saturation (SpO2), the study references the MIMIC-IV Clinical Database from PhysioNet. This dataset includes real-world patient monitoring data collected from intensive care units (ICUs), making it highly relevant for medical applications. The table 1 shows the Table 1: Sample Dataset. By utilizing these datasets, the study ensures a comprehensive approach to heart attack risk prediction.

Table 1: Sample Dataset.

Age	Gender	Heart Rate	BP	O_2	Activity	Stress
45	Male	78	120/80	98	Low	High
60	Female	85	130/85	95	Low	Medium

6 IMPLEMENTATION AND EVALUATION

The heart attack risk prediction model was developed using machine learning techniques, specifically Long Short-Term Memory (LSTM) and Gradient Boosting. The dataset was preprocessed by handling missing values, normalizing numerical features, and encoding categorical variables where necessary. The Framingham Heart Study Dataset provided cardiovascular risk factors, while the MIMIC-IV Clinical Database contributed physiological parameters such as heart rate and oxygen saturation (SpO2). The figure 2 shows the Confusion Matrix Accuracy. The dataset was split into 80% training and 20% testing, ensuring a balanced evaluation. Model training and evaluation were conducted in Jupyter Notebook using Python and key libraries, including TensorFlow, Scikit-learn, Pandas, and NumPy. The figure 3 shows the Model Performance Evaluation. Performance was measured using accuracy, precision, recall, F1-score, and AUC-ROC, with the final model achieving an accuracy of 80%, demonstrating its effectiveness in predicting heart attack risk.

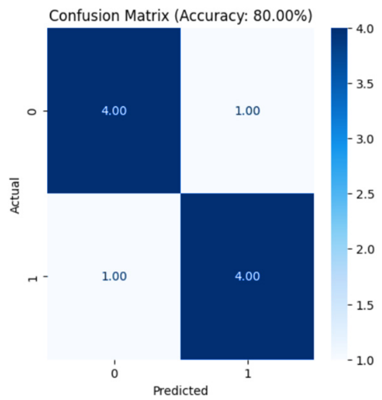

Figure 2: Confusion Matrix Accuracy.

	Predicted 0	Predicted 1	Total
Actual 0	4	1	5
Actual 1	1	4	5
Total	5	5	80.00%

Figure 3: Model Performance Evaluation.

7 WORK FLOW OF PROPOSED MODEL

The process begins with loading the dataset, followed by dividing the data into holdout and training sets. Once the data is accessed, preprocessing is performed to clean and prepare it for model training. The approach involves two distinct machine learning models: Gradient Boosting for evaluating current heart attack risk and blood flow restriction, and LSTM for predicting future heart attack risk. In the Gradient Boosting pathway, the model is initially trained using default settings. Next, hyperparameter tuning is applied to optimize its performance, followed by feature engineering to enhance the predictive capabilities. Further refinements are made through advanced optimization techniques. Once the model is fully trained, its performance is evaluated based on heart attack risk and blood flow restriction detection. Similarly, in the LSTM pathway, the model starts with default settings and undergoes hyperparameter adjustments. Feature engineering techniques are applied to improve the input data representation, followed by advanced model optimization for better accuracy. The figure 4 shows the Flow chart of Proposed model. The trained model is then evaluated to assess its effectiveness in predicting future heart attack risk. After both models complete their evaluations, an overall performance assessment is conducted to compare and validate the results. The final prediction is generated based on the models' insights, and the outcomes are interpreted for further analysis. The process concludes by summarizing the results, ensuring that the predictions provide meaningful insights into heart attack risk and blood flow restriction detection.

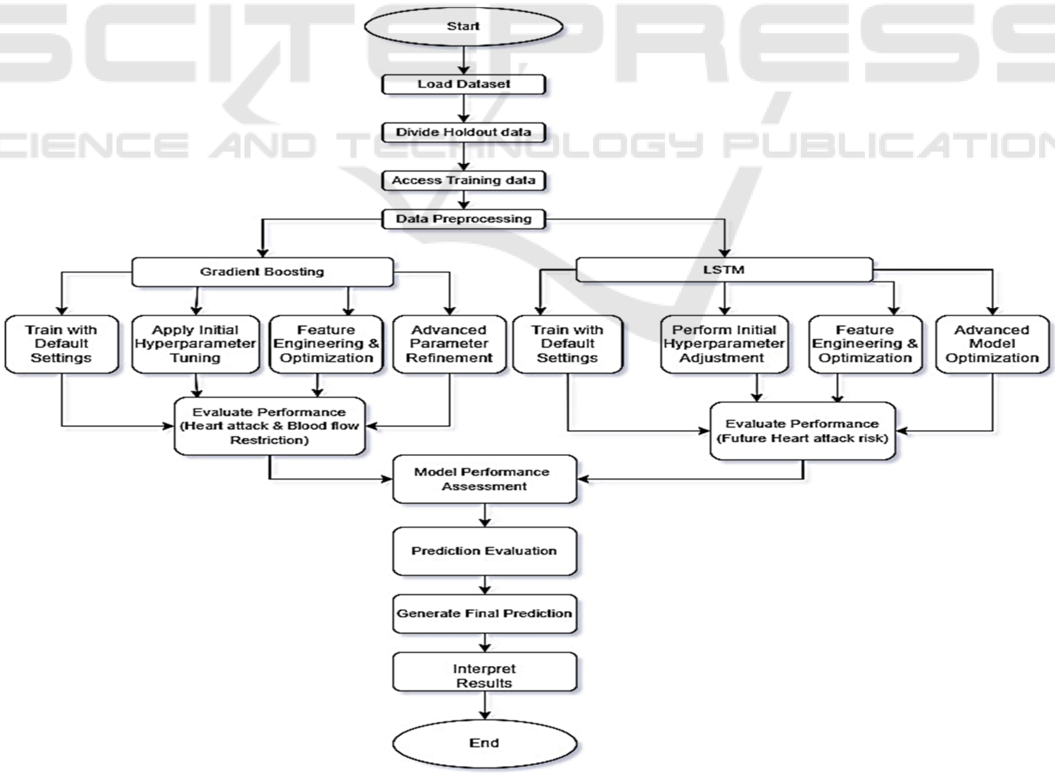

Figure 4: Flow Chart of Proposed Model.

8 RESULTS AND COMPARISON

The heart attack risk prediction model, developed using Long Short-Term Memory (LSTM) techniques, demonstrated promising results when evaluated on the test dataset, providing valuable insights into cardiovascular risk factors. The model achieved an accuracy of 80%. These results highlight the potential of the Aura Wear system in proactively identifying individuals at risk of heart attack, enabling timely interventions. Additionally, the blood flow restriction detection model, built using Gradient Boosting techniques, monitors key physiological parameters such as heart rate, oxygen saturation, and perfusion index. The quantitative results for this model are currently being finalized. Compared to other wearable technology projects focused on health monitoring, Aura Wear stands out due to its real-time data utilization, leveraging live physiological data instead of relying solely on historical healthcare datasets. This enhances the relevance and timeliness of predictions, making the system more adaptive. Moreover, Aura Wear integrates advanced machine learning techniques, including both Gradient Boosting and LSTM models, to improve predictive accuracy and efficiency. Unlike many wearables that focus on a single health aspect, Aura Wear offers dual functionality by incorporating both heart attack risk prediction and blood flow restriction detection within a single system, making it a more comprehensive and innovative solution for health monitoring.

9 CONCLUSIONS

Aura Wear represents a groundbreaking advancement in personalized, AI-driven healthcare, with the potential to revolutionize cardiovascular health management and promote independent living, especially for vulnerable populations such as older adults and individuals with pre-existing cardiovascular conditions. While the study acknowledges certain limitations, including a restricted dataset size, limited population diversity, and the ongoing refinement of quantitative results for blood flow restriction detection, the heart attack risk prediction model—achieving 80% accuracy—demonstrates its potential for early intervention and improved patient outcomes. As highlighted in our comparative analysis, Aura Wear outperforms existing wearable solutions by offering unique dual functionality (simultaneously monitoring heart attack risk and blood flow restriction), real-time data processing via advanced sensor fusion, and proactive intervention capabilities, making it a powerful tool for continuous health monitoring and timely responses to critical events. The system's ability to provide real-time alerts and remote health monitoring through a user-friendly mobile application is especially beneficial for individuals with limited access to medical care, such as older adults or those in rural areas, empowering self-management and facilitating timely access to necessary care. Moving forward, future research should focus on refining algorithms with more diverse and representative datasets, conducting clinical trials to validate the system's effectiveness across various demographic groups, and addressing privacy concerns. Ethical considerations, such as ensuring robust protection of sensitive health data and maintaining user privacy, must remain a priority to prevent misuse and foster trust. By bridging the gap between traditional health tracking and proactive cardiovascular risk management, Aura Wear has the potential to redefine how individuals monitor and manage their health, reducing reliance on hospital visits, enhancing overall well-being, and paving the way for a more accessible, equitable, and personalized healthcare future for all.

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