

CardioPredictor: An Intelligent IoT-Based Risk Prediction Model for Cardiovascular Disease in Low Resourced Environments

Cardiovascular diseases (CVDs) are the leading cause of mortality worldwide, with three-quarter of related deaths occurring in low- and middle-income countries. In Nigeria, the CVD mortality rate is 76.11%, and one-third of global CVD deaths occur prematurely in individuals under 70 years (WHO, 2023). Major risk factors include hypertension, obesity, inactivity, and smoking. Advances in machine learning (ML) and wearable technologies have created new opportunities for continuous monitoring and early detection, yet many existing models lack real-time deployment on embedded devices.

This work introduces CardioPredictor, an intelligent, low-power system for early CVD prediction and risk level classification using electrocardiogram (ECG) signals. The framework of the developed system integrates four stages: ECG data acquisition, ML-based classification, embedded hardware implementation, and real-time prediction. A publicly available ECG dataset containing 4,997 heartbeat samples (2,079 normal and 2,918 abnormal) was preprocessed and evaluated using seven supervised ML models: XGBoost, Support Vector Machine (SVM), K-Nearest Neighbour (KNN), Decision Tree, Naïve Bayes, Multilayer Perceptron (MLP), and Linear Discriminant Analysis (LDA). Stratified 10-fold cross-validation was used to preserve class balance, and the performance of the models was compared using accuracy, precision, recall, and F1-score.

All models achieved accuracies above 90%; however, XGBoost outperformed others, achieving 99.9% accuracy, 99.8% precision, 99.5% recall, and 99.4% F1-score. This model was therefore deployed onto an embedded microcontroller platform for real-time inference in low-resource settings. Testing confirmed diagnostic reliability, with predictions generated within 0.3 seconds and displayed on the OLED screen interface.

The results demonstrate the feasibility of deploying ML-based CVD risk prediction systems on low-power, wearable-friendly hardware. CardioPredictor has the potential to reduce diagnostic delays, improve access to preventive healthcare, and support clinical decision-making in resource-constrained environments.