GuardianLink: A Personalized Neuro-Cardiological Health-Monitoring System for Real-Time Heart Arrhythmia Detection, Prediction, and Analysis Through an Adaptive Machine Learning Framework With an ECG Necklace and Biometric Smartwatch

Ali, Adam (School: International Academy - Amman)
Abuelhumos, Kareem (School: International Academy - Amman)

Neurocardiological emergencies claim over 18 million lives every year. With out-of-hospital survival dropping 10% every delayed minute, intervening early is critical. However, generalized physiological baselines in current MedTech wearables and health-monitoring systems trigger false alarms over 80% of the time. This leads to unnecessary emergency visits, contributing to the $15-billion annual cost of hospital readmissions and penalties. To add, the adoption of clinical AI and ML models often faces the “black box” problem, where predictions lack clear physiological reasoning. This project introduces a cost-effective wearable ecosystem consisting of a biometric smartwatch, ECG necklace, and companion app. These devices collect biomedical data (heart rate, SpO2, sweat conductivity for electrodermal activity, ECG etc…) and detect neurocardiological emergencies in real time while predicting them 10 to 15 minutes before happening. The system uses an ML framework that processes ECG waveforms through a 1-dimensional convolutional neural network containing four models. Its main innovation is an EDA-informed personalized alerting approach: transfer learning establishes personalized baselines, while sweat conductivity provides physiological context to better distinguish true emergencies from non-dangerous anomalies such as athletic bradycardia or stress-related changes, thereby targeting false-alert reduction. To bridge the clinical trust gap, a heatmap with labels justifying the model’s outputs is displayed, and detailed explanations are also provided. Public PhysioNet databases, including MIT-BIH and the SDDB database, were used, achieving over 87.25% mean accuracy. The system is a step forward in accurate, personalized, and explainable monitoring of brain-heart axis health.

Awards Won: