Implementation and Validation of a Machine-Learning-Based Mobile Mechanocardiography System for Arrhythmia Detection

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Irregularities in heart rhythm, known as arrhythmias, are often indicative of cardiac diseases. Electrocardiograms (ECGs) are the standard method for detecting arrhythmias, recording electrical potential differences from cardiac muscle contractions. However, ECGs require time-consuming electrode preparation and complex signal processing techniques, limiting their accessibility outside of clinical settings. The widespread availability of mobile devices equipped with high-precision accelerometers and gyroscopes has facilitated the development of cardio-mechanical monitoring techniques such as seismocardiography (SCG) and gyrocardiography (GCG). These methods capture mechanical vibrations and movements associated with cardiac activity, presenting a non-invasive alternative to ECGs with simplified preparation and processing. This research implements and evaluates a machine-learning-based mobile application for arrhythmia detection using gyroscope and accelerometer readings from a smartphone placed on the sternum. Two publicly available datasets containing cardio-mechanical recordings from individuals with and without valvular heart diseases were obtained and preprocessed for machine learning training. A deep convolutional neural network (CNN) was developed to classify arrhythmic and healthy recordings through a probabilistic binary classification, achieving a 95% accuracy. The trained model was integrated into a cross-platform, Flutter-based mobile application for Android and iOS devices, enabling real-time sensor data acquisition and on-device arrhythmia detection. This application provides an intuitive interface for potential clinical validation, offering a cost-effective, non-invasive solution for early arrhythmia detection and cardiac health monitoring.

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