The Use of AI Algorithms to Automatically Identify Premature Atrial Contractions from Electrocardiogram Recordings

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Electrocardiograms (ECGs), which show a person's heartbeat patterns, are essential for identifying heart diseases hinted by arrhythmias. Some of these patterns can be detected using modern-day computer algorithms, but there is no commercially available algorithm for premature atrial contraction (PAC) detection. PACs are quickened heartbeat characterized by distorted/hidden P waves. These can be difficult to be detected reliably since ECGs can be noisy and PACs can often be mistaken as premature ventricular contractions (PVCs), another irregular heartbeat. While usually harmless, PACs in large quantities can lead to various heart problems. In this project, the student focused on developing an algorithm that can robustly detect PACs, and did the following: (1) downloaded ECG recordings from the MIT-BIH-Arrhythmia Database and developed a MATLAB computer program to observe them; (2) tried various detection methods based on observations and implemented them into the MATLAB program; (3) evaluated detection performance using detection sensitivity (Se) and positive predictivity (+P) for all applicable ECG recordings so the algorithm can be generic and patient-independent; (4) further improved the algorithm based on evaluation results. A PAC/PVC differentiation method was also created based on some architectural concept of a convolutional neural network to identify if a regular, distorted, or hidden P wave exists before each heartbeat, which significantly improved PAC detection accuracy. The final algorithm consists of an accurate heartbeat detection method (Se=98.6%, +P=99.3%) and a robust PAC detection method (Se=70.1%, +P=51.2%). This algorithm can reduce doctors’ times for analyzing ECGs and can be implemented in wearable devices to monitor patients' ECGs continuously.

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