Arrhythmia Detection Using Photoplethysmogram Signal; Can It Replace ECG signal?

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Introduction: Many arrhythmia cases, which may trigger sudden cardiac death (SCD), are often found in Indonesia. It is due to many hospitals in the country do not have arrhythmia detection equipment, such as Holter Monitors or 12 channels ECG Machine. Arrhythmia is a heart rhythm disorder that is characterised by changes in the speed and electrical signal pattern of the heart. Besides using Electrocardiogram (ECG), arrhythmia can also be detected using Photoplethysmogram (PPG). PPG visualize heart beat based on the principle of skin discolouration that is affected by blood pumped from or towards the heart.

Methods: Several stages to achieve the objectives of the research are as follows: 1. Make label on ECG and PPG data of MIMIC due to the data do not have labels whether normal or not (PVC and PAC). Several cardiologists from Saiful Anwar Hospital Malang Indonesia are involved in this stage to ensure the correctness of labelling process. MIMIC is a freely accessible critical care database from physionet that contains both PPG and ECG data. 2. Extract PAC and PVC features by measuring the distance of the peak to the peak (PP) of the PPG data. The above method is validated by comparing the PP of PPG with the RR interval of the corresponding ECG signal. 3. Classify the features data using Artificial Neural Network (ANN)-based multi-class classification for detecting Normal, PAC and PVC.

Result: Rigorous experiments to detect Normal, PAC and PVC have been performed on the data. The performance analysis on the detection method is also been done, which is validated by dividing training and testing dataset in 10-Fold Cross Validation. Using the method above, the detection accuracy on both training and testing stages are 75% and 84.09%, respectively. While the specificity of the detection is 84.10%.

Conclusion: PPG signal perform well enough to detect arrhythmia. The sensitivity and specificity 84.09% and 84.10% respectively. Its clinical use may not replace basic ECG, but can be used in general population or early screening for cardiac arrhythmia. Especially its combination with wearable or mobile device.