A Fusion of Handcrafted Features and Deep Learning Classifiers for Heart Murmur Detection

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Accurate, automatic heart auscultation for diagnosis of cardiovascular diseases has potential to support health outcomes, especially in areas with limited access to effective healthcare. The proposed method for heart murmur detection consists of a decision fusion between two models.

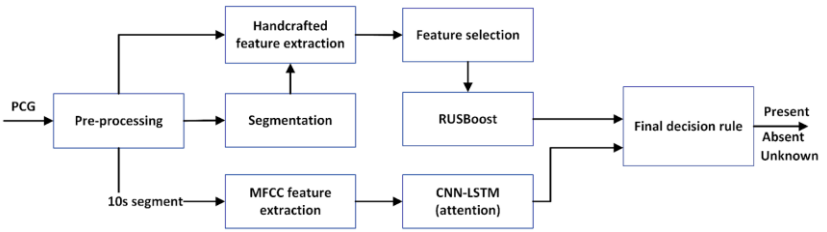

Fig. 1 Overview of the proposed method. CNN-LSTM= Convolutional Neural Network - Long Short-Term Memory, MFCC= Mel-Frequency Cepstral Coefficient, PCG= Phonocardiogram, RUSBoost= Random Undersampling Boosting.

The first model is an efficient Convolutional Neural Network (CNN) that takes unsegmented phonocardiograms (PCG), with Long-Short Term Memory (LSTM). second model takes handcrafted features and innately deals with class imbalance. Before extraction, the PCG recordings were segmented using modified Hidden Semi Markov Model with heart-rate range adjusted to patient's age group. Features representing sound quality, temporal, spectral, autocorrelation, wavelet and statistical features were extracted. The 1636 handcrafted features were normalized and ranked using Minimum Redundancy Maximum Relevance. The top 50 features and three voting methods were assessed via 10-fold cross validation. The most effective voting method was if murmur detected in any recording, the patient classifies as murmur present, else perform majority voting. In patient-wise 10-fold cross validation, and evaluated using the competition score, the deep learning model scored mean ± standard deviation of 849±380 and the hand-crafted feature method scored 581±80. The submitted entry based on deep learning (CNN-LSTM with attention mechanism) achieved an unofficial score of 1315 (Team: Melbourne_Kangas). The fusion of this method, shown in Fig 1, with the feature-based classifier will be submitted to the challenge in the official phase as a cost-effective classifier algorithm for heart murmur detection.