

Multichannel ECG Classification using Parallel CNN and GAP with Patient Specific Features

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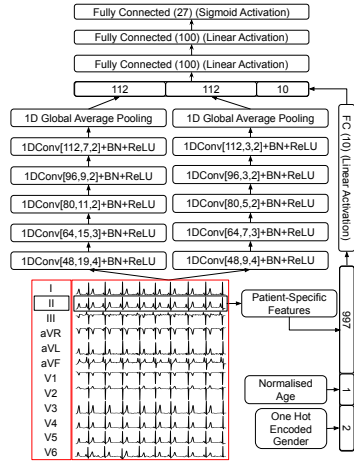
Introduction: Early and correct diagnosis of cardiac arrhythmias present in Multichannel Electrocardiogram (MECG) is a challenging problem. The CinC 2021 Challenge classifies 27 cardiac rhythms using all or reduced MECG.

Method: The model composed of 5 cascaded 1D-convolution layers (filters, filter size, stride), batch normalization, and ReLU activation followed by Global Average Pooling layer (PCNNGAP) in parallel uses MECG, age, gender, and patient-specific features (PSF). The MECG is decluttered from baseline wander and powerline interference followed by resampling to 500 Hz and segmentation. Since, Lead II is common in all/reduced lead sets, R-peaks are extracted from it using Pan Tompkins detector to obtain PSF such as Heart rate, RR Intervals, Mean QRS Amplitude, and beat level features such as Hermite polynomial coefficients, Skewness, Kurtosis, and Amplitude Based Features.

PCNNGAP extracts local and global patterns present in MECG using small and large kernels. GAP calculates spatial average of filters and replaces flatten and fully connected (FC) layer with no additional trainable parameters leading to faster training, less overfitting, and reduced model size. GAP outputs are fused with encoded features followed by 3 FC layers for classification.

Result: Our team “skylark” achieved scores of 0.51, 0.33, 0.5, and 0.48 with rank 33, 62, 28, and 32 for 12, 6, 3, and 2 lead ECG according to the leaderboard. 5 Fold CV results on challenge metric (CM) are provided in Table 1.

Conclusion: The PCNNGAP model with feature fusion performed well for all leads except 6-Lead model. We are currently adding lead dropouts, implementing CM as a loss function, transferring other lead configuration models to increase 6-Lead model performance.



PCNNGAP Architecture

Table 1. 5 Fold CV on CM.

Fold	2-Lead	3-Lead	6-Lead	12-Lead
1	0.5	0.51	0.187	0.504
2	0.5	0.482	0.083	0.382
3	0.462	0.475	0.137	0.524
4	0.457	0.442	0.098	0.492
5	0.41	0.425	0.043	0.384