ECG Quality Assessment from a PCG-Oriented Device Using a Minimal Fine-Tuning Strategy on a Pre-trained Convolutional Neural Network

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Background and Aim. Portable and wearable devices initially designed for phonocardiography (PCG) monitoring can now record electrocardiogram (ECG) signals from non-standard positions that alter ECG morphology. Convolutional neural network (CNN)-based algorithms for ECG quality assessment are usually trained on standard or near-standard leads using continuous monitoring devices and validated on morphologically similar data, reporting excellent performance. This work evaluates, for the first time, the performance of such an algorithm on ECG signals from a PCG-oriented device and examines the need and impact of minimal fine-tuning using limited subject data.

Methodology. A previously published CNN-based algorithm for ECG quality assessment was directly validated on a dataset comprising 1,228 ECG signals recorded from four standard positions used for PCG acquisition in 267 patients. To enhance the algorithm's adaptation, minimal fine-tuning was performed using ECG signals from 1, 5, 10, and 20 patients, who were subsequently excluded from the validation set. The algorithm's ability to distinguish between manually annotated high- and low-quality ECG segments for reliable subsequent analysis was evaluated in terms of sensitivity (Se), specificity (Sp) and accuracy (Acc).

Results. Without fine-tuning, the CNN achieved an accuracy of 71.54%, with a sensitivity of 56.60% and a specificity of 96.19%. Incorporating ECG data from a single patient resulted in a marked improvement, increasing accuracy to 85.20% and sensitivity to 88.25%. Enlarging the fine-tuning dataset produced moderate additional gains, reaching a maximum accuracy of 87.68% and sensitivity of 92.22% when signals from ten patients were included.

Significance. The obtained results indicate that limited fine-tuning is sufficient to adapt pre-trained CNNs to ECG signals recorded from PCG-oriented devices, achieving strong generalization despite location-dependent morphological variations. This minimal adaptation strategy represents a practical solution for real-world integration in multimodal cardiac monitoring systems.

Fine-tuning	Se	Sp	Acc
None	0.566	0.961	0.715
1 patient	0.882	0.801	0.852
5 patients	0.891	0.769	0.845
10 patients	0.922	0.798	0.876
20 patients	0.888	0.826	0.866