Title of the work: Convolutional Neural Network Based **ECG Quality Assessment** Using Derivative Signal

Summary of the work: Automatic electrocardiogram (ECG) signal quality assessment (SQA) is essential before its analysis for vital signs monitoring and disease detection, for reducing false alarm rates and energy consumption of wearable health monitoring devices. In this work, we propose an automatic ECG signal quality assessment (detection of clean and noisy ECG signals) method by using derivative ECG (dECG) signal and convolutional neural network (CNN). The proposed dECG-CNN method (for different convolution layers and dense layers combinations) is trained and tested using standard MIT-BIH Arrhythmia database and Physikalisch-Technische Bundesanstalt (PTB) database. The proposed method achieved 100% false alarm reduction rate for a total 30850 noisy segments. The optimal CNN model is tested with PhysioNet challenge 2017 database achieving an accuracy of 91.767%. The optimal CNN model is implemented on Raspberry pi-4 model as real-time computation platform and the testing time is 125.256±28.945 millisecond.

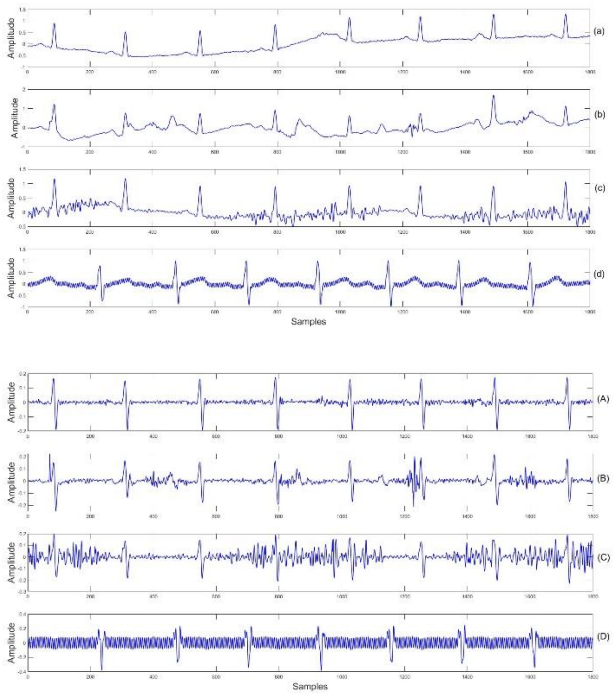

Figure 1: (a), (b), (c), and (d) represent the ECG signals with baseline wander, electrode movement, muscle artifacts, and powerline interference artifacts respectively added with ECG signals taken from MIT-BIHA and PTB datasets. (A), (B), (C), and (D) are the derivative of (a), (b), (c), and (d) ECG signals respectively.

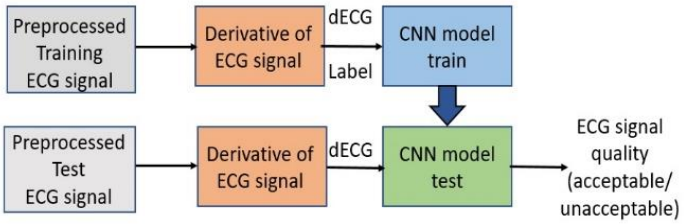

Figure 2: CNN model training and testing for ECG-SQA

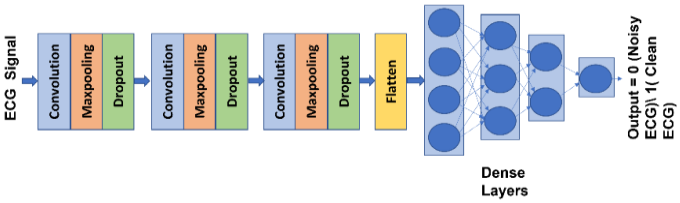

Figure 3: Proposed optimal convolutional neural network

Table 1: Performance and testing time for CNN-SQA models

Activation function	Architecture (Convolution and dense layers)	Accuracy	Testing time (msec) PC-CPU
Leaky ReLU	3,3	53.913	0.854
	3,4	100	0.886
	4,4	52.170	1.039
	4,5	100	1.492
	5,5	62.223	1.509
	5,6	99.464	1.492
	6,6	97.577	1.683

Table 2: Performance comparison with methods using MIT-BIHA database for training and testing

Reference	Database	Method	Accuracy
Proposed	MIT-BIHA	1D CNN	100
Q. Zang el al.	MIT-BIHA	DBN	91.8
B. Taji et al.	MIT-BIHA	1D CNN, 2D CNN	97.2

Table 3: Performance comparison with methods using PCCC2017 for training and testing

Reference	Database	Method	Accuracy
Proposed	PCCC2017	1D CNN	91.767
A. Huerta	PCCC2017	1D CNN	91.4
X. Zhou	PCCC2017	1D CNN	87.0