Chest-Lead Generation with Single-Lead

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ABSTRACT

Background and Objective: The three main ECG measurement methods are resting ECG, Holter monitoring, and treadmill method. Wearable devices have been developed that could measure long-term ECG signals daily. Heart is a three-dimensional structure in which ECG signals are vectors. Therefore, a single lead is limited in detailed information of the heart. The aim of this study is to synthesize chest lead ECGs from a single-lead ECG using a generative adversarial network (GAN).

Methods: Lead I was used as input data of our model. For generator U-net model was implemented and for the discriminator patch discriminator was used. Our model was trained with two independent datasets which are China dataset and PTB-XL dataset both open data from Physionet. Each dataset was trained independently and were cross validated with one another. For evaluation methods fréchet distance (FD) score and mean squared error (MSE) were used. Low FD and MSE score validate the similarity between generated and reference signal.

Results: Mean FD score and MSE score of the model trained with China dataset were 13.757 and 0.042, respectively. Mean FD score and MSE score of the PTB-XL dataset were 11.321 and 0.038. Despite the vector difference of lead I and chest leads the FD score and MSE score were low.

Conclusion: Novelty of or proposed methods are that chest leads are generated by lead I which can be easily obtained from wrist. Proposed method can overcome the limitations of modern ECG measurements. Low FD and MSE scores indicate the possibility that the proposed method can be applied to wearable devices and obtain ECG signals measured from the chest.

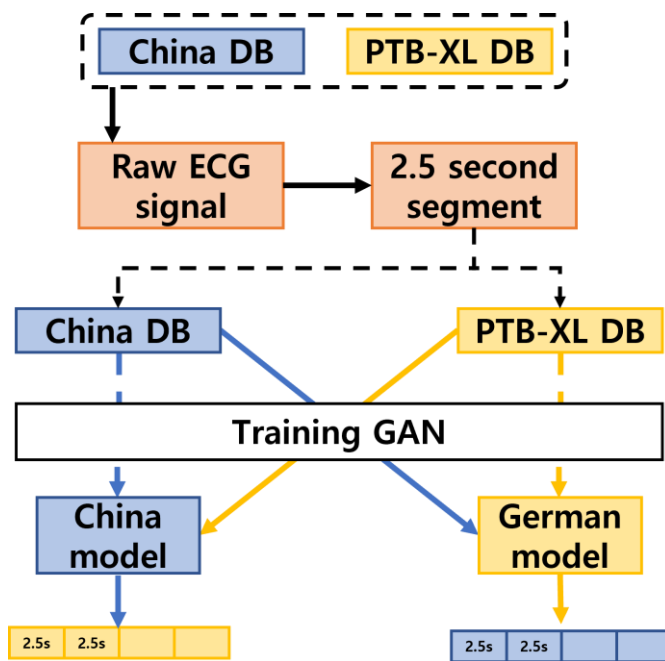**Keywords**— Generative adversarial networks, deep learning, electrocardiogram

Figure 1. Model overview of proposed method.

Table 1. FD score and MSE score results

	China database		PTB-XL database	
	FD score	MSE	FD score	MSE
V1	13.637	0.029	**6.101**	**0.021**
V2	10.847	0.058	**10.837**	**0.050**
V3	17.639	0.058	**10.128**	**0.051**
V4	15.265	0.046	**12.581**	**0.043**
V5	**13.602**	**0.033**	15.931	0.034
V6	**11.550**	**0.028**	12.347	0.026
Mean value	13.757	0.042	**11.321**	**0.038**