RNN model that predicts blood pressure using ECG and PPG

Sungho Jung[1], Sang Mee Lee[1,3], Junghyun Kim[1], Myung Jin Chung[1,2], Zero Kim[1,2], Taeyoung Kim[1]*

[1]*Medical AI Research Center, Samsung Medical Center, Seoul, Republic of Korea*

[2]*Department of Data Convergence and Future Medicine, Sungkyunkwan University School of Medicine, Seoul, Republic of Korea*

[3]*SAIHST, Sungkyunkwan University, Seoul, Republic of Korea*

Corresponding author (Electronic mail: tae23.kim@samsung.com)

One of the important indicators to check a patient's condition is blood pressure. There are two main methods for measuring blood pressure, invasive measurement and non-invasive measurement. Invasive blood pressure measurement is performed by inserting a cannula needle directly into the artery of the patient. Changes in blood pressure of patients can be monitored in real time. Non-invasive blood pressure measurement is to measure blood pressure by putting a cuff-type pressure device on the arm that we usually do. This method can obtain the systolic and diastolic blood pressures at the time of measurement, but the real-time change is not known.

This study is to predict changes in blood pressure in real time using an recurrent neural network model equivalent to invasive blood pressure measurement using an electrocardiogram (ECG) and photoplethysmogram(PPG) signal among the patient's vital signals. The data set for learning consists of vital signals from invasive blood pressure measurement among patients admitted to the intensive care unit.

For this study, a basic process of signal purification was established. Empty sections, continuous sections, and outliers were found and deleted. Also, since ECG and PPG have different units, scaling was applied. A model was built to implement the waveform of ABP. As a result of the learning, it showed a state of chasing a pulse, but showed a pulse even where there was no pulse, showing the difference between the maximum and minimum values.

Future research will advance the implementation of waveforms, and additionally implement a model to obtain feature values such as systolic and diastolic of ABP.

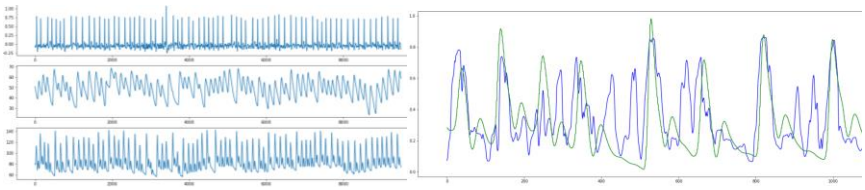

Figure 1. Signal Data of ECG,PPG, ABP and Predicted waveform

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References

[1] Ümit Şentürk et al., "**Repetitive neural network (RNN) based blood pressure estimation using PPG and ECG signals**", *2018 International Symposium on Multidisciplinary Studies and Innovative Technologies*, (2018).

[2] Meghna Roy Chowdhury et al., "**Deep learning via ECG and PPG signals for prediction of depth of anesthesia**", *Biomedical Signal Processing and Control*, 68 (2021).

[3] Sakib Mahmud t al., “**A Shallow U-Net Architecture for Reliably Predicting Blood Pressure (BP) from Photoplethysmogram (PPG) and Electrocardiogram (ECG) Signals**”, *Sensors*, 22 (2022).