Comparison of PSD Correlation between HRV and PRV

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Abstract— **This paper compares whether PPG signals can replace ECG signals. With that method, the Welch's method, Lomb-Scargle, and Autoregressive algorithms are compared to calculate the PRV from the PPG signal and compare the similarity with the HRV-PSD.**

I. INTRODUCTION

Recently, it has become possible to measure various biological signals using a smart watch. Using PPG (Photoplethysmography) signals, it is possible to obtain Heart Rate Variability more simply than conventional ECG (Electrocardiograms). This is called Pulse Rate Variability.

This paper analyzes the degree of PSD (Power Spectral Density) correlation between HRV and PRV.

II. METHODS

This paper used PhysioNet [1] data. The ECG and PPG signals were analyzed and compared with the algorithms of Welch's method [2], Lomb-Scargle Periodogram [3], and Autoregressive method [4], respectively. All three algorithms are spectral estimation algorithms. Welch's method assumes periodicity and is suitable for uniformly sampled signals. In the case of Lomb-Scargle, it is basically the same as Welch's method, but it does not matter if it is not uniform sampling. Autoregressive is characterized in that it is linearly configured by applying a specific probability to the previous value. HRV index for each algorithm is divided into VLF, LF, HF and LF/HF according to the frequency range.

TABLE I. VALUES OF ECG-PSD AND PPG-PSD

Algorithm	Index	ECG-PSD	PPG-PSD
Welch's Method	LF	513.737	1766.452
	HF	2160.099	3464.722
	LF/HF	0.238	0.510
Lomb-Scargle Periodogram	LF	1644.596	1727.138
	HF	2870.653	3491.238
	LF/HF	0.573	0.495
Autoregressive	LF	5178.981	5288.861
	HF	10915.164	10968.943
	LF/HF	0.474	0.482

III. RESULTS

Table 1 shows the results for each algorithm. Numerically, it can be seen that HRV-PSD and PRV-PSD are the most similar when calculated with the Autoregressive algorithm. However, depending on the data entered, other algorithms

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may come out better. That is why it is necessary to compare the outline and proportions of the graph. As shown in figure 1, it was confirmed that the outline of the graph was the most similar to the Autoregressive algorithm.
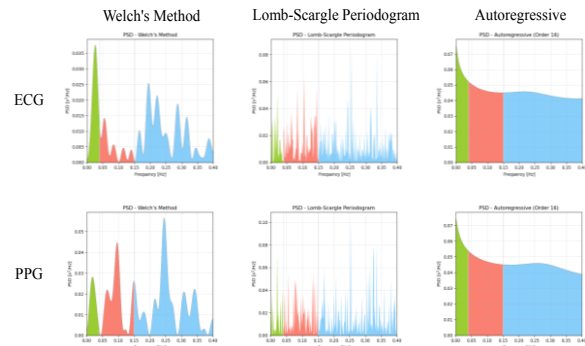

Figure 1. Comparison of HRV-PSD analysis graph based on ECG signal and PRV-PSD analysis graph based on PPG signal.

IV. DISCUSSION & CONCLUSION

As a result, when the HRV-PSD is estimated using the PPG signal, the most similar signal can be obtained if the Autoregressive algorithm is applied.

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