

Morphological Reconstruction of Smartphone Photoplethysmogram

Won Hee Hwang, Chan Hee Jeong, and Young Chang Jo

Abstract— In this study, We proposed an algorithm that reconstructs the morphology of the photoplethysmogram (PPG) measured from a smartphone camera.

Clinical Relevance— This paper contributed to the PPG reconstruction with correlation R value with 0.943 from smartphone camera.

I. INTRODUCTION

In recent years, measuring PPG using a smartphone camera has been actively researched. In clinical practice, PPG is used to monitor Heart Rate Variability(HRV) and Blood Pressure (BP) [1, 2]. Therefore, there are many studies that improve the accuracy of HRV from PPG detected from smart phone [3]. However, the shape of PPG extracted from the video is different from PPG measured by a medical device. It is difficult to evaluate the elasticity of blood, which can be seen in the shape of PPG. Therefore, we proposed an algorithm that reconstructs the morphology of PPG.

II. METHODS

Our method consists of three stages to get reconstructed PPG from the video: measurement, extraction, and filtering (Fig.1). First, we collect data simultaneously using both smart phone and ubpulse360. The data from ubpulse 360 which can measure the PPG pattern, was used as reference data (Fig.2). After obtaining a video from smart phone, we extract signal using independent component analysis(ICA). The filtering stage has two steps .We use the filtering method to remove noise from signals and Butterworth filters to reconstruct PPG signals. We compare the reconstructed PPG with the reference PPG obtained from ubpulse360 device.

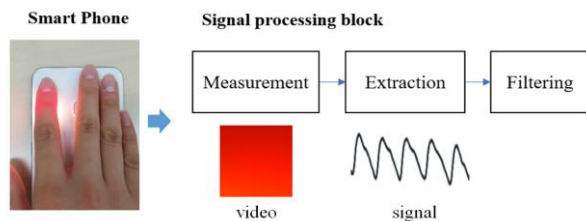


Figure 1. Overall procedure of PPG Reconstruction.

III. RESULTS

We use Pearson correlation coefficients to compare the similarity of PPG signals. Reconstructed PPG is highly correlated with reference PPG ($r=0.943$, $p\text{-value}<.001$) as shown in Table 1.

W.H.H, C.H.J and Y.C.J are with the Korean Electronics Technology Institute, Seongnam 13509 Korea, e-mail: anne0615@keti.re.kr.

TABLE I. CORRELATION COEFFICIENT COMPARISON

	Correlation with reference signal ($p < .001$)	
	PPG from smartphone	Reconstructed PPG
R	0.763	0.943

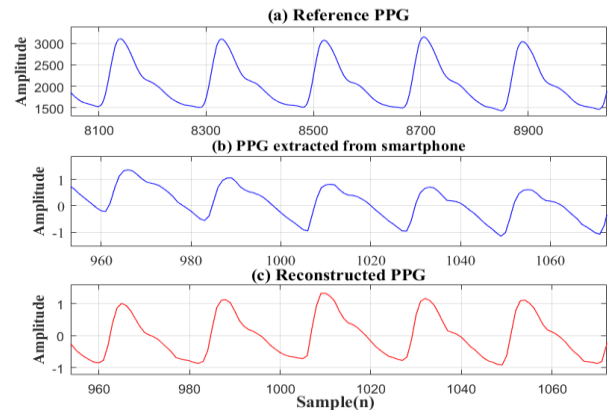


Figure 2. (a) reference PPG signal from ubpulse360. (b) PPG extracted from video using ica. (c) reconstructed PPG.

IV. DISCUSSION & CONCLUSION

Since the morphology and inflection points of PPG reflect bio signals such as HRV and BP, it is possible to obtain additional bio characteristics from smart phone camera using reconstructed PPG.

ACKNOWLEDGMENT

This work was supported by the Korean Ministry of Science and ICT and IITP under project contract No. 2020-0-01970-001(Development of Smart Patch and Multimodal Bio signal Analysis Algorithm for ~) and partly supported by the Korean Ministry of Trade, Industry, Energy/KIAT under project contract No. P0017819 (Early commercialization development of digital therapeutics technology for ~).

REFERENCES

- [1] ALQARAAWI, Ahmed; ALWOSHEEL, Ahmad; ALASAAD, Amr. *Heart rate variability estimation in photoplethysmography signals using Bayesian learning approach*. Healthcare technology letters, 2016, 3.2: 136-142.
- [2] ELGENDI, Mohamed, et al. *The use of photoplethysmography for assessing hypertension*. NPJ digital medicine, 2019, 2.1: 1-11
- [3] PENG, Rong-Chao, et al. *Extraction of heart rate variability from smartphone photoplethysmograms*. Computational and mathematical methods in medicine 2015, 2015.