Cuff-less Estimation of Blood Pressure from Vibrational Cardiography using a Convolutional Neural Network

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Objective: Wearable monitoring is important for the diagnosis, prevention, and treatment of cardiovascular diseases and overall cardiac health. A key indicator, blood pressure (BP), currently relies on cuff-based devices for measurement that are cumbersome for ambulatory monitoring scenarios. Vibrational cardiography (VCG) is an unobtrusive, non-invasive tool which records cardiac vibrations on the surface of the chest. This work proposes using VCG in a novel method to estimate BP from a single point of contact.

Methods: VCG was recorded by an inertial measurement unit on the xiphoid process of 62 subjects. The Biopac non-invasive blood pressure device recorded continuous BP from the finger. VCG recordings with three axes of acceleration and three axes of gyration were segmented by heartbeat then input to a one-dimensional convolutional neural network. The network was trained to estimate systolic BP (SBP) and diastolic BP (DBP).

Results: This resulted in an r-squared correlation coefficient of 0.86 and 0.89 and a mean-absolute-error of 3.4 mmHg and 2.2 mmHg for SBP and DBP, respectively. Using a Bland-Altman analysis, the mean error was 0.34 and −0.55 mmHg with 95% limits of agreement of -9.21 to 9.88 mmHg and -6.51 to 5.41 mmHg for SBP and DBP, respectively. As the error metrics are within the industry's tolerance, this work shows the applicability of using exclusively VCG for BP estimation.

Conclusion: The achieved low error and high correlation confirm the ability of using VCG as a robust vital signs monitor, capable of measuring heart rate, respiration, and now BP from a single point of contact on the body. This integration of multiple monitoring metrics gives VCG an edge over traditional techniques due to the improved ease of use in remote healthcare, fitness, and wellness monitoring.