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Towards Enabling Perpetual Vital Signs Monitoring using a Body Patch

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Poster: Towards Enabling Perpetual Vital Signs Monitoring using a Body Patch

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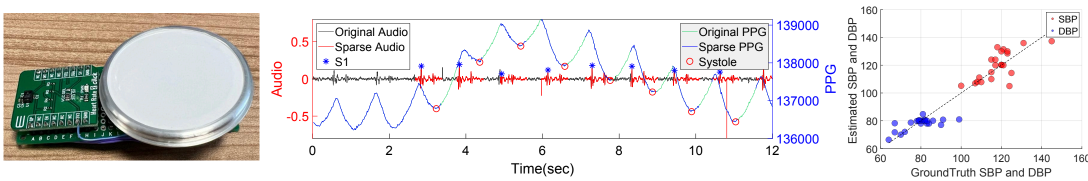

Figure 1: (a) BioPulse body patch prototype used for evaluation. (b) PPG and audio signal snippets showing the sparse sampled signals and detected peaks (c) Comparison of estimated BP using BioPulse with sparse sampling Vs the ground truth.

ABSTRACT

Continuous vital sign monitoring is essential for digital healthcare and self-awareness but is hindered by the limited battery life of wearable devices and barriers faced by older adults with low digital literacy. BioPulse, a battery-free patch device, addresses challenges in vital sign monitoring by using sparse sampling and NFC energy transfer to track heart rate, HRV, and blood pressure.

CCS CONCEPTS

• **Hardware → Sensor devices and platforms**; *Sensor applications and deployments.*

ACM Reference Format:

C.Rajashekar Reddy[1], Vivian Dsouza[2], Ashok Samraj Thangarajan[3],, Przemysław Pawełczak[2], Fahim Kawsar[3,4], Alessandro Montanari[3]. 2025. Poster: Towards Enabling Perpetual Vital Signs Monitoring using a Body Patch. In *The 26th International Workshop on Mobile Computing Systems and Applications (HOTMOBILE '25), February 26–27, 2025, La Quinta, CA, USA.* ACM, New York, NY, USA, 1 page. https://doi.org/10.1145/3708468.3715689

1 INTRODUCTION

Wearable technology has transformed health monitoring, providing a convenient way to track vital signs and expand access to health services, especially in regions with limited healthcare infrastructure. However, adoption among populations requiring continuous monitoring, such as the elderly [2], remains limited. A major barrier is energy consumption [3]. Battery-powered wearables require frequent recharging, interrupting monitoring and creating issues when users forget to recharge or reapply the device. While fast charging reduces downtime [2], it accelerates battery degradation. Estimates suggest that for 1 trillion devices, 913 million battery changes would be required. Such frequent replacements raise significant environmental concerns [4].

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To address these challenges, we introduce BioPulse, a platform for continuous, battery-free vital signs monitoring designed for chest application. To achieve battery-free operation, BioPulse utilizes supercapacitors instead of traditional batteries, offering a significantly longer device lifespan. However, supercapacitors have lower energy density when compared to conventional batteries, which results in sensing and communication challenges. We developed a sparse sampling algorithm that exploits the properties of vital signs and drastically reduces energy consumption. Using a sparse sampling approach we trigger the sensor to sample only when the relevant features of the signal are estimated to arrive. Second, to combat the communication and energy harvesting problem, we use NFC.

2 DESIGN

Figure 1 shows the BioPulse prototype used in our experiments. It uses the Nordic nRF52840 MCU, a 64 MHz Cortex-M4F processor. The prototype includes the MAXM86161 PPG sensor, and the IM69D130 microphone. The microphone is mounted on a chest piece adapted from PatchKeeper [1].

BioPulse measures BP using VTT with time-synchronous sparse sampling from the microphone and PPG sensor, with a 12-second sample window. The algorithm estimates the heart rate from PPG, predicts the arrival time of the first heart sound (S1), and switches sensors on only during critical windows. The working of the sparse sampling is shown in Figure 1. We evaluate on 6 healthy individuals and use Omron M7 Intelli IT as the ground truth. We store the harvested energy in a 0.47 F supercapacitor which can be charged in 6 minutes. Sparse sampling increases measurements over 24 hours from 25.12 to 59.67 (137.5%), and reduces power consumption by 57.9% with mean absolute errors of 5.61 mmHg (SBP) and 4.5 mmHg (DBP).

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