

Pulse Arrival Time–Based Blood Pressure Estimation in ICU Waveforms from the MIMIC–BP Database

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Abstract:

Continuous blood pressure (BP) monitoring is essential in critical care, yet invasive arterial blood pressure (ABP) measurement is limited to specialized settings and cuff-based methods provide only intermittent readings. This study investigates the extent to which pulse arrival time (PAT), derived from synchronized electrocardiogram (ECG) and photoplethysmogram (PPG) signals, reflects ABP-derived systolic and diastolic blood pressure (SBP and DBP) in real-world intensive care unit (ICU) data. Using curated 30-s waveform segments from the MIMIC–BP dataset, two PAT definitions were computed based on the PPG systolic peak and pulse onset relative to the ECG R-peak. Reference SBP and DBP were extracted from ABP waveforms on a segment basis, and nonlinear PAT-based formulations (M5 for SBP and M2 for DBP) were evaluated against these references. The results demonstrate that PAT captures broad systolic pressure trends but exhibits a compressed dynamic range and increased dispersion relative to ABP, with weaker agreement observed for diastolic pressure. Analysis of fiducial point detection highlights the impact of waveform quality on timing variability, particularly for foot-based PAT. These findings provide a transparent physiological baseline for cuffless BP estimation using timing-based surrogates in heterogeneous ICU environments and motivate the integration of complementary waveform features and subject-specific calibration in future work.

Keywords:

Arterial blood pressure, pulse arrival time, photoplethysmography, electrocardiography, MIMIC, ICU wave- forms, cuffless blood pressure.