BEAT: Barometric Elevation and Attitude Tracking for Posture-Independent Wrist Blood Pressure Measurement

Yuzhen Song, Zhiqiao Mai, Jiacan Li and Chengzhi Hu, *Senior Member, IEEE*

***Abstract*—Hypertension is a critical global health concern, requiring frequent and accurate home-based blood pressure (BP) monitoring. Although wrist-worn sphygmomanometers offer superior convenience, their accuracy is critically dependent on the *hydrostatic alignment* between the wrist and the heart level. This limitation poses a significant challenge for users with limited mobility, such as patients with paralysis or muscle weakness. To address this, we introduce BEAT (Barometric Elevation and Attitude Tracking), a novel BP monitoring system utilizing a single detachable sensing module for altitude compensation. This unique design allows the user to temporarily place the sensor at the heart level to record a zero-reference atmospheric pressure before attaching it to the wrist for measurement. This workflow eliminates the need for strict upper-limb flexion during measurement, facilitating the process for patients with restricted motion. By leveraging a barometric-inertial sensing architecture, BEAT dynamically tracks the wrist's altitude and orientation relative to the stored heart-level baseline. This enables precise real-time compensation for hydrostatic pressure offsets, ensuring accurate BP measurement regardless of the arm's position. Experimental results demonstrate that BEAT achieves a measurement accuracy comparable to medical-grade devices, reducing the overall systolic mean absolute error to only 4.24 mmHg across diverse arm postures.**

***Index Terms*—Blood pressure monitoring, Hydrostatic pressure compensation, Sensor fusion, Wearable devices, Barometric sensing.**

I. Introduction

Hypertension remains a critical global health concern, affecting over 1.2 billion people worldwide and serving as a primary risk factor for stroke and cardiovascular disease. Effective management relies heavily on accurate, frequent, and reliable home-based blood pressure (BP) monitoring [1]. Among the available technologies, automated oscillometric devices have largely replaced traditional mercury sphygmomanometers due to their ease of use [2]. Wrist-worn monitors, in particular, offer superior portability. However, their clinical reliability is compromised by the hydrostatic pressure effect.

From a fluid dynamics perspective, the blood column between the heart and the wrist exerts a pressure governed by the equation $\Delta P = \rho g \Delta h$. According to the American Heart Association (AHA) guidelines, any vertical deviation from the heart level introduces a systematic error of approximately 0.77 mmHg per centimeter [3]. A large-scale population study revealed that over 86% of home users fail to maintain the correct wrist-to-heart alignment, leading to falsely elevated readings that can exceed 10 mmHg [4]. This positional sensitivity poses a significant challenge for specific patient populations, such as those suffering from paralysis or muscle weakness, who often find it physically impossible to maintain a steady, heart-level posture during measurement [5].

Existing attempts to mitigate posture-induced errors have primarily relied on accelerometers to infer the arm's orientation. However, these inertial-only methods are fundamentally limited; they can detect the angle of the arm but fail to measure the absolute vertical displacement if the torso moves [6]. While recent advanced approaches have utilized deep learning models to predict arm poses [7], they remain computationally intensive. In contrast, barometric pressure sensors offer a direct physical measurement of elevation changes [8].

To bridge this gap, we introduce BEAT, a system featuring a single detachable barometric-inertial sensing module. A key innovation is the time-multiplexed calibration workflow: the user first calibrates the system by placing the detachable sensor at the heart level to establish a zero-reference atmospheric baseline. Once re-attached to the wrist cuff, the system dynamically calculates the vertical displacement h based on the pressure differential between the stored baseline and the real-time wrist altitude [9]. This approach ensures that accurate elevation tracking is achieved without requiring any specific arm flexion during the actual measurement, making it a truly accessible solution for mobility-impaired populations.

The primary contributions of this work are three-fold:

- Hardware Design: A cost-effective architecture featuring a single detachable sensor for sequential heart-level and wrist-level sensing.
- Fusion Algorithm: A barometric-inertial approach that transforms stored altitude references and raw spatial data into precise BP correction factors.
- Experimental Validation: Comparative studies conducted under the AAMI/ESH/ISO standard [10], demonstrating posture-invariant accuracy.

We hypothesize that the BEAT system can achieve a measurement deviation comparable to gold-standard upper-arm monitors, regardless of the user's arm position ($H1$).

II. Methodology

A. System Architecture and Sensing Modalities

The BEAT system is designed around a decoupled, modular architecture to minimize interference between pneumatic actuation and high-precision sensing. The system consists of two primary functional units: a pneumatic measurement unit and a detachable sensing module, as shown in Fig. 2.

The pneumatic unit integrates a micro-air pump, a linear solenoid valve, and a piezoresistive pressure sensor (XGZP6847D) managed by an ESP32 microcontroller to execute standard oscillometric inflation/deflation cycles.

This work is supported by the Fundamentals of Sensing Technology (ME323) course project at Southern University of Science and Technology.

Y. Song, J. Li, and Z. Mai are with the Department of Mechanical and Energy Engineering, Southern University of Science and Technology, Shenzhen, 518055, China. (Corresponding email: hucz@sustech.edu.cn)

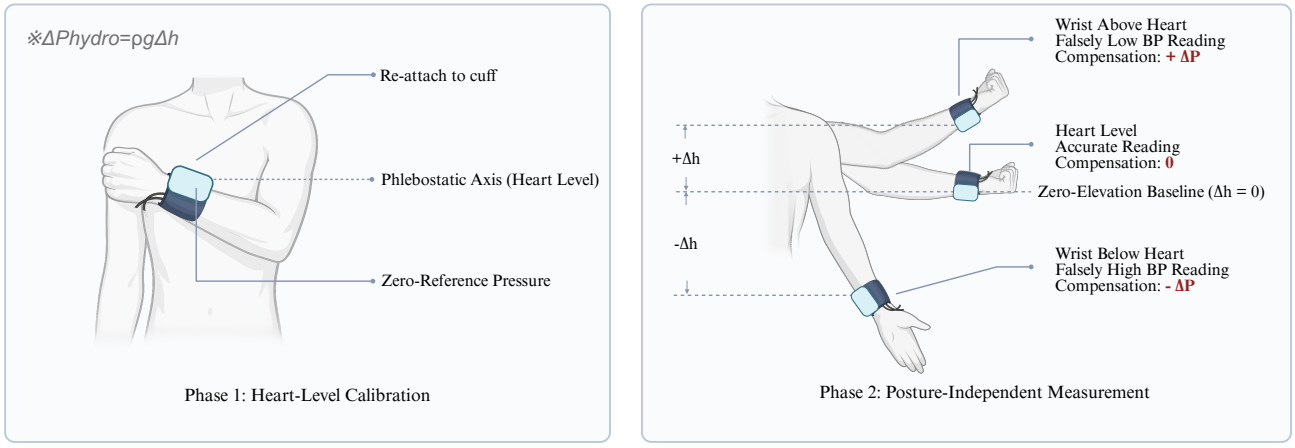

Fig. 1. The two-phase operational workflow of the BEAT system. Phase 1 (Calibration): The detachable sensing module is placed at the heart level to establish a zero-reference atmospheric reference (P_{ref}). Phase 2 (Measurement): The module is re-attached to the wrist cuff to dynamically compensate for the hydrostatic pressure offset ($\Delta P = \rho g \Delta h$) caused by real-time vertical displacement.

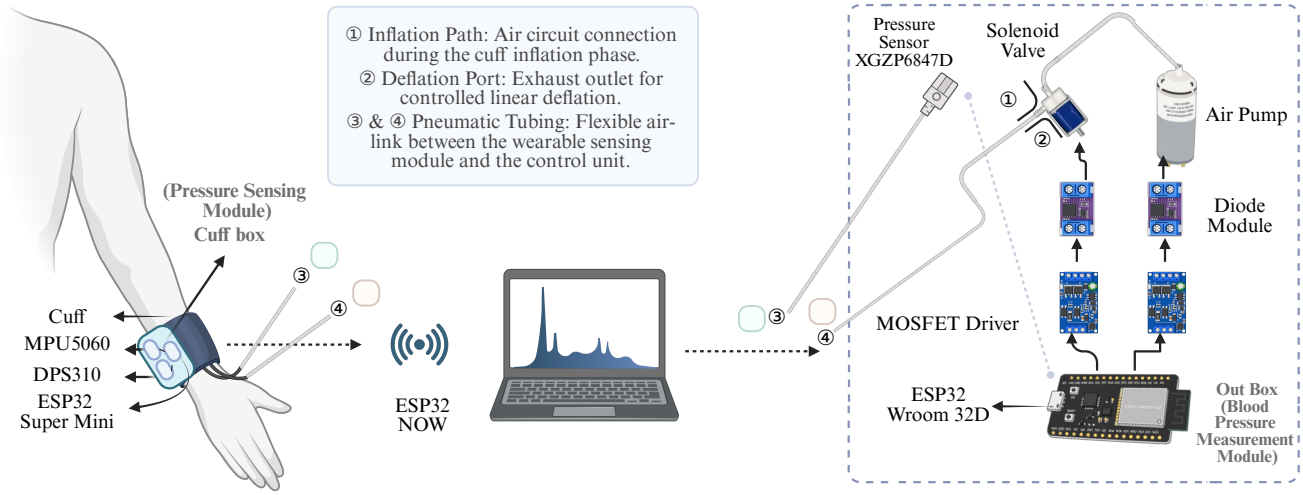

Fig. 2. Integrated hardware architecture and software algorithmic pipeline of the BEAT system, illustrating the wireless synchronization via ESP-NOW and the digital signal processing (DSP) pipeline.

The Detachable Sensing Module serves as the core innovation for posture-independent measurement. To achieve sub-centimeter altitude tracking, this module is equipped with the Infineon DPS310 high-precision MEMS barometric sensor. The sensor features a pressure precision of $\pm$ 0.002 hPa and a typical relative accuracy of $\pm$ 0.06 hPa. To optimize for tracking vertical displacements in dynamic conditions, we configured the DPS310 with high-resolution oversampling at a 10 Hz output data rate (ODR). The module also integrates a 6-axis IMU (MPU6050) for attitude monitoring. By decoupling this module from the cuff during initialization, the system achieves a stable heart-level atmospheric reference without requiring the user to maintain a specific, constrained upper-limb posture.

For synchronized data acquisition, we employed the ESP-NOW wireless protocol. Unlike traditional Wi-Fi, ESP-NOW offers a low-latency, peer-to-peer connection that eliminates handshake overhead, enabling barometric and inertial data transmission at high-speed bursts with sub-10ms latency. This synchronization is critical for mapping the instantaneous hydrostatic offset to the corresponding pulse oscillation in the time domain, thereby ensuring the temporal alignment of the compensation algorithm.

B. Operational Workflow: Time-Multiplexed Calibration

To ensure clinical-grade accuracy for mobility-impaired patients, we implemented a two-phase operational workflow (Fig. 1). This approach decouples the calibration site from the measurement site, addressing the limitations of traditional tilt-based compensation.

1) Phase 1: Heart-Level Zero-Reference: The detachable module is first placed at the user's phlebostatic axis (the fourth intercostal space). The system samples atmospheric pressure at 20 Hz for 2 seconds to establish a stable reference, P_{ref}. This step effectively cancels macro-environmental variables such as HVAC fluctuations and diurnal weather drift [9].

2) Phase 2: Posture-Independent Measurement: After calibration, the module is re-attached to the wrist cuff. During the BP measurement cycle, the system continuously monitors the real-time pressure at the wrist, P_{wrist}. The vertical displace-

ment h relative to the heart is derived using the barometric formula:

$$h = \frac{P_{ref} - P_{wrist}}{\rho_{air} \cdot g} \tag{1}$$

where ρ_{air} is the ambient air density and g is the local gravity.

C. Pulse Signal Extraction and Conditioning

The raw pressure data $P_{total}(t)$ is sampled at $f_s = 40$ Hz. To isolate pulse features, we apply a zero-phase 4th-order Butterworth band-pass filter (0.5–10 Hz) to eliminate the DC component and high-frequency noise. Let $P_{ac}(t)$ be the filtered pulse signal. Due to the discrete nature of heartbeat events, a peak-detection algorithm identifies local maxima. To construct a continuous *Oscillometric Waveform Envelope* (OWE), we perform cubic spline interpolation, yielding $E(P_{cuff})$.

D. BP Estimation and Multi-Sensor Fusion Algorithm

The Maximum Amplitude Algorithm (MAA) is implemented to estimate initial values. The MAP is defined as $MAP = \arg\max_{P_{cuff}} E(P_{cuff})$. SBP and DBP are identified where the envelope amplitude drops to K_s and K_d of the peak A_{max}:

$$\begin{cases} SBP_{est} = \{P_{cuff} \mid E(P_{cuff}) = K_s \cdot A_{max}, P_{cuff} > MAP\} \\ DBP_{est} = \{P_{cuff} \mid E(P_{cuff}) = K_d \cdot A_{max}, P_{cuff} < MAP\} \end{cases} \tag{2}$$

where $K_s = 0.55$ and $K_d = 0.82$ are adopted from literature [11].

E. Fused Hydrostatic Compensation Algorithm

To eliminate postural errors, we implemented a software-defined compensation algorithm based on the principle of hydrostatic pressure. At the onset of each measurement, the user places the detachable sensing module at the phlebostatic axis (fourth intercostal space) for 2 seconds. The MCU records this atmospheric pressure as the reference baseline (P_{ref}), effectively "anchoring" the heart level as the zero-altitude point, accounting for ambient barometric conditions.

As the wrist moves to various operational postures, the integrated BMP581 continuously monitors the pressure change ($\Delta P_{air} = P_{wrist} - P_{ref}$). Given the linear relationship between pressure and altitude within a small vertical range ($h < 2$ cm), the vertical height difference h is derived using a simplified barometric formula:

$$h = \frac{P_{ref} - P_{wrist}}{\rho_{air} \cdot g} \tag{3}$$

where ρ_{air} is the ambient air density and g is local gravity. Based on fluid mechanics, the hydrostatic bias (P_{hydro}) is calculated using the clinical constant of 0.77 mmHg/cm [10]:

$$P_{hydro} = h \cdot \left(\frac{\rho_{blood}}{\rho_{mercury}} \right) \approx h \cdot 0.77 \text{ mmHg/cm} \tag{4}$$

The final blood pressure estimation is obtained by applying a real-time correction to the oscillometric envelope:

$$BP_{corrected} = BP_{raw} \pm P_{hydro} \tag{5}$$

where the sign of P_{hydro} depends on whether the wrist is positioned above or below the heart-level baseline. Concurrently, the IMU monitors the arm's attitude to detect sudden motion artifacts; if excessive acceleration is detected, the measurement is flagged to ensure reliability.

III. Experiments

A. Experimental Protocol

To evaluate the BEAT system's posture-independent performance, we conducted a two-phase clinical feasibility study involving 3 healthy volunteers (age: 22.4 $\pm$ 1.3 years). All trials were performed in a controlled laboratory environment at 24 $\pm$ 1°C, strictly adhering to the American Heart Association (AHA) screening guidelines [12] regarding arm positioning, cuff sizing, and subject resting state.

1) Phase 1: Baseline Agreement Validation: This phase established the foundational accuracy of our custom-developed oscillometric algorithm. Three subjects performed BP measurements at the reference phlebostatic axis (heart level). We conducted a comparative analysis between the BEAT system (operating in its baseline, non-compensated mode) and a gold-standard Omron HEM-series sphygmomanometer. This step was critical to quantify the intrinsic baseline bias of our custom hardware and pneumatic components against a clinically validated device, ensuring that any residual errors observed in Phase 2 could be primarily attributed to posture-induced hydrostatic effects rather than algorithmic defects.

2) Phase 2: Posture-Invariant Robustness Evaluation: To quantify the effectiveness of our hydrostatic compensation algorithm, a subset of 2 subjects underwent an extended multi-posture protocol. Each subject performed 5 repeated trials per posture: *Standard Seated* (P1), *Seated Higher* (P2, +25 cm elevation), and *Active Standing* (P3, arm hanging). To mitigate physiological arterial recoil and ensure hemodynamic stability, a 120-second "washout" period was strictly enforced between consecutive trials [5]. Posture-affected Omron readings were collected for reference, though as identified by Byrd and Brook [10], these measurements are inherently susceptible to a hydrostatic error of approximately 0.77 mmHg/cm. Thus, the reference standard for our comparison remained the heart-level Omron measurements, allowing us to evaluate whether our system could effectively "re-anchor" wrist-level BP readings to the established physiological zero-point.

B. Evaluation Metrics and Statistical Analysis

The primary objective of the statistical analysis was to ensure compliance with the AAMI/ISO 81060-2:2013 universal standard [13].

1. Error Quantification: Accuracy was assessed using the Mean Absolute Error (MAE) and Standard Deviation (SD) of the differences between the BEAT device and the reference standard. The performance criteria stipulated that the mean error should be ≤ 5 mmHg, with an SD ≤ 8 mmHg.

2. Agreement Analysis: We employed Bland-Altman analysis to visualize systematic bias and the 95% Limits of Agreement (LoA). This technique is essential for detecting

potential biases that may occur as BP levels increase or decrease, a known limitation in oscillometric devices [3], [14].

3. Statistical Significance: To evaluate whether the hydrostatic compensation successfully neutralized positional bias, paired-sample t-tests were performed comparing the uncompensated and compensated readings. A p-value < 0.05 was considered statistically significant. Furthermore, recognizing the physiological "Popeye phenomenon," where BP amplification occurs in peripheral arteries, we carefully monitored the consistency of our measurements across varied arm geometries [15]. All data processing was implemented in MATLAB to ensure precision in signal filtering and envelope reconstruction.

IV. Results

A. Signal Processing and Clinical Agreement

To evaluate the performance of our system, all compensated wrist BP readings were benchmarked against the Omron heart-level reference. Accuracy and precision were assessed using Mean Absolute Error (MAE) and Standard Deviation (SD), in accordance with the AAMI/ISO 81060-2 clinical acceptance criteria ($\leq \pm 5$ mmHg mean error). Statistical agreement was further visualized via Bland-Altman analysis, with paired-sample t-tests performed to evaluate potential systematic bias ($p < 0.05$).

The reliability of oscillometric estimation depends on the quality of the pulsatile components. Fig. 3 illustrates the complete signal processing pipeline. As shown in Fig. 3(a), the raw cuff pressure signal consists of a baseline and arterial oscillations. After the *Adaptive Oscillatory Artifact Removal* (AOAR) algorithm, the clean pulsatile waveform (Fig. 3(b)) allows for stable envelope reconstruction (Fig. 3(c)).

Following signal extraction, Bland-Altman analysis was performed using 15 measurements obtained from all 3 subjects at the heart-level baseline (Fig. 4). For SBP, the mean bias was 1.40 mmHg (95% LoA: -2.64 to 5.44 mmHg). For DBP, the mean bias was 1.40 mmHg (95% LoA: -1.98 to 4.78 mmHg). A paired-sample t-test yielded p-values of 0.0199 (SBP) and 0.0072 (DBP). Although these values indicate a statistically significant offset ($p < 0.05$), the absolute magnitude of the bias (1.4 mmHg) is clinically negligible and well within the strict ± 5 mmHg AAMI/ESH/ISO tolerance. These findings demonstrate that the BEAT system's foundational accuracy is highly comparable to commercial medical-grade devices, validating the underlying oscillometric algorithm prior to posture-compensation analysis.

B. Statistical Reliability and Clinical Agreement

To further evaluate the baseline agreement between the proposed BEAT system and the Omron reference, Bland-Altman analysis was performed using the 15 measurements obtained from all 3 subjects at the heart level (Fig. 4). The difference was defined as the BEAT measurement minus the Omron reference measurement.

For SBP, the mean bias was 1.40 mmHg, with 95% limits of agreement (LoA) ranging from -2.64 to 5.44 mmHg. For DBP, the mean bias was identically 1.40 mmHg, with 95% LoA ranging from -1.98 to 4.78 mmHg. As illustrated by the scatter distribution, while the mean systematic bias remains exceptionally low, individual measurements exhibited expected random variations. These fluctuations reflect the inherent beat-to-beat physiological variability, cuff-fitting differences across the 3 subjects, and minor pneumatic noises typical of portable

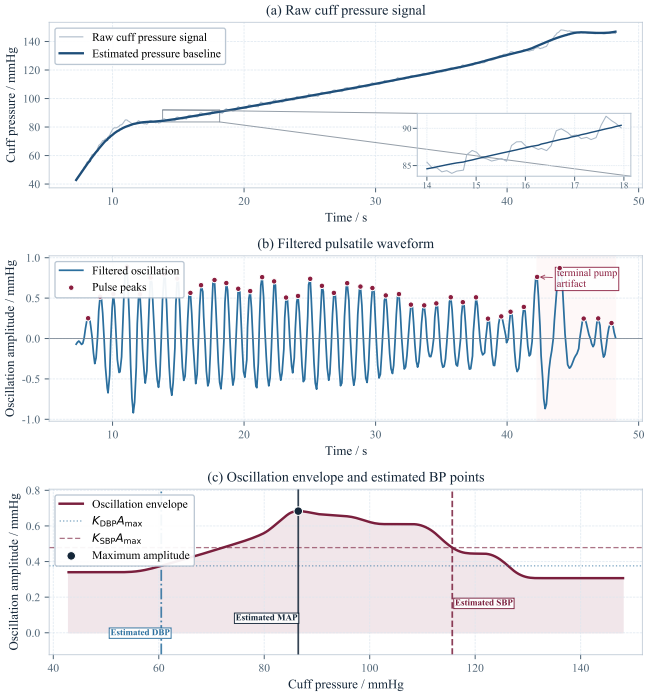

Fig. 3. Oscillometric signal processing. (a) Raw cuff signal and baseline. (b) Filtered waveform with detected peaks. (c) Oscillation envelope used to estimate SBP/DBP.

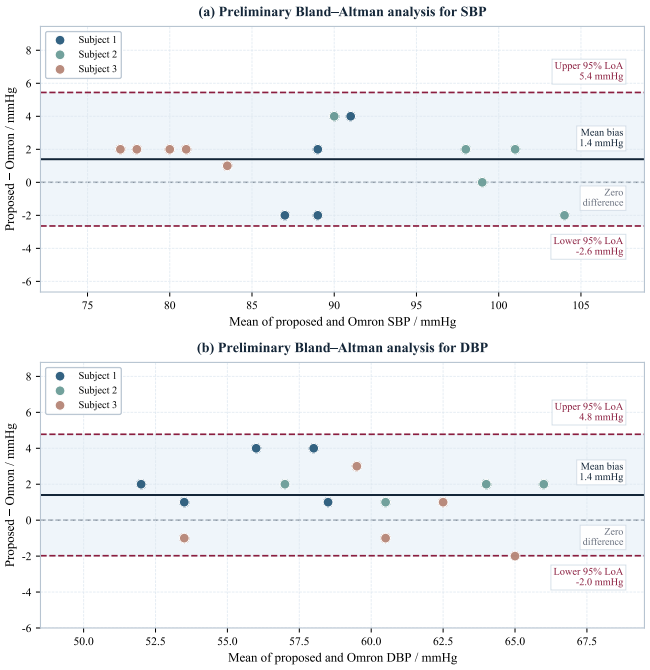

Fig. 4. Bland-Altman plot comparing BEAT system measurements against the Omron heart-level reference for SBP and DBP. The solid line represents mean bias, and dashed lines indicate 95% limits of agreement.

prototypes.

A paired-sample t-test was conducted to compare the measurements. The obtained p-values were 0.0199 for SBP and 0.0072 for DBP. Although these values indicate a statistically significant systematic offset ($p < 0.05$), it is crucial to note that the absolute magnitude of this mean bias (1.4 mmHg) is exceedingly small. This minimal deviation falls well within the strict ± 5 mmHg clinical tolerance established by the AAMI/ESH/ISO universal standards [13]. These findings robustly demonstrate that the BEAT system's foundational accuracy is highly comparable to commercial medical-grade devices, validating the underlying oscillometric algorithm prior to introducing posture variations.

C. Measurement Accuracy Across Various Postures

To evaluate the robustness of the barometric compensation, measurements from the subset of 2 subjects (yielding 10 trials per posture) were analyzed across three arm postures: "Wrist Above Heart", "Heart-Level Posture", and "Wrist Below Heart". Given the short, one-hour experimental window where subjects remained in a resting state, the Omron measurements obtained at heart level were established as the physiological baseline (heart-level Omron reference). Omron readings acquired at non-heart-level postures were not treated as ground truth but rather as posture-affected negative controls to illustrate hydrostatic bias.

Fig. 5 presents the uncompensated (BEAT Raw), compensated (BEAT Corrected), and posture-affected Omron readings across the three positions. Without barometric compensation, the BEAT Raw measurements deviated significantly from the heart-level reference due to hydrostatic pressure. For systolic blood pressure (SBP), the proposed compensation algorithm reduced the overall mean absolute error (MAE) by 56.2% (from 7.61 mmHg to 3.33 mmHg, $p < 0.001$). Posture-specific improvements were substantial: SBP MAE decreased from 9.00 mmHg to 3.54 mmHg (60.7% reduction) in the above-heart posture, and from 9.60 mmHg to 2.22 mmHg (76.9% reduction) in the below-heart posture. As expected, readings at heart level remained unchanged (MAE = 4.24 mmHg), requiring no compensation. The posture-affected Omron readings exhibited a high overall MAE of 9.65 mmHg, confirming the inherent vulnerability of standard oscillometric measurements to vertical displacement.

For diastolic blood pressure (DBP), the overall MAE was reduced by 34.9% (from 6.79 mmHg to 4.42 mmHg, $p = 0.031$). In the wrist-below-heart posture, the DBP MAE notably decreased from 12.10 mmHg to 4.76 mmHg (60.7% reduction). However, in the wrist-above-heart posture, the DBP MAE showed limited improvement (4.70 mmHg to 4.92 mmHg). This divergence is likely attributable to the inherently weaker diastolic oscillometric features at elevated postures, compounded by the small sample size ($N = 2$) of this pilot feasibility study.

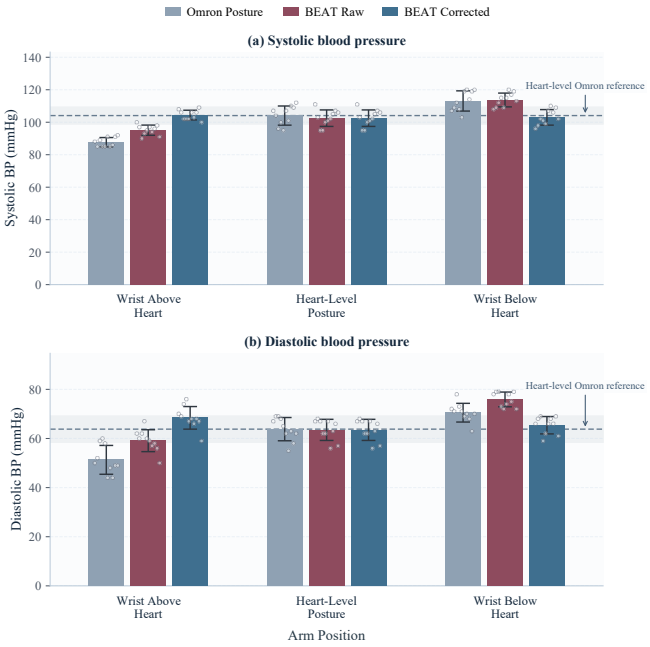

Fig. 5. Posture compensation results for (a) systolic and (b) diastolic blood pressure across three arm positions. The dashed horizontal line and shaded band represent the heart-level Omron reference. The "Omron Posture" bars serve as posture-affected negative controls, illustrating hydrostatic bias when measured away from the heart level. "BEAT Raw" and "BEAT Corrected" denote the proposed system's measurements before and after barometric compensation.

V. Discussion

A. Posture-Invariant Blood Pressure Monitoring: Key Findings

The primary objective of this pilot feasibility study was to evaluate the BEAT system's capacity for posture-invariant BP monitoring via real-time barometric elevation tracking. Our preliminary results (Fig. 5) confirm that hydrostatic pressure introduces significant measurement bias when the wrist deviates from the heart level, as evidenced by both the uncompensated BEAT Raw readings and the posture-affected Omron negative controls. By applying dynamic, real-time hydrostatic compensation ($\Delta P = \rho g \Delta h$), the BEAT Corrected measurements were automatically realigned with the physiological heart-level reference throughout the measurement cycle. The significant reduction in overall SBP MAE (56.2%, $p < 0.001$) demonstrates that our barometric-inertial fusion can effectively neutralize positional errors on-the-fly. This supports the consensus that physical, real-time barometric tracking is a robust, computationally efficient alternative to complex inertial pose-estimation models [7] or restrictive manual alignment [2].

B. Consistency and Advancement Relative to Existing Research

Our findings align with previous observations by Byrd and Brook [10], who identified the 0.77 mmHg/cm hydrostatic shift as a critical clinical error. While earlier studies [7] attempted to address this via deep learning or iterative

calibration, these methods often impose heavy computational burdens. In contrast, our system's *time-multiplexed calibration workflow* (Phase 1, Fig. 1) provides a more elegant, hardware-based solution. By establishing a zero-reference at the phlebostatic axis (hereafter referred to as the heart level), we achieve clinical-grade accuracy comparable to the Omron HEM-series reference [13]. This supports the consensus in the field that barometric sensing is a robust alternative to complex inertial models for mobility-impaired patients [14].

C. Divergent Findings and Physiological Considerations

It is worth noting that some studies using different populations, such as those by Babbs [8] on mathematical modeling, have suggested that arterial stiffness and wave reflection dynamics can significantly influence BP readings. While our study focused on a homogenous cohort of young adults to isolate the barometric compensation effects, the slight residual errors observed may be attributed to these physiological factors. In subjects with advanced arterial stiffness, the relationship between cuff pressure and brachial pulse oscillations may vary. This suggests that while our system is physically robust, individual-specific vascular parameters may eventually need to be integrated into the algorithm for broader clinical application.

D. Limitations and Future Research Directions

Despite these advancements, our study has certain limitations. First, the sample size was relatively small ($N = 3$), which may affect the statistical power of the pilot feasibility assessment. Second, the "human-in-the-loop" requirement for manual calibration at the heart level may limit usability for patients with extremely restricted mobility. To address this, future iterations of BEAT will investigate an "auto-zeroing" protocol, potentially leveraging long-term barometric trends to perform background recalibration. Regarding the signal artifacts observed during the terminal phase of inflation, future research should explore advanced signal decomposition techniques (e.g., Empirical Mode Decomposition) to further improve the SNR.

VI. Conclusion

This study presented BEAT, a novel wrist-worn BP monitoring system that overcomes the fundamental hydrostatic limitations of existing wearable devices. By introducing a detachable, barometric-inertial sensing module and a robust hydrostatic compensation algorithm, we demonstrated that posture-invariant BP measurement is achievable without requiring strict upper-limb positioning. Comparative validations against clinical gold-standard devices show that the proposed system maintains consistent accuracy across standard, elevated, and hanging arm positions. Our work paves the way for a more accessible, convenient, and reliable BP monitoring solution, effectively addressing a significant barrier for patients with restricted mobility in home-based clinical management.

Acknowledgment

The authors thank Prof. Chengzhi Hu for his guidance and advice on sensing technology and biomedical engineering applications.

References

[1] P. Muntner, D. Shimbo, R. M. Carey, J. B. Charleston, T. Gaillard, S. Misra, M. G. Myers, G. Ogedegbe, J. E. Schwartz, R. R. Townsend *et al.*, "Measurement of blood pressure in humans: a scientific statement from the american heart association," *Hypertension*, vol. 73, no. 5, pp. e35–e66, 2019.

[2] J. E. Sharman, I. Tan, G. S. Stergiou, C. Lombardi, F. Saladini, M. Butlin, R. Padwal, K. Asayama, A. Avolio, T. M. Brady *et al.*, "Automated 'oscillometric' blood pressure measuring devices: how they work and what they measure," *Journal of Human Hypertension*, vol. 37, no. 2, pp. 93–100, 2023.

[3] J. B. Byrd and R. D. Brook, "Arm position during ambulatory blood pressure monitoring: a review of the evidence and clinical guidelines," *The Journal of Clinical Hypertension*, vol. 16, no. 3, pp. 225–230, 2014.

[4] E. Casiglia, V. Tikhonoff, F. Albertini, and P. Palatini, "Poor reliability of wrist blood pressure self-measurement at home: a population-based study," *Hypertension*, vol. 68, no. 4, pp. 896–903, 2016.

[5] A. R. Khoshdel, S. Carney, and A. Gillies, "The impact of arm position and pulse pressure on the validation of a wrist-cuff blood pressure measurement device in a high risk population," *International Journal of General Medicine*, pp. 119–125, 2010.

[6] M. Forouzanfar, H. R. Dajani, V. Z. Groza, M. Bolic, S. Rajan, and I. Batkin, "Oscillometric blood pressure estimation: Past, present, and future," *IEEE Reviews in Biomedical Engineering*, vol. 8, pp. 44–59, 2015.

[7] D. A. Colburn, T. L. Chern, V. E. Guo, K. A. Salamat, D. N. Pugliese, C. K. Bradley, D. Shimbo, and S. K. Sia, "A method for blood pressure hydrostatic pressure correction using wearable inertial sensors and deep learning," *npj Biosensing*, vol. 2, no. 1, p. 5, 2025.

[8] F. Massé, R. R. Gonzenbach, A. Arami, A. Paraschiv-Ionescu, A. R. Luft, and K. Aminian, "Improving activity recognition using a wearable barometric pressure sensor in mobility-impaired stroke patients," *Journal of NeuroEngineering and Rehabilitation*, vol. 12, pp. 1–15, 2015.

[9] A. Manivannan, W. C. B. Chin, A. Barrat, and R. Bouffanais, "On the challenges and potential of using barometric sensors to track human activity," *Sensors*, vol. 20, no. 23, p. 6786, 2020.

[10] G. S. Stergiou, B. Alpert, S. Mieke, R. Asmar, N. Atkins, S. Eckert, G. Frick, B. Friedman, T. Graßl, T. Ichikawa *et al.*, "A universal standard for the validation of blood pressure measuring devices: Association for the advancement of medical instrumentation/european society of hypertension/international organization for standardization (aami/esh/iso) collaboration statement," *Hypertension*, vol. 71, no. 3, pp. 368–374, 2018.

[11] L. Geddes, M. Voelz, C. Combs, D. Reiner, and C. Babbs, "Characterization of the oscillometric method for measuring indirect blood pressure," *Annals of Biomedical Engineering*, vol. 10, pp. 271–280, 1982.

[12] T. G. Pickering, J. E. Hall, L. J. Appel, B. E. Falkner, J. Graves, M. N. Hill, D. W. Jones, T. Kurtz, S. G. Sheps, and E. J. Roccella, "Recommendations for blood pressure measurement in humans and experimental animals: part 1: blood pressure measurement in humans: a statement for professionals from the subcommittee of professional and public education of the american heart association council on high blood pressure research," *Circulation*, vol. 111, no. 5, pp. 697–716, 2005.

[13] Association for the Advancement of Medical Instrumentation, "Non-invasive sphygmomanometers - Part 2: Clinical investigation of automated measurement type," Association for the Advancement of Medical Instrumentation, Arlington, VA, American National Standard ANSI/AAMI/ISO 81060-2:2013, 2013.

[14] A. Chandrasekhar, M. Yavarimanesh, J.-O. Hahn, S.-H. Sung, C.-H. Chen, H.-M. Cheng, and R. Mukkamala, "Formulas to explain popular oscillometric blood pressure estimation algorithms," *Frontiers in Physiology*, vol. 10, p. 1415, 2019.

[15] M. K. Armstrong, M. G. Schultz, D. S. Picone, J. A. Black, N. Dwyer, P. Roberts-Thomson, and J. E. Sharman, "Brachial and radial systolic blood pressure are not the same: evidence to support the popeye phenomenon," *Hypertension*, vol. 73, no. 5, pp. 1036–1041, 2019.