

Wearable Sensing Devices and Technology

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The field of wearable sensing devices and technology has witnessed remarkable advancements, driven by the need for more integrated, efficient, and user-friendly systems. This Special Issue has compiled a collection of significant contributions that address various aspects of wearable technology, ranging from healthcare applications to novel sensing mechanisms and data processing techniques.

The papers in this Special Issue have collectively addressed several critical gaps in the current body of knowledge:

1. Authentication and security:

- **MetaEar:** This paper introduces an innovative approach to continuous authentication using imperceptible acoustic side channels, enhancing security without compromising user experience. This method leverages the Enhanced Reverberation Transfer Function (ERTF) for imperceptible authentication, filling the gap in secure yet user-friendly authentication methods for wearables (Contributor 1).

2. Localization in wireless sensor networks:

- **A novel anchor-free localization method:** This study presents a cross-technology communication-based method for anchor-free localization in wireless sensor networks. It bridges the gap in efficient and accurate localization techniques necessary for robust wearable applications in dynamic environments (Contributor 2).

3. Sign language recognition:

- **Data glove with bending sensor and inertial sensor:** the introduction of a weighted DTW fusion technique for sign language recognition demonstrates significant improvements in accuracy and usability, addressing the need for more effective communication aids for the hearing-impaired (Contributor 3).

4. Healthcare systems:

- **MDP-based MAC protocol for WBANs:** this paper discusses a new MAC protocol designed for wireless body area networks (WBANs) in edge-enabled eHealth systems, enhancing the reliability and efficiency of health monitoring (Contributor 4).
- **Lidom:** a predictive model for disease risk in nursing homes using LightGBM, providing a valuable tool for proactive healthcare management (Contributor 5).
- **Usability of inexpensive optical pulse sensors:** this study evaluates the integration of optical pulse sensors into textiles, highlighting advancements in affordable and non-invasive heart rate monitoring (Contributor 6).
- **Dynamic fall detection:** using graph-based spatial-temporal convolution and attention networks, this research improves fall detection systems' accuracy and response times, crucial for elderly care (Contributor 7).



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- **Gait for Parkinson's Disease:** This study investigates the reduced upper-limb swing capabilities during gait in Parkinson's Disease (PD) patients. It employs a viscoelastic model to assess forearm swing, comparing PD patients to healthy individuals (Contributor 8).
 - **IoT-based home telehealth system:** this preliminary study explores smart healthcare by monitoring sleep and water usage, offering insights into home-based health monitoring innovations (Contributor 9).
5. **Enhancing user experience:**
- **Enhanced wearable force-feedback mechanism:** the development of a free-range haptic experience extended by mixed reality showcases advancements in user interaction and immersion in virtual environments (Contributor 10).
 - **VR drumming pedagogy:** this paper explores action observation and virtual co-embodiment in VR drumming, providing innovative approaches to music education and training (Contributor 11).
6. **Positioning and movement analysis:**
- **Smarter positioning through GNSS and multi-sensor data:** this research enhances positioning accuracy using raw GNSS and multi-sensor data, crucial for navigation and tracking applications in wearables (Contributor 12).
 - **PIFall:** a novel fall detection system using pressure insoles and ResNet3D, addressing the need for reliable fall detection in elderly care (Contributor 13).

Future Research Directions

The advancements presented in this Special Issue open several avenues for future research:

- **Interdisciplinary integration:** combining insights from materials science, data science, and human–computer interaction to develop more sophisticated wearable devices.
- **Scalability and miniaturization:** further miniaturizing sensors and improving battery life to enhance wearability and convenience.
- **Enhanced security:** continuing to explore secure, non-intrusive authentication methods to protect user data in wearable devices.
- **Personalized healthcare:** advancing predictive models and real-time monitoring to provide personalized healthcare solutions tailored to individual needs.
- **User experience:** improving user interfaces and feedback mechanisms to make wearable technology more intuitive and engaging.

This Special Issue has provided a comprehensive overview of the current state of wearable sensing devices and technology, addressing key challenges and setting the stage for future innovations. We look forward to witnessing the continued evolution of this dynamic field, driven by the collaborative efforts of researchers and practitioners worldwide.

Conflicts of Interest: The authors declare no conflicts of interest.

List of Contributions

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