

## **Personalized Joint Radial Rotation Angle Estimation Based on Dual-Sensor Signal Coupling**

Wenli Mao<sup>1</sup>, Yang yang<sup>1,2</sup>, Jue hou<sup>1,2</sup>, Zheng Liu<sup>1,2\*</sup>

<sup>1</sup> *International Institute of Fashion Technology, Zhejiang Sci-Tech University, Hangzhou, Zhejiang 310018, China*

<sup>2</sup> *Zhejiang-France Joint Laboratory of Digital Fashion, Zhejiang Sci-Tech University, Hangzhou, Zhejiang 310018, China*

\*Presenter's email: [koala@zstu.edu.cn](mailto:koala@zstu.edu.cn)

### **ABSTRACT**

Flexible sensors have become an essential component in wearable systems for human motion monitoring due to their stretchability and seamless integration into garments. However, current methods largely depend on skin-strain cues from sagittal movements, limiting their ability to capture radial rotation, which induces coupled torsional deformation. Furthermore, the mechanical interaction between sensors and the skin varies considerably across individuals, resulting in substantial performance degradation in posture estimation. To overcome these limitations, this study introduces a skin-deformation-driven framework for quantifying radial rotational angles. A dual sensor cooperative system captures multidimensional deformation, and a personalized deep learning model integrates multi-sensor cues while compensating for inter individual differences. Experimental results demonstrate that the proposed method achieved a mean absolute error of 8.85° and an estimation accuracy of 93.21%, reducing estimation error by 17.66% compared to baseline methods. Validation across 20 participants with BMI ranging from 17.9 to 29.4 confirms the robustness of the framework under diverse anthropometric conditions and motion speeds. Overall, this work highlights the potential of flexible sensing for accurate, continuous monitoring of complex human motion and provides a solid foundation for future developments in wearable ergonomics, rehabilitation assessment, and human-computer interaction.