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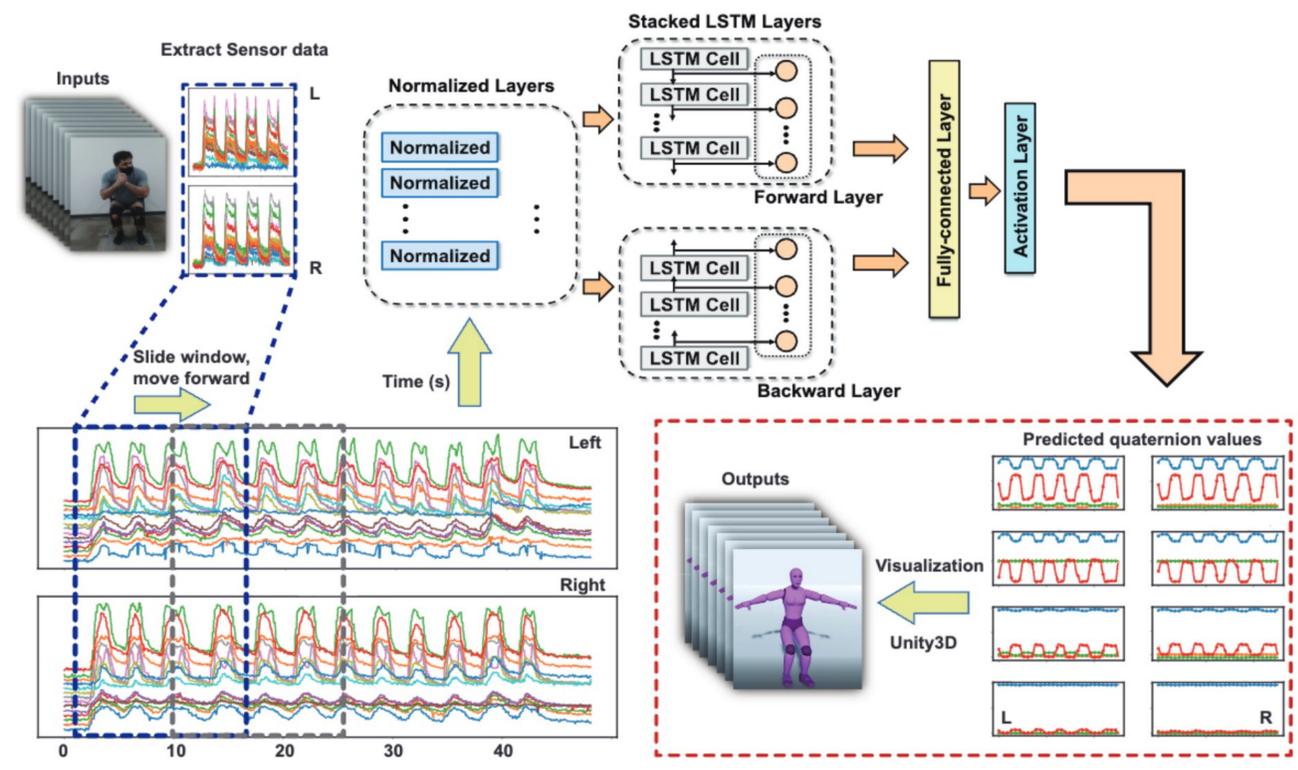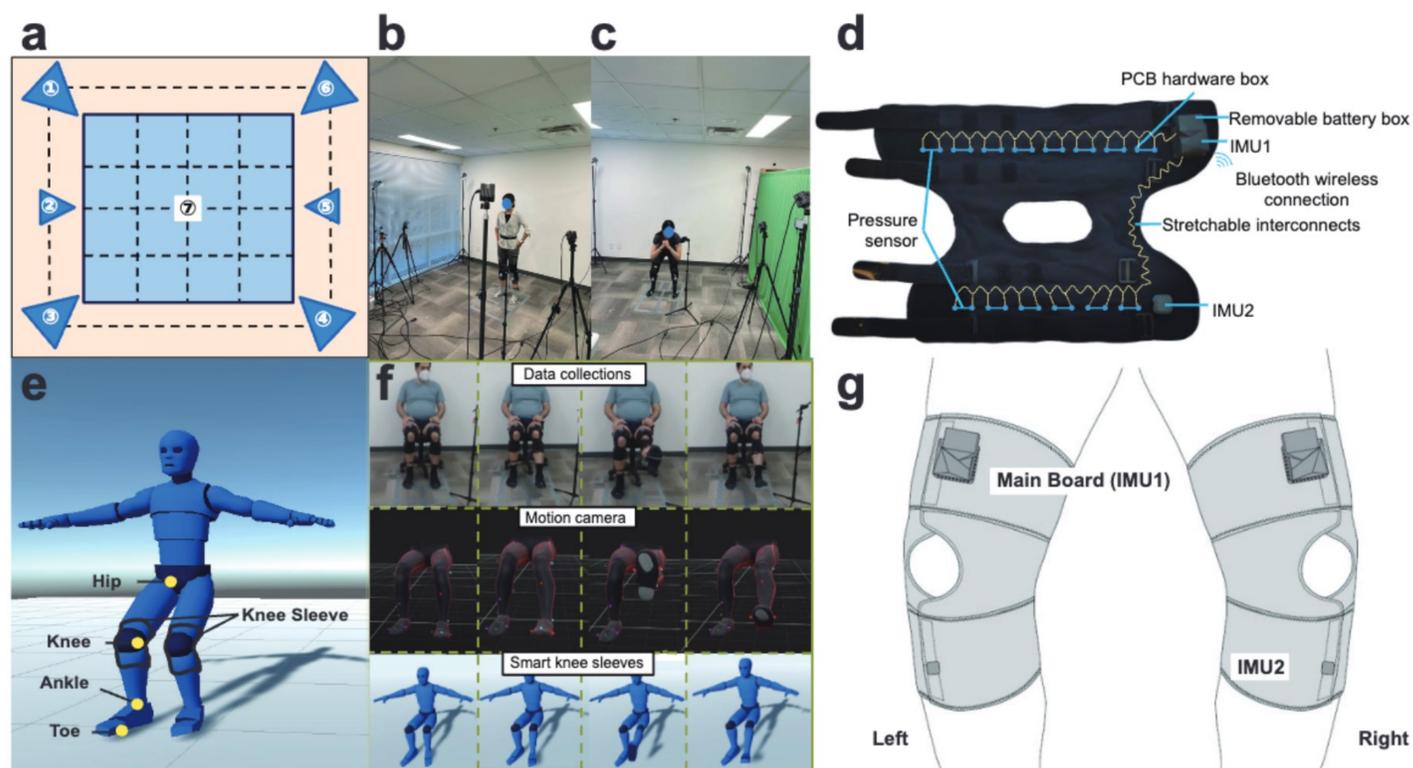
Intelligent Knee Sleeves: A Real-time Multimodal Dataset for 3D Lower Body Motion Estimation Using Smart Textile

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Introduction

The kinematics of human movements and locomotion are closely linked to the activation and contractions of muscles. To investigate this, we present a multimodal dataset with benchmarks collected using smart wearables for human pose estimation. Our system utilizes synchronized datasets that comprise time-series data from the Knee Sleeves and the corresponding ground truth labels from visualized motion capture camera system. We employ these to generate 3D human models solely based on the wearable data of individuals performing different activities. We demonstrate the effectiveness of this camera-free system and machine learning algorithms in the assessment of various movements and exercises including extension to unseen exercises and individuals.

Results

The results show an average error of 7.21 degrees across all eight lower body joints when compared to the ground truth, indicating the effectiveness and reliability of the Knee Sleeve system for the prediction of different lower body joints beyond knees. Our work offers a novel sensing modality that complements traditional vision systems and enables human pose estimation without being impacted by visual obstructions in a seamless and confidential manner. This innovation has potential applications from home fitness to sports analysis, personalized healthcare, and physical rehabilitation focusing on pose and movement estimation.

Scene	Pose	LHip	LKnee	LAnkel	LToe	RHip	RKnee	RAnkel	RToe
All_seen	Avg	9.03	11.80	6.23	3.81	9.31	7.69	7.04	2.77
Unseen Tasks	BendSquat	17.50	14.20	12.30	4.25	17.90	15.10	12.10	5.12
	Hamstring Curl	12.70	18.00	6.13	2.71	12.40	16.90	6.49	4.13
	Leg Raise	10.20	19.80	9.05	2.56	9.55	16.20	9.29	5.50

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