ABSTRACT

Postoperative recovery is a crucial phase in ensuring successful rehabilitation. However, many healthcare facilities face challenges due to the limited availability of medical personnel, making routine patient monitoring difficult. This limitation can lead to delays in the early detection of complications and decrease the overall effectiveness of recovery. To address this issue, this study proposes a non-invasive, radar-based remote monitoring system for postoperative patients. The system utilizes the IWR6843AOP radar to generate 3D point cloud data that spatially represents patient movements. This approach enables continuous monitoring without compromising patient privacy, allowing healthcare professionals to provide more efficient care and to monitor patients in remote areas. The collected data undergoes several preprocessing steps, including normalization, labeling, and dataset splitting, before being classified using deep learning models such as CNN, 3D CNN, CNN-Bi-LSTM, and PointNet. The dataset consists of six activity categories: empty space, sitting, standing, walking, walking using tool, and squatting, recorded at a frame frequency of 18.18 Hz.Experimental results demonstrate that the hybrid CNN-BiLSTM model achieves the highest accuracy (99.39%), precision (0.9939), and F1-score (0.9939) with the lowest MAE (0.012), outperforming 3D-CNN (88.54%), PointNet (88.79%), and standalone CNN (89.95%). The dataset, collected from five participants performing six activities (walking, sitting, standing, squatting, walking using tool, and empty room), was processed at 18.18 Hz frame rate and normalized using StandardScaler. This study pioneers a novel integration of mmWave radar with a hybrid CNN-BiLSTM architecture, achieving state-of-the-art accuracy (99.39%) in classifying rehabilitation-specific activities. The framework demonstrates significant potential for deployment in resource-constrained healthcare settings, reducing clinical workloads compared to manual monitoring. This technology holds significant potential for broader healthcare applications, contributing to more advanced, accessible, and technology-driven patient monitoring systems. By integrating artificial intelligence and radar sensing, this research paves the way for innovative solutions in modern healthcare, ensuring better postoperative rehabilitation outcomes while optimizing medical resources, especially in remote areas with limited medical personnel

Keywords: HAR, Health Rehabilitation, CNN-BiLSTM, mmWave Radar.