ABSTRACT

Human Activity Recognition (HAR) technology, particularly in contactless HAR systems, is widely utilized in healthcare monitoring applications. Cameras are often employed as sensors to monitor human activities. However, the use of cameras in HAR systems frequently raises privacy concerns. In addition, cameras have limitations in accurately classifying human activities. This study focuses on the development of a contactless HAR system based on Frequency Modulated Continuous Wave (FMCW) radar technology, with the aim of producing an accurate system that does not rely on visual data, thereby preserving individual privacy.

This research employs four types of activities as classification targets: standing, sitting, walking, and falling. Point cloud data obtained from the FMCW radar are processed using the PointNet algorithm based on deep learning. In the pre-processing stage, a bootstrapping method based on the Gaussian Mixture Model (GMM) is applied to balance the number of points in each timestamp uniformly without altering the spatial distribution of the data. Subsequently, a windowing method is used to divide the data into segments of 30 timestamps with a one-timestamp shift between consecutive segments, enabling continuous analysis. In addition to 3D coordinates as the main features, the system also incorporates two additional features: Doppler values and the Signal-to-Noise Ratio (SNR).

Evaluation results using metrics such as accuracy and confusion matrix demonstrate that the GMM-based bootstrapping process successfully generates synthetic point clouds with a consistent number of points in accordance with the model input requirements. The developed PointNet model achieved an accuracy of 99.9% in controlled testing. However, in real-time testing, the accuracy decreased to 71.4%, based on seven trials for each class.

Keywords: *Deep Learning, FMCW Radar, Human Activity Recognition, Point Cloud, PointNet.*