Human Activity Recognition Using Radar

Vinay Joshi, UNC Charlotte
Hongfei Xue, College of Computing and Informatics

Introduction

The classification of human activity Using radar have many real life applications, such as:
- Autonomous vehicles
- Surveillance
- senior care

We have utilized the 'micro-Doppler' signatures reflected by humans during activities. This enables us to classify activity.

Objectives

Why use Radar to classify human activity?

- Radar signals have longer wavelengths which allows it to go through many obstacles

- The radar data we collect only contains activity data, and does not include biological data such as facial features or height.
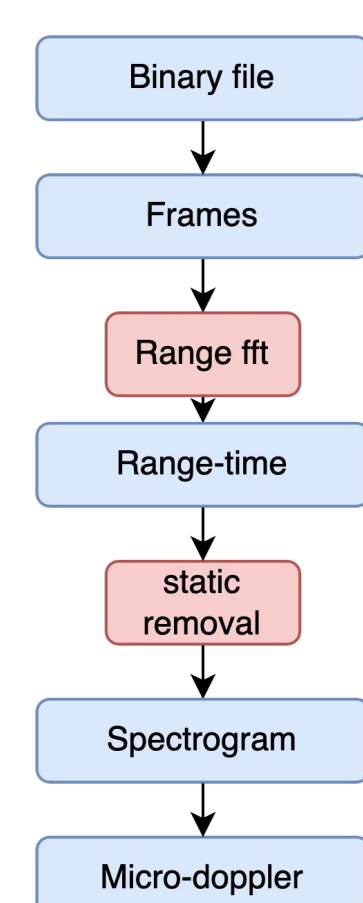
Method

Data Collection

- We use the TI-AWR-1843-boost radar to collect our data, which is stored in binary files. We also utilized a public dataset.

Radar → UDP → Binary file

Data Processing

- The data is processed into micro-Doppler images and also utilizes a public dataset.

Binary file → Frames → Range fft → Range-time → static removal → Spectrogram → Micro-doppler

Method

Data Classification

- The micro-Doppler images from the public dataset are then classified by a pretrained ResNet model to determine the activity.

Micro-doppler / Dataset → ML classification ← Train → ResNet → Activity Classification
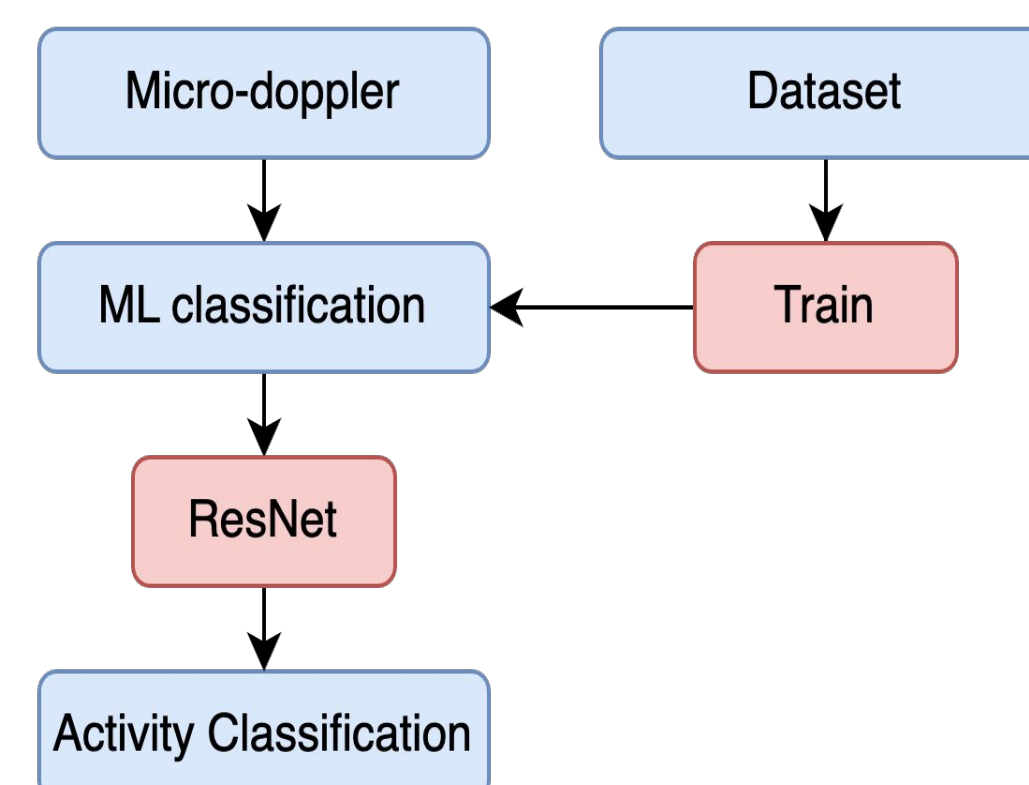
Conclusions

- The data exhibits distinct features corresponding to three activities: hand waving, sitting down and standing up, and walking back and forth.

- The ML algorithm will distinguish between them based on the spectrogram characteristics.

- This data can be further expanded to include many other activities, making it suitable for general-purpose human activity classification.

Results

- The micro-Doppler features include walking, sitting down, standing up, and hand waving. For the public dataset, we have drinking water, sitting down, and walking.

Drinking Water | Sitting Down | Walking

Hand Waving | Sitting down and standing up | Walking
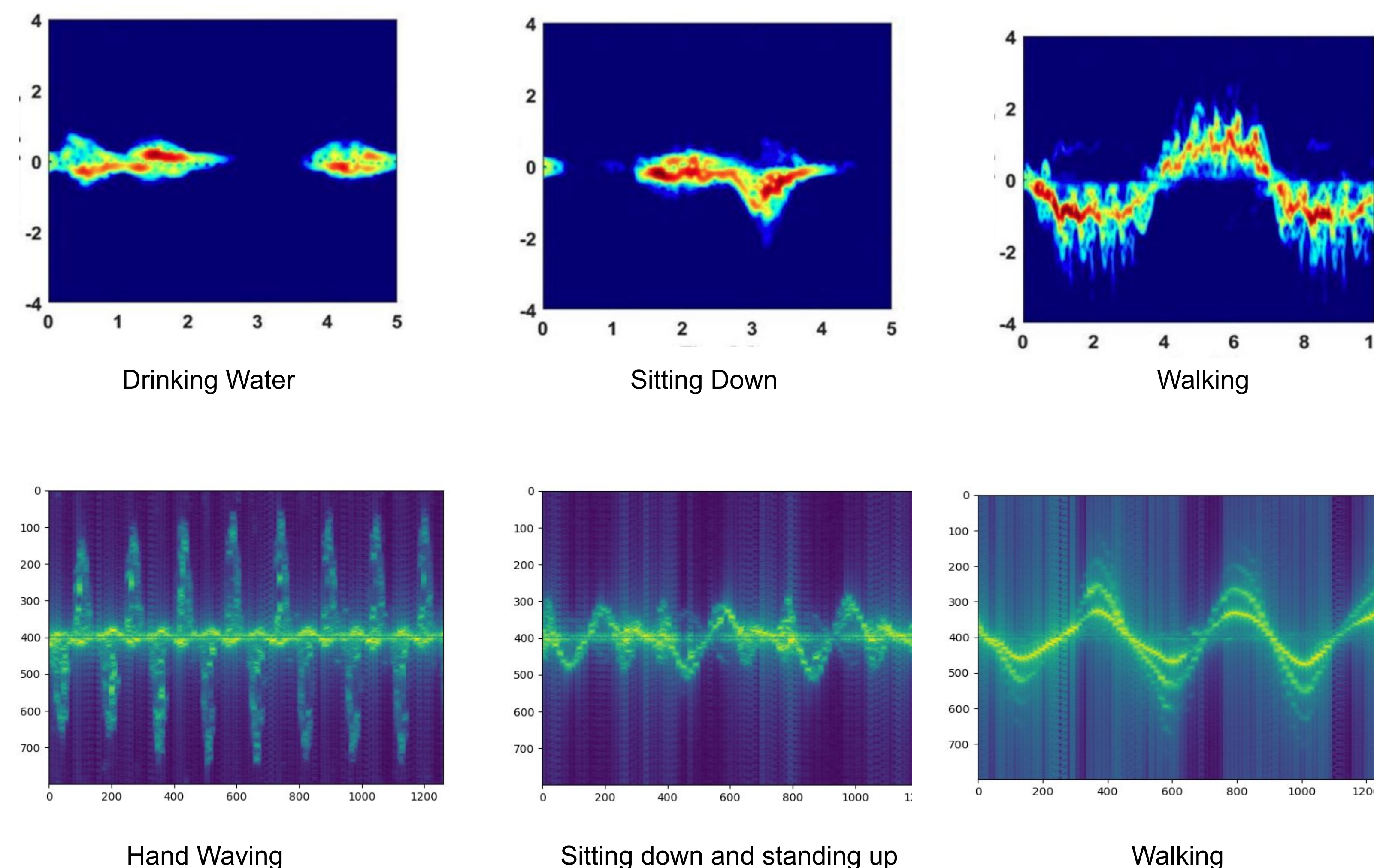
- The machine learning model, which was trained on public data, achieved an accuracy of around 63%.
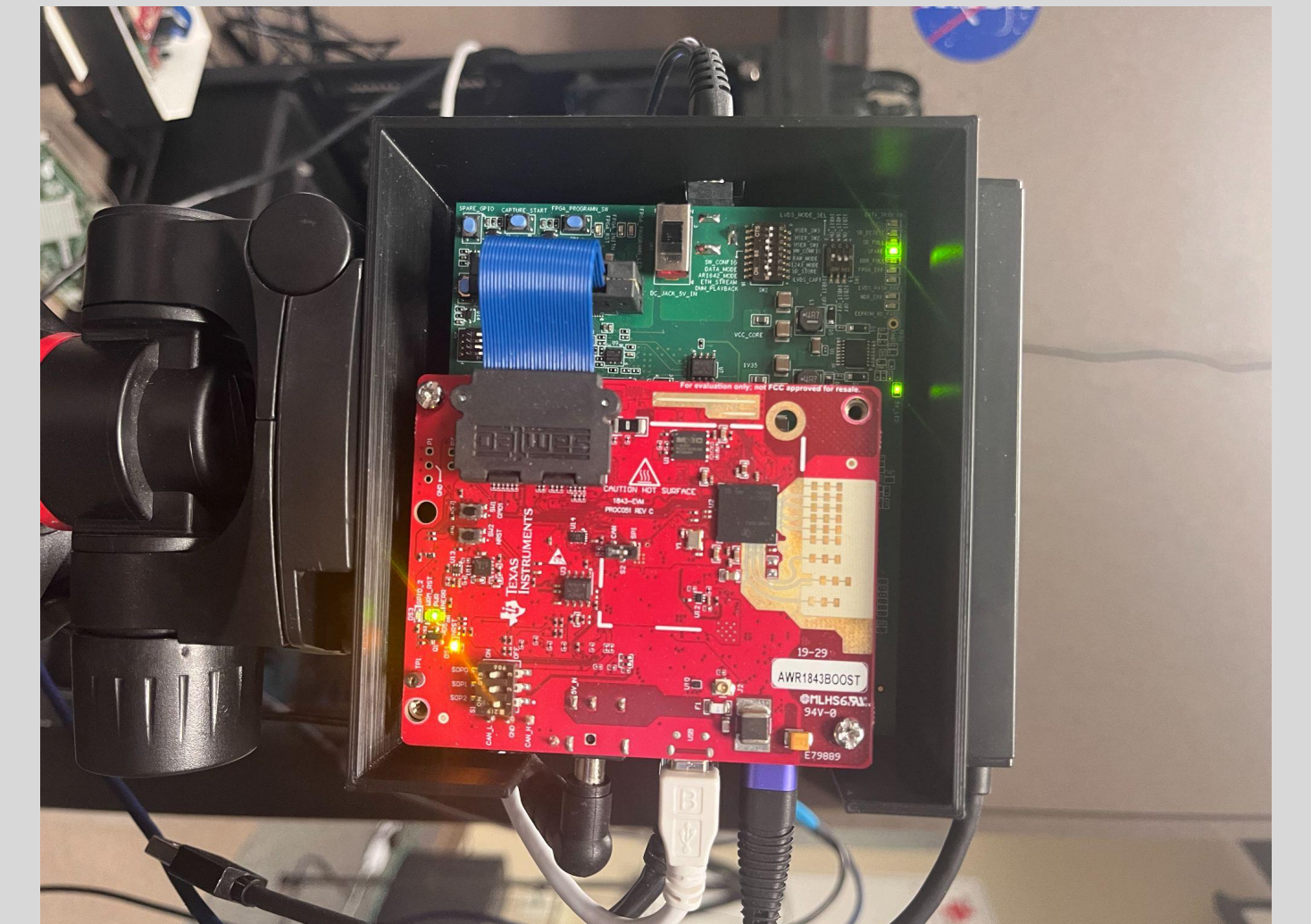
AWR-1843-boost radar

Future Work

- The machine learning model has only been trained on the public dataset and should be trained on our dataset.
- We have used pretrained models like ResNet and should consider training our dataset on other machine learning models such as deep convolutional neural networks, ReLU, and K-nearest neighbor algorithms.
- Training the dataset with various distances can enhance the robustness of ML classification.

References

- Youngwook Kim and H. Ling, "Human activity classification based on micro-Doppler signatures using an artificial neural network," 2008 IEEE Antennas and Propagation Society International Symposium, San Diego, CA, USA, 2008, pp. 1-4, doi: 10.1109/APS.2008.4619933.

- Taylor W, Dashtipour K, Shah SA, Hussain A, Abbasi QH, Imran MA. Radar Sensing for Activity Classification in Elderly People Exploiting Micro-Doppler Signatures Using Machine Learning. Sensors. 2021; 21(11):3881. https://doi.org/10.3390/s2111388

- Hongfei Xue, Yan Ju, Chenglin Miao, Yijiang Wang, Shiyang Wang, Aidong Zhang, and Lu Su. 2021. MmMesh: towards 3D real-time dynamic human mesh construction using millimeter-wave. https://doi.org/10.1145/3458864.3467679