Classification of Human Movement using mmWave FMCW Radar Micro-Doppler Signature

Edwin Pan
epan2@illinois.edu

Jingning Tang
jtang10@illinois.edu

1. Introduction

As the form factor of the millimeter wave (mmWave) radar hardware decreases drastically, radar is growing into a competitive sensing platform complementing other sensing modalities such as camera and LiDAR. Compared to camera, radar is immune to bad weather and able to detect objects with minimal intrusion of people's privacy. Radar is also naturally sensitive to phase shift and therefore is superior in detecting the speed and micro-motion of the target. The micro-motion, commonly referred as micro-Doppler, signature of the target can be regarded as unique, and it provides additional information that is complementary to existing methods for target classification and recognition[4]. For our final project in Machine Learning in Signal Processing (CS 598 PS), we propose to extract micro-Doppler signature from human and dogs, learn how to classify them in a radar-based solution.

2. Background

This is a continuation of a project started within the Alchemy program. These projects span a total of 18-months and aim to bring deep technology to commercial viability. Our current pipeline is called OpenRadar[2], and performs all radar signal processing tasks from ADC data input to object tracking with Extended Kalman Filter (EKF). We are using a Texas Instruments^{TM}mmWave radar platform. A lot of the core low-level DSP code we have developed will be reused. The aim is to use the gathered data from the OpenRadar pipeline, our knowledge gained through this course, and a touch of personal ingenuity, to address many higher level problems such as noise reduction, classification and source separation. It will justify the work counted for the grade of this course and also boost the progress of our mmWave radar project.

3. Procedure

Easy - Something Achievable

1. Reliable extraction of micro-Doppler spectrogram to minimize re-computation in the DSP chain.
2. noise reduction due to multi-path reflection, ground bounce, etc. with classic radar algorithms.
3. classification of different human-movement (walking, running, squatting, etc).

Intermediate - Something Technically Challenging

1. Define source separation problem. Explore the feasibility of extracting multiple targets' micro-Doppler signature.
2. Multiple targets can be different people or different animals. Source separation of human walking a dog, with the prior of human and dog walking pattern. Source separation of multiple humans walking at the same time.

Hard - Something Worthy of Publication

1. Explore the feasibility of wavelet[3] instead of FFT on Spectrogram.
2. Explore the feasibility of tracking the micro-Doppler of moving target.
3. Explore if the heartbeat and respiration rate of human can be detected[1].

References

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