Radar Waveform Classification Example Design

1.0 Example Design

Description

The Doppler effect is a frequency shift or wavelength change in a reflection signal when a target moves or makes a change in a relative distance to an observer. While a bulky motion of an entire body part of the target generates the Doppler effect, its micro-movements of detailed structure can also create micro frequency shifts, which is called the micro-Doppler effect. This micro-Doppler signal reflects fine movements of the target, such as vibration, rotation, tumbling, or coning, etc., and these movement are unique and have certain patterns depending on objects or their motions.

Intel's Radar waveform classification example design is built to recognize unique micro-Doppler signatures of a target using a Convolutional Neural Network (CNN) model. It trains a probabilistic model to learn specific patterns or features of a target over prelabeled data set. It recognizes a target with such signatures easily based on the trained CNN model. A CNN is a popular method to be used for object recognition or classification of two-dimensional data formats, such as images, so the example design is intended to recognize a spectrogram of the target as input for an inference.

The example design accepts raw reflection signal data in time domain as input and produces a classification result based on a convolutional neural network model. The classification sequence has two steps to process: spectrogram and inference. Firstly, it converts reflection signal into a spectrogram using a short time FFT, where micro-doppler patterns appear. These motions are not deterministic, but rather probabilistic having certain patterns that is hard to be formulated clearly with an existing method. Then, the pretrained CNN model infers a target from these patterns.

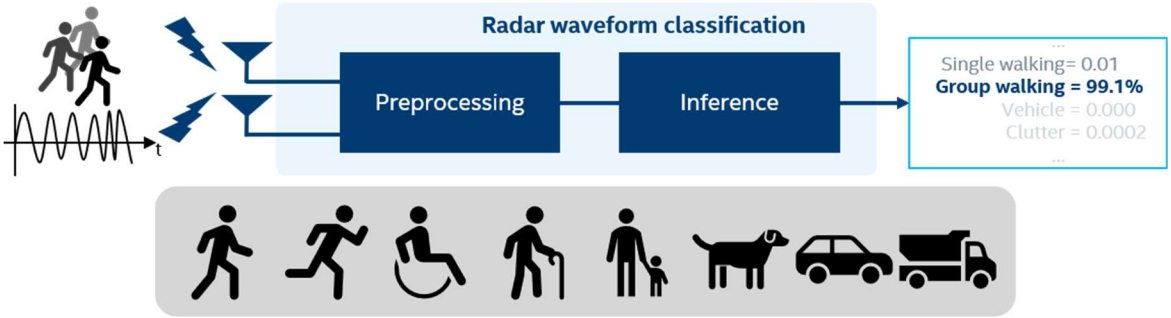
The CNN model used in the inference engine is trained using CAFFE, an open-sourced deep learning framework, and Intel OpenVINO™ optimizes the trained model to import to the inference engine running in Intel CPU or Intel Arria 10 FPGA. The classification sequence run in CPU and/or FPGA and an interface between them is also handled by OpenVINO™.

Features

- Micro-Doppler classification
- Real-time radar waveform recognition
- A pretrained CNN model for 96W×513H×3D data in 7 classes
- An imported CNN model to Intel Arria 10 FPGA and Intel CPU using an OpenVINO™
- Running on Intel Arria 10 Dev kit board

Applications

- Autonomous vehicle
- Surveillance radar for military
- Robotics



Target object examples

101 Innovation Drive
San Jose, CA 95134

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