Investigation of Human Micro-Doppler Features in Foliaged Environments

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Remote detection and tracking of human subjects in a forested environment is an important component for border security as well as search and rescue missions. One promising technique, Doppler radar, utilizes the Doppler effects to monitor motions of the human body. In addition to the measurement of a human's torso velocity, Doppler radar allows measurement of the limbs' velocities- known as micro-Dopplers - enabling classification of targets based on the unique motion signatures. However, in a forested environment, such micro-Doppler features may be less distinguishable due to higher path loss, multi-scatterings between human and trees, and foliage motions caused by wind. Kilic, et. al., simulated human micro-Doppler returns of a 5GHz Doppler radar in a forested environment (*Kilic, et.al., Radio Sci., 50, 238–248,2015*); however, no experimentation or classification is performed. Narayanan claims to be the first to classify human motion in a vegetation cluttered environment through the use of a support vector machine (SVM) (*R.M. Narayanan, International Journal of Microwave Science and Technology, vol. 2014, Article ID 958905, 21 pages, 2014*); however, the foliage was a single bush which does not represent a highly cluttered environment.

The focus of this work is on measuring and classifying human micro-Doppler features in forested environments. As a first step, measurements and simulations of human motion activities were performed in an open space environment to establish the baseline of this study. Next, forest measurements were taken at two locations in a local park for: different frequencies (2.45, 5 and 10 GHz), different activities (walking, running and crawling), and different number of subjects (1 or 2). Each event was measured for 20 seconds using a vector network analyzer (VNA) and post-processed into spectrograms using joint time-frequency transforms. Finally principle component analysis was used on the spectrograms to classify human motion activities. The results were compared between open field and forest cases.