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Detection and Classification of Consumer Drones Using Low Cost Radars

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Radar has been used since WWII for detection and tracking of large objects such as airplanes and ships (Skolnik, 2018), while detection and classification of small objects is a recent innovation. In particular, Doppler radar, which measures frequency variation in the returned signal cause by target motion and is commonly used in weather radar systems (US Department of Commerce & NOAA, 2018), has been successfully used to discern between birds and drones (Rahman & Robertson, 2018). If such a system could provide the type, size, and origin (commercial or military) of the drone in question, as well as the potential for unique hardware identification it could be utilized for safety purposes. While several commercial systems exist or are in development (Echodyne, 2019) they rely on custom hardware and software tailored for a specific use case. Extending this detection and classification with the use of readily-available low-cost commercial radar systems could provide a cost effective and easily accessible solution. Drones and quadcopters are available on the consumer level which opens the possibility of misuse, whether intention or unintentional. Just having the ability to detect and classify could aid in the decision-making process when it comes to event impacted by drone or quadcopter use.

The question that was set out to be answered was to determine if small, inexpensive, and low-powered radar systems could be used to detect and classify small drones and quadcopters using micro-doppler radar. Our research approach was to use the Analog Devices Demorad 24 GHz radar to measure active radar returns from a number of drone and quadcopter targets. The first research goal was to determine the maximum detection range of our radar system. We expect this range will be highly dependent on drone size (scattering cross-section). The second research goal was be to extract features from the RF signals that can be used to classify the different drones. We planned to use micro-Doppler, an analysis technique which looks at the Doppler shift (change in signal frequency) caused by each of the propellers. This phenomenon creates a unique pattern in a time-frequency spectrogram representation of the data.

What was found out was that the drones can be detected but the raw doppler data from the factory set system software didn’t provide enough detail to determine any distinguishing features that can be used for classification purposes. Future research will include possible manipulation of the software code to be able to identify those features. This is an important part of the future research because it will allow the user to what the shape of the drone, propeller number and placement, and even relative size. The radar was tested in a 3-10-meter range which is a relatively short distance but once the software code is optimized, it will be able to detect the drone as well as its features at a great distance.

Citations

Echodyne. (2019). Retrieved from https://echodyne.com/

Rahman, S., & Robertson, D.A., “Radar micro-Doppler signatures of drones and birds at K-band and W-band”, *Nature Scientific Reports*, 8:17396, 2018 DOI:10.1038/s41598-018-35880-9

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