PASSIVE RADAR – A LOW-COST TESTBED SYSTEM

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Passive radar [1] is a type of radar which unlike traditional active radar systems uses existing transmitters in the environment. By using these existing receivers, they have the potential to be low-cost, low-power and portable, as they do not need to include any high-powered electronics in the transmitter. The existing transmitters are commonly broadcast communication systems like digital radio (DAB) and digital television (DVB-T), as they have city-wide coverage and have desirable signal characteristics in terms of frequency spectrum. The passive radar receiver will receive the signal being transmitted from the transmitter, as well as delayed and frequency shifted copies of this signal for each reflecting object in the environment.

The gain of the antenna or antenna system, and the choice of digitising circuitry has a significant impact on the detection capability of the radar system. This is because the strength of the signal reflecting off targets is relatively weak compared to the signal directly arriving from the transmitter, there is a significant need to introducing system and processing gain into the target detection. Without doing these, the dynamic range required to not saturate the receivers from the strong transmitted signal and also receive information from the weak targets would be too large.

The processing gain is implemented in a few ways. Firstly, the signal from the transmitter can be attenuated by the geometry of the environment. By placing a building between the transmitter, an “over-the-shoulder” radar configuration is produced, decreasing the direct path by over 10 dB. Secondly by use of a directional antenna towards the surveillance area, the strength of the target signal (12 dB from a Yagi) is further increased relative to the strong direct signal. Lastly by selecting a long integration time (0.5 seconds) the strength of the target signal is increased, meanwhile the noise is averaged.

An example of low-cost passive-radar system is presented in Fig. 1. Data collected from a digital radio (DAB) transmitter being used as the illuminator, and the target is an airplane on its journey to Brisbane airport. The line-of-sight distance between the transmitter and the receiver is around 5 km, and the airplane is a little under 5 km from the receiver. The system is built using a low-cost software defined radio (RTL-SDR) which has a cost of ~$10 AUD, and a 12 element Yagi antenna is used. The centre frequency of the illumination signal was 204.64 MHz with a bandwidth of 1.5 MHz. The software defined radio captured data at 2 MS/second with 8-bit resolution.

Other systems use higher bandwidth receivers and consider multiple antennas and appropriate detection algorithms [2].

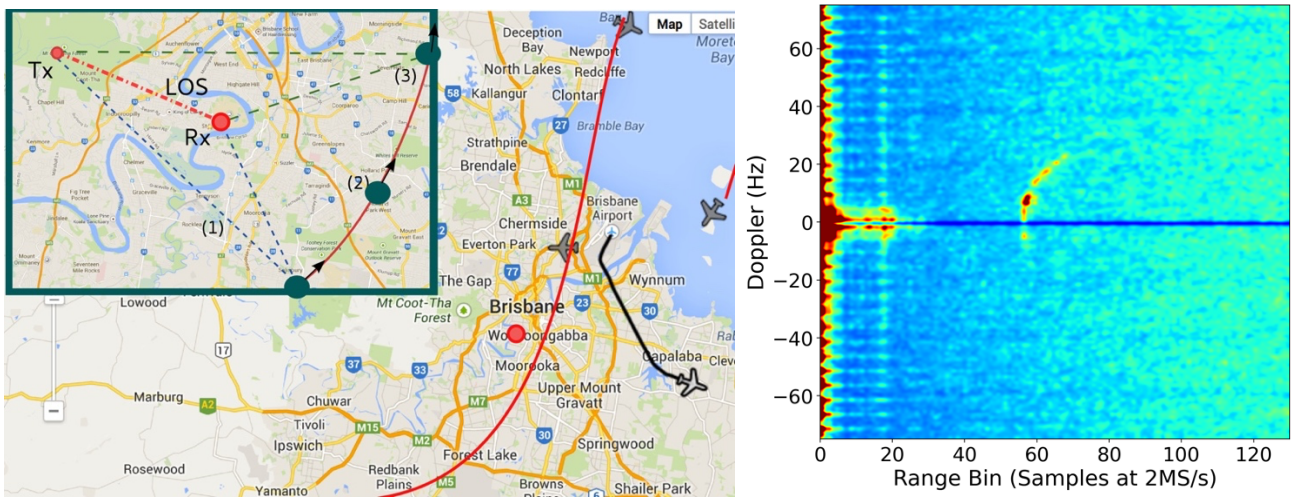

Fig. 1: Experimental Geometry of plane detection, and Range-Doppler map with max-hold over 96 seconds (2400 frames).

[1] Griffiths, Hugh D., and Christopher J. Baker. *An introduction to passive radar*. Artech House, 2022.
[2] Bialkowski, K. S., Clarkson, I. V. L., & Howard, S. D. (2011). Generalized canonical correlation for passive multistatic radar detection. *IEEE Workshop on Statistical Signal Processing Proceedings*, 417-420. doi:10.1109/SSP.2011.5967719