Topics for Thesis

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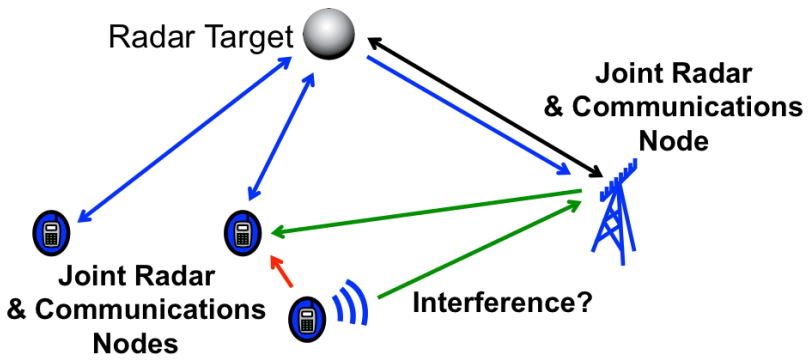
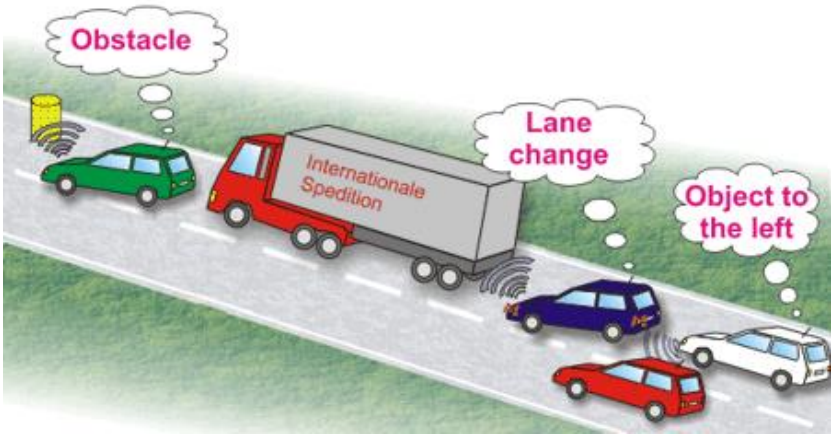
Coexistence of communication and radar systems



Current communication and radar systems have been developed to operate in isolation; however, due to the limitation of the available spectrum, future systems are encouraged to operate on the same bandwidth. Also, the coexistence of communication and radar systems on the same frequency spectrum will allow the design of more intelligent and efficient devices that jointly perform both functions by re-using the same hardware. Achieving this goal is challenging, as it requires the development of novel resource allocation strategies and signal waveforms to mitigate the mutual interference.

Opportunistic radar using the IEEE 802.11ad standard



The IEEE 802.11ad standard defines a communication scheme operating at mm-waves. Establishing directional links at mm-waves requires sophisticated beam-forming protocols aimed at sensing the surrounding environment in order to determine the best transmit/receive sectors. The echoes generated during this phase can be exploited to implement key radar functions, such as the detection of prospective obstacles and their localization in the range-Doppler domain. This opportunistic radar allows adding new handy features to devices complying with the 802.11ad standard with limited additional costs. For example, it can be used for collision avoidance, adaptive cruise control, and traffic management in vehicular networks or for intrusion detection, patient monitoring, and child/elder home-care in indoor networks; also, it can facilitate some operations of the communication module, such as channel estimation and beam alignment.

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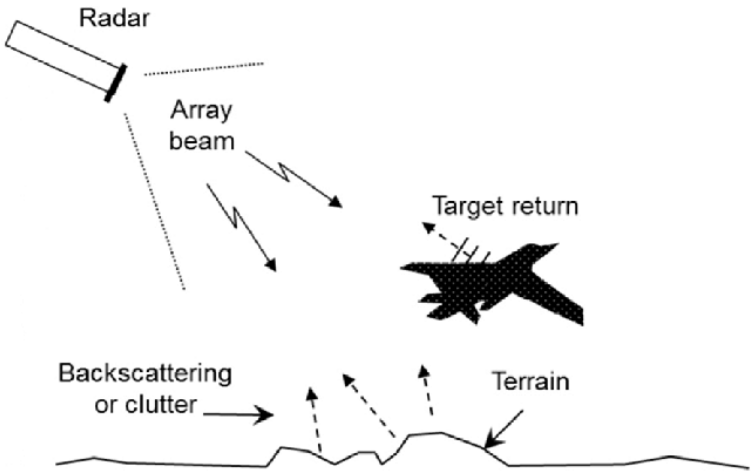
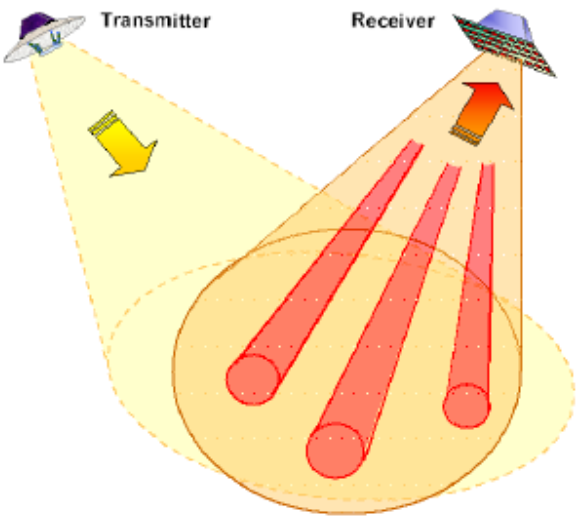
Sequential and multi-frame detection in surveillance radars



Sequential detection is a method to improve the radar sensitivity by adapting the dwell time in each azimuthal sector; specifically, new data samples are acquired only if a reliable decision cannot be made with the current and past observations. Multi-frame detection is a method to improve the radar sensitivity by integrating the echoes received over multiple scans; this is challenging in the presence of target motion where track-before-detect algorithms are necessary. Sequential and multi-frame detection can be integrated in the same system to increase the range of first detection of an approaching target, reduce the time required for the first detection of a newly born target, and improve the number of detections per unit of time from a persistent target.

Detection algorithms for surveillance radars with a wide transmit beam and multiple receive beams



Surveillance radars can operate with a wide transmit beam and a cluster of multiple narrow receive beams. The advantages of this architecture includes covering the same volume with fewer dwells, reduced beam shape loss, improved performance in extreme clutter environments, and improved angle estimation. Since the transmit antenna has usually a lower gain as compared to traditional phased array radars, the dwell time in each probed sector must be increased to maintain the same sensitivity, and a major challenge is the design of signal detection algorithms accounting for the target motion during this extended time-on-target.