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# Radar Signal Processing Algorithms for Integrated Sensing and Communication with Millimeter Wave Radar Waveforms

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Automotive target detection and recognition have been the biggest challenges faced by autonomous vehicles in order to avoid road accidents and ensure safe driving for all. During the past few years, there has been a tremendous advancement in vehicular technologies such as environmental sensing, in-vehicle control, inter-vehicular synchronization and vehicular control. Conventionally, sensors such as cameras and lidars have been exploited for target detection strategies. However, the performance of the above-mentioned sensors degrades severely in adverse weather conditions. Radar effectively addresses this constraint, providing robust detection capabilities even in challenging visual conditions, as highlighted in [1]. The millimeter-wave (mmW) radar, which operates above 24GHz, is preferred for target detection in automotive applications. These radars are favored due to their wide bandwidths (approximately 4-7 GHz), resulting in exceptionally high range resolution, as discussed in [2]. The most commonly preferred mmW radars are frequency-modulated continuous wave (FMCW) [3] and phase-modulated continuous wave (PMCW) [4]. The FMCW radar is a low-cost and least complex waveform with high-range resolution. However, it suffers from the range-Doppler coupling and requires a linear frequency ramp for range estimations. A viable alternative for these limitations is a PMCW for high-resolution automotive radars in which range estimation is done through parallel correlations, which are simpler to implement by avoiding frequency synthesizers. However, these mmW radars act as auxiliary sensors, and thus, their deployment is expensive. Further, interference issues and synchronization problems with the communication system arise. This challenge is overcome by integrated sensing and communication (ISAC), which enables the cohabitation of communication and radar systems on a common spectrum. ISAC has several advantages, including no extra hardware costs or synchronization problems and a common waveform for radar-based localization and communication. The prior art has extensively studied the ISAC with different waveforms, which include FMCW, PMCW, and Wireless LAN protocols. Recently, several works have discussed the ISAC implementations of the IEEE 802.11ad protocol [5, 6] and demonstrate the radar ranging with fine range resolution and lower sidelobes.

In this work, we demonstrate the performance of different waveforms that can be used for the localization of the target in ISAC systems in the mmW spectrum. We show that the response of FMCW to Doppler-shifted targets is poorer than PMCW. However, the IEEE 802.11ad radar may outperform PMCW radar and FMCW radar.

## References

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