Joint Radar and Communications for Frequency-Hopped MIMO Systems

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Dual-Function Radar Communications (DFRC) systems have emerged as a solution to the increasing competition between communications and radar over the limited electromagnetic spectrum. In DFRC systems, the radar waveforms are permitted to deliver data symbols to a communications receiver [1]. However, current DFRC implementations in slow-time suffer from low data rates that are fundamentally limited by the radar pulse repetition interval [2]. In this work, we focus on frequency-hopped MIMO systems and develop a generalized framework for performing information embedding by exploiting the fast-time structure of the radar waveform.

The proposed framework exposes the amplitude, phases, selection and permutation of the hopping frequencies of the chips in each radar pulse, thus allowing them to be used to embed information into the radar waveform. Through this unified formulation, we show that a variety of existing signalling strategies can be accommodated, such as quadrature amplitude modulation (QAM)/multiple-phase shift keying (MPSK), FH code selection (FHCS), FH permutation, and/or frequency carrier index modulation. This generalised framework also allows for the implementation of hybrid schemes using combinations of the aforementioned signalling strategies.

We evaluate the performance of the various schemes through simulation and demonstrate that the hybrid schemes can deliver significantly higher bit rates with only small increases in the required bit-energy-to-noise ratio (BER).

[1] A. R. Chiriyath, B. Paul, and D. W. Bliss, “Radar-Communications Con-vergence: Coexistence, Cooperation, and Co-Design,” IEEE Transactions on Cognitive Communications and Networking, vol. 3, no. 1, pp. 1–12, March 2017.

[2] W. Baxter, E. Aboutanios, and A. Hassanien, “Dual-Function MIMO Radar-Communications via Frequency-Hopping Code Selection,” in 2018 52nd Asilomar Conference on Signals, Systems, and Computers. IEEE, 2018, pp. 1126–1130.