Extracting the Communication Channel from Monostatic Sensing Channels: From Propagation to Impact Analysis

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March 27, 2025

Abstract

Integrated Sensing and Communication (ISAC) technology is pivotal in advancing multifunctional radio applications for next generation wireless communications. One of the primary challenges in ISAC systems lies in understanding and interpreting wireless channels for both sensing and communication purposes. A clear relationship between these channels would allow ISAC systems to reduce channel estimation complexity. This paper introduces a comprehensive framework for reconstructing communication channels using monostatic sensing channels within an ISAC system. We first consider the frequency spacing of an ISAC system to geometrically illustrate the synergies and differences between the sensing and communication regions. Subsequently, we construct a communication propagation channel based on overlap determined by this geometric relationship and a simplified monostaticto-bistatic equivalence theorem. Lastly, we combine multipaths located in the same delay bin to construct channel state information (CSI), taking bandwidth limitation into account. Simulations demonstrate that the proposed framework efficiently generates communication channels across various configurations, with numerical results highlighting the impacts of environmental and system constraints on key channel characteristics.