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Efficient DOA Estimation With Distributed Iterative Beamforming

Fauzia Ahmad[(1)]* and Traian Dogaru[(2)]
[(1)]Temple University, Philadelphia, PA 19122, USA; e-mail: fauzia.ahmad@temple.edu
[(2)]DEVCOM Army Research Laboratory, Adelphi, MD 20783, USA

Owing to recent technological advances in unmanned vehicles and multi-generational evolution of high-speed processors over the past few decades, research and development efforts in distributed system architectures have gained impetus [1-4]. A distributed system comprises a multiplicity of smaller subsystems, referred to as *nodes* hereinafter, which can adapt to dynamic environments, thus performing tasks with higher flexibility. From a signal processing perspective, distributed systems can be broadly categorized as *centralized* and *decentralized*. The former requires data collections locally at each node and centralized computations on shared information at a single processing/fusion center. The information being shared by the nodes with the processing/fusion center can range from raw data measurements (*fully centralized*) to intermediate results (*partially centralized*) obtained by local processing of each node's own measurements [3]. In the decentralized case, on the other hand, various nodes perform computations locally in a collaborative manner through exchange and incorporation of intermediate results rendered by other nodes without the need of a processing/fusion center [4].

In this work, we address the problem of source direction-of-arrival (DOA) estimation with distributed sensing. We consider operation in dynamic environments, where the sources can rapidly alter their numbers, locations, and powers over time. Efficient perception of the sensing environment is highly desirable and essential to the follow-on action phase in many applications, such as RF coexistence and cognitive radar sensing. Because of their fast convergence and high-resolution DOA estimation abilities, iterative beamforming techniques [4-6] are strong contenders for such applications, as they can quickly sense the environment and provide the source information for effective situational awareness and proper follow-on action. These techniques have been proposed primarily for stand-alone system operation. Focusing on partially centralized paradigm with constraints on node processing power and communication budget, we propose an iterative beamforming solution for DOA estimation with distributed array systems. Using numerical data, we demonstrate that, under suitable assumptions, the proposed solution is effective in providing efficient and accurate DOA estimates for distributed configurations.

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