Multistatic Radar: relation between the Green Function and the Ambiguity Function

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Abstract

We consider multiple input multiple output (MIMO) radar systems with M transmit and N receive elements. We derive the Green's function of the system in terms of the locations of the transmitters, the receivers, and a few additional physical parameters related to wave propagation. The derived return model is parametric in the target's position and velocity. The target parameter estimation problem is then solved by using techniques from binary hypothesis testing, and the resulting ambiguity function is directly related to the Green's function.

1. Introduction

Multistatic radars hold the potential of substantially improving the accuracy of detection, estimation, and tracking of targets compared to monostatic radars. The improvements come from the fact that the target is illuminated from several different directions, and it is observed from other directions (geometrical diversity). In monostatic radars, the target return is expressed parametrically in terms of target's position and radial velocity [1]. A simple receiver consisting of a matched filter and a threshold detector is commonly employed to estimate the target parameters, and the detector performance is then presented in terms of the ambiguity function, which relates the estimation error to the system Green's function. The same framework has been extended to single transmit and single receive bistatic radar in [2], where the authors stress the importance of accounting for the geometry of the system in the return model. The approach of [2] has been further extended to multistatic radar systems with a single transmitter and multiple receivers [3,4].

In our work, we consider the general MIMO radar. Specifically, we derive the relationship between the Green's function and the corresponding ambiguity function for the MIMO radar problem, which is determined by the system geometry and the propagation characteristics of the transmitted pulse. This, in turn, impacts the error variance of signal processing algorithms for target parameter estimation in a MIMO radar setting.

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3. References

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