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Detecting and localizing moving targets using multistatic radar system

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Abstract

This paper deals with multistatic radar system consisting of several independent monostatic radars. Processing of the acquired radar signals that are scattered from a moving target was performed in order to locate the target and to predict its velocity. Using the measurement data provided by the different radar antennas, extraction of time delays and Doppler frequencies was achieved. Then the target position coordinates and the target velocity were identified by means of an algorithm inspired from the global positioning system technology.

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Keywords: multistatic radar; monostatic radar; target detection; target localization; doppler shift; target velocity.

1. Introduction

Multistatic radar employs several spatially distributed antennas for transmission and reception in the purpose to retrieve maximum information about the target. While the accuracy of classical monostatic radar measurements, with transmitter and receiver located at the same point has reached its limits due to limited antenna aperture dimensions [1], multistatic radar systems can be used to overcome this limitation. These enable positioning their antennas at large distances and creating super-antenna structures with extremely big apertures. Multistatic radar

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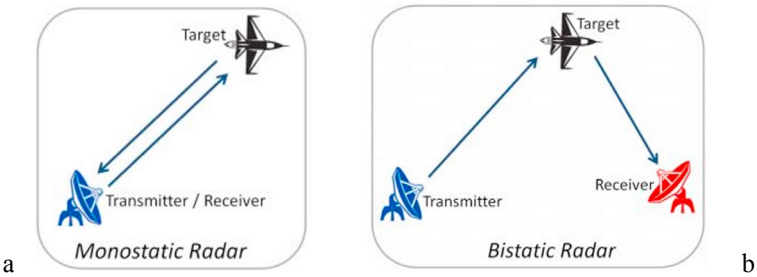
systems with several transmitters and receivers, while providing hardware optimization, pose new challenges regarding signal processing in order to perform target detection and tracking [2]. Radar is basically a device that transmits an electromagnetic signal and receives its echo after it is reflected by an object. The echo delay determines the range of the target. The transmitter and the receiver can be in the same antenna (monostatic radars) or in separated antennas (bistatic radars). The main difference between monostatic and bistatic radars is this separation of the transmitter and receiver. However, a co-located Transmitter and Receiver are not considered a bistatic system, even though they do not use a common antenna. To be considered a bistatic radar system, the separation between the transmitter and the receiver should be large enough in comparison to a typical target range.



a b

Fig. 1. (a) Monostatic radar arrangement; (b) Bistatic radar arrangement.

A multistatic system is one or more transmitters and receivers working together in a coordinated and integrated way. Multistatic radar could be a combination of monostatic radars bistatic radars or a mixture of both [3]. Each transmitter combined with a receiver form a bistatic system and all the possible bistatic systems formed with all these transmitters and receivers form the multistatic system and so on for the monostatic radar as well.

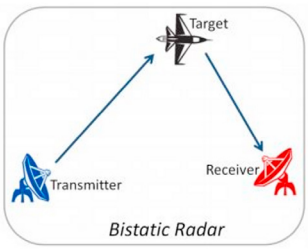


Fig. 2. Multistatic radar arrangement.

Nomenclature

T_x	Transmitter of monostatic Radar
R_x	Receiver of monostatic Radar
R	Range between target and Radar station
V	Target Velocity
τ	Time delay
λ	wavelength
c	light speed used as signal speed(m/s)
K	Boltzmann's Constant (1.38×10-23 J/K),
T_0	System Temperature (usually 290K),
SNR	Signal to noise Ratio (dB)
RCS	Radar Cross section ($m^{2)}$
Pfa	Probability of False Alarm
Pd	Probability of detection