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Digital Beamforming with Frequency-modulated Signals

Field of Application

Digital beamforming is a process that allows an estimation of the angle for received radar signals by making use of the phase difference in an array of receiver antennas which work synchronously. Due to the frequency shift, signals with low modulation indices are transformed in a quasi monofrequency manner. If the phase difference between neighboring antenna elements exceeds 2π, the result is no longer unambiguous and results in so-called grating lobes. The present invention allows to recognize and resolve such ambiguities, thus allowing the correct angle measurement to be determined.

Current Status of Technology

Currently used DBF antenna clusters are limited in the maximum angle at which the incoming signal can arrive without ambiguity being created, so called grating lobes. The phase difference between neighboring antenna elements, created by the angular position of the source, must not surpass 2π. This limitation prescribes the maximum distance between neighboring antenna elements. The physical dimenson of the antenna cluster, the apartur, is inversely proportional to the achievable resolution – with a smaller aperture, the angular resolution is reduced. For a given number of antennas in a DBF antenna cluster, angular resolution and maximum unambiguous angle of reception are opposing variables: the higher the resolution, the smaller the maximum angle.

Innovation

The invention makes it possible to analyze the radar signal with all its signal contributions. The currently practiced mono-frequency signal processing of the carrier wave for the determination of the target direction is being complemented by signal processing of the frequency modulation. The processing of two parts of a signal in one antenna cluster is equivalent as concerns aperture and wavelength to the processing of two different antenna clusters where the respective signal part of the same signal is being used. Because of the fact that the modulation frequency is substantially lower than that of the carrier wave, the determination of the target direction is always unambiguous, but the resolution is lower. By multiplying the outputs of the two processes, one gains the advantages of both: unambiguousness with high resolution. Making use of the frequency modulated part of the signal allows to overcome the compromise that has normally to be accepted between resolution and unambiguousness of the angular field that can be depicted.

Your Advantage at a Glance:

- Making use of all elements of a signal in angular measurements
- No additional requirement when generating the signal, since the frequency modulated part of the signal, which is used in this novel approach, is already present in the radar signal to allow distance measurements
- Reduction of the number of elements in a cluster of senders and receivers resulting in reduced hardware costs
- Overcoming the well-known compromise between the angular field able to be depicted without ambiguity and the achievable angular resolution

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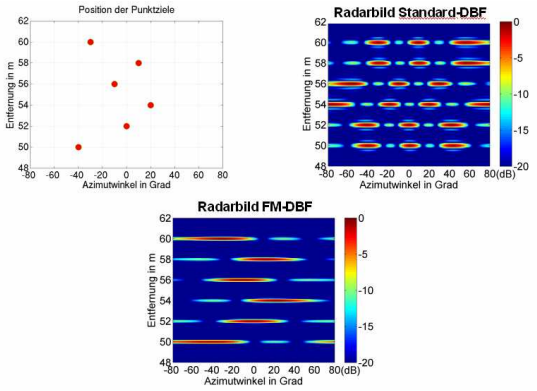
Fig. 1: FM-BDF: Multiple-target scenario



Multiplying the result of the two signal processing operations produces an unambiguous result at high resolution.

Technology Transfer

The Technologie-Lizenz-Büro GmbH has been charged with the commercialization and now offers companies the opportunity to obtain a license to exploit this new technology.

Patent Portfolio

German (10 2008 011 889 A1), EU (2 096 457) and US (2009/0219208 A1) patent applications have been lodged.

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