Calibration Aalgorithm for the minimisation of Ggain-phase and Mmutual Ceoupling Eerrors in a Uuniform Llinear Aarray

(Ph.D Student in Electronic Engineering)

Abstract

The effect ofIt is well known that gain-phase perturbations and mutual coupling between antennas, impinging on array calibration, significantly degrades the performance of digital array radar (DAR). This paper proposes a new algorithm, forconcerns about array calibration, applicable in the scenarios where the true azimuths of auxiliary sources deviate from nominal values but the angle intervals between them are known. Making use of the special structures of the gain-phase matrix and the mutual coupling matrix (MCM), infor a uniform linear array (ULA), a simplified form of the distortion matrix is developed. ItThis matrix is utilized in the new algorithm to obtain thea least-squares estimation of a closed form of the distortion matrix based on the orthogonal characteristics between the signal subspace and noise subspaces. TheIt is demonstrated that, for the estimation of the distortion matrix, the new algorithm achievesprovides for a considerable improvement in estimation accuracy, duewhich is attributed to thea reduction of the influence of unknown parameters, and rarely suffers from ambiguous problems. It requiresRequiring only one auxiliary source with the help ofon a rotation platforms is an additional benefit associated with practical implementations. Simulation results demonstrate the validity, robustness and high performance of the proposed new algorithm. Finally, the results of experiments are carried out by anwith S-band DAR on a test-bed withcomprising eight antenna elements. The expected results of measured data show that the proposed new algorithm is both practical in implementation and effective in actual circumstanceimproving the performance of DAR.

Introduction

Digital array radar (DAR) employs a full digital beam-forming (DBF) architecture in the associated receivingtransmission and transmittingreception systems. Itand has the potential of formingto form multiple simultaneous beams while provingwith improved dynamic range and anti-interference abilitycapabilities. In the last decades, itDAR has attracted considerable attention and is widely used in space surveillance[[1-2], however, Mmost array signal processing algorithms, such asincluding DBF and direction of arrival (DOA), relayrely crucially on the assumption that the array manifold is perfectly known. In actual systems, the array manifold is inevitably affected by gain-phase perturbations and mutual coupling effects, leading to a loss of array calibration, which will seriously degrades the performance of DAR. [3].

Calibration, therefore, is an important factor in DAR performance; however, Traditionalthe established method way to obtain calibration information is to carry outthrough measurements using computational electromagnetic solvers, a method which is both time-consuming and demanding in terms of the computational environment required to implement the associated algorithm. ItThe method has been applied in some actual radar systems for channel calibration. [4-5] but, although tThe algorithm is useful for an initial calibration, but it is time consuming and has high demands for environments. As a result, it may be impractical to manage during the general operation of array systems.

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Comment [a1]: A brief statement of the problem that gain-phase perturbations and mutual coupling affects calibration leading to poor performance.

Comment [a2]: Now say what the paper is about – introducing a new algorithm for calibration to improve performance!

Comment [a3]: Singular if the two matrices have the same structure.

Comment [a4]: Spell checkers will change to singular, however, the mathematical technique, in the West, is known as “least-squares”.

Comment [a5]: Just to make it more readable avoiding sentences that resemble lists.

Comment [a6]: Reference in brackets.

Comment [a7]: Just to make it more readable – the use of “however” to link the sentences.

Comment [a8]: Rearranged to make it more readable.

Comment [a9]: For additional clarity:

这段话是描述电磁测量法，主要是为了体现之前的实测系统中用的主要是该方法。但感觉和本文的关系不太密切，是否有必要保留？

References

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[4]. H.ans Steyskal, J.effrey S. Herd. Mutual coupling compensation in small array antennas. IEEE Transactions on Antennas and Propagation, 1990; 38(12): 1971–1975.

[5]. L. Pelttersson, L., M. Danestig, M., U. Sjostrom, U.. An experimental S-band digital beam forming antenna. IEEE International Symposium on Phased Array Systems and Technology; Boston. 1996.

Comment [a10]: Reference in brackets.

Comment [a11]: Usually just specify their initials rather than their full first names.