International Journal of Innovative Computing, Information and Control
Volume **5**, Number **9**, September **2009**
ICIC International ©2009 ISSN 1349-4198
pp. **2907–2916**

DIAGONAL LOADING BEAMFORMERS FOR PAM COMMUNICATION SYSTEMS

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Received June 2008; revised October 2008

Abstract. *The diagonal loading method is a simple and efficient method that can improve the robustness of beamformers. However, determining an ideal diagonal loading factor (DLF) is not a trivial problem. Maximizing the signal to interference-plus-noise ratio (SINR) can be one criterion for determining an ideal DLF. Unfortunately, the maximizing SINR is not realistic for practical applications. Although beamformers are widely used in radar, sonar and many other applications, in this paper, we consider a beamformer for PAM communication systems. In PAM communications, user information is coded into a sequence with the constant modulus (CM) in the baseband. Obviously, if the beamformer can cancel interference and noise sufficiently, the outputs of the beamformer should satisfy the CM condition more precisely. Therefore, minimizing the CM error (MCME) criterion can act as a reasonable substitution for maximizing the SINR criterion. In this paper, we present a cost function for the MCME criterion. We also propose a search algorithm for DLF determination by minimizing the cost function. Numerical experiments show the effectiveness of the proposed method.*

Keywords: Constant modulus, Diagonal loading, Robust beamforming, Blind equalization

1. **Introduction.** A beamformer is a spatial filter that operates on the observations of an array of M sensors in order to enhance the desired signal relative to directional interferences and background noise. That is, its output is given by

$$y(k) = \boldsymbol{w}^H \boldsymbol{x}(k)$$

where k is the discrete time index, $\boldsymbol{x}(k) \in \boldsymbol{C}^{M\times 1}$ denotes the array of observations, and $\boldsymbol{w} \in \boldsymbol{C}^{M\times 1}$ denotes the beamformer weights, which need to be determined for the beamformer. In this paper, $(\cdot)^T$ and $(\cdot)^H$ stand for the transpose and the Hermitian transpose, respectively. The observation (training snapshot) can be expressed as

$$\boldsymbol{x}(k) = \boldsymbol{s}(k) + \boldsymbol{i}(k) + \boldsymbol{n}(k) \tag{1}$$

where $\boldsymbol{s}(k)$, $\boldsymbol{i}(k)$ and $\boldsymbol{n}(k)$ are the desired signal, the interference and the noise, respectively. The desired signal relates to the user information according to $\boldsymbol{s}(k) = c \cdot s(k) \cdot \boldsymbol{a}$, where $\boldsymbol{a}$ is the signal steering vector of the sensor array, $s(k)$ is the desired user information, and c is the channel attenuation.