A Study on Minimum Angular Resolution Model Errors Base on Sensitivity Analysis on Subspace Methods

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Abstract. An improved algorithm for DOA estimation of coherent signal is proposed. This algorithm has based on the structure of mutual coupling matrix of uniform linear array and effects model error sensitivity analysis. The performance of these two approaches is then compared with that of the well-known MUSIC algorithm using spatial smoothing. Through simulation, we show that the proposed method offers significantly improved estimation resolution and accuracy relative to existing method.

Keywords: Model error, Sensitivity, Estimation, Resolution, MUSIC

1 Introduction

The estimation of direction of arrival(DOA) in multiple signals by using an array antenna very important in radar, sonar and wireless communication. Many effective algorithm for simultaneously estimating DOA for multiple signals have been developed in the recent past[1]. Many high resolution eigendecomposition methods have been proposed, such as MUSIC, ESPRIT and other ML[2]. Most of these algorithms assume that the array manifold is known and the signals are non-coherent. DOA estimation has been known as spectral estimation, angle of arrival estimation, or bearing estimation[3]. In this paper, a new DOA estimation considering minimum effects of model error uses sensitivity analysis on subspace method is proposed[4]. In the proposed DOA estimation method, the target DOA estimationcan be minimize model errors from the angle in the target signal by sensitivity analysis on subspace method, which is a function of the target DOA. Since DOA resolution high increased fromproposed method in this paper.Alsothe interference on the DOA estimation is reduced. In this way, the estimation resolution and accuracy of the proposed method are better than those for existing method.

2 Proposed Method Signal Analysis

Consider an antenna composed of M antenna sensors arbitrarily located in spatial and assume that a signal impinges on the arrayWe assume that the array correlation covariance matrix is exactly estimated, which means having an infinite number of independent samples, and the effect of model errors is sufficiently small so that the MUSIC spectrum has distinct peaks. In the presence of two sources with true DOA, θ_1 and θ_2, we perform the first-order Taylor expansion to see how much the peak locations shift due to model errors and get the angular deviation[5]

$$\Delta\theta_i = \theta - \theta_i = -\frac{\left.\frac{\partial \overline{EF}_1(\theta_i,\mu)}{\partial \mu}\right|_{\mu=\mu_0} (\mu - \mu_0)}{\left.\frac{\partial \overline{EF}_1(\theta,\mu)}{\partial \theta}\right|_{\theta=\theta_i}} \tag{1}$$

Where $\overline{EF}_1(\theta,\mu) = \frac{\partial \overline{EF}(\theta,\mu)}{\partial \theta}$, $i = 1,2$, $\mu - \mu_0$ is the model error. Let us assume that

$$\mu - \mu_0 = \sigma_\mu \, \gamma \tag{2}$$

Where γ is a random vector with zero mean and unit variance and $\sigma_u$is a positive scalar.The mean can be written as follow

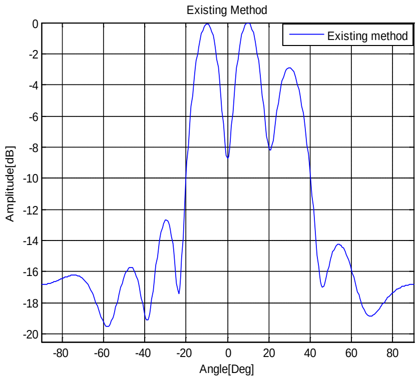
$$E[\mu - \mu_i] = 0 \tag{3}$$

The standard deviation can be written as follow

$$SD(\theta - \theta_i) = \frac{\left|\left.\frac{\partial \overline{EF}_1(\theta_i,\mu)}{\partial \mu}\right|_{\mu=\mu_0}\right|}{\left|\left.\frac{\partial \overline{EF}_1(\theta,\mu)}{\partial \theta}\right|_{\theta=\theta_i}\right|} \sigma_\mu \tag{4}$$

3 Simulation

In this section, through simulation, we showed that we compare existing method with proposed method. Existing method used MUSIC method. Consider a uniform linear array with 9 sensors, each sensor separated by half wavelength. Fig.1 shows DOA estimation using existing method in angle[-10^o,10^o, 30^o]. The existing method increase DOA estimation resolution of a desired signal. Fig.2 shows DOA estimation using proposed method in angle[-10^o, 10^o, 30^o]. The proposed method all estimated a desired signal, and DOA estimation improved resolution than existing method.



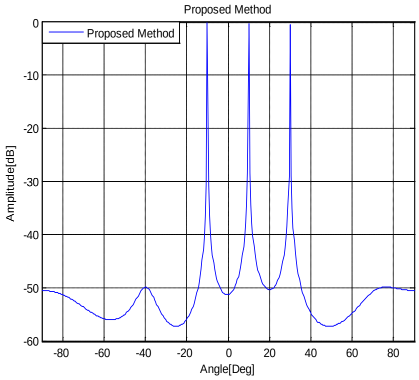


Fig. 1.DOA of Existing method **Fig. 2.**DOA of Proposed method

4Conclusion

In this paper, a new DOA estimation considering minimum effects of model error uses sensitivity analysis on subspace method is proposed. Since DOA resolution high increased from proposed method in this paperIn the proposed method, sensitivity analysis on subspace methods are used to obtain an optimum estimation of the desired signal among received signal on antennal array system.

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