# High Resolution Direction of Arrival Estimation Based on Adaptive Beamforming and Bayesian Method

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**Abstract.** DOA estimation is an important research area in array signal processing. We propose a novel adaptive beamforming with a Bayesian method. The proposed method is based on clear modeling of unknown in the desired signal array response, which provides sufficiently robustness to unknown in desired DOA, enhances the adaptive array system performance. Simulation results showed that the proposed method appear significantly better than performance as compared with general adaptive beamforming method.

**Keywords:** MUSIC, DOA, Beamforming, Bayesian , Weight

## 1 Introduction

Many DOA estimation have been proposed and analyzed during the past decades including beamforming method[1]. Capon method, and subspace based methods such as Multiple Signal Classification(MUSIC) method. Many high resolution DOA estimation methods have been developed over the years[2]. Among these methods, MUSIC method is well known for its super resolution feature. However the performance of this method will deteriorate significantly under the low numbers of snapshots and low signal to noise ratio scenarios. More advanced approaches are high resolution methods that are root MUSIC and Estimation of Signal Parameters via Rotational Invariance Technique(ESPRIT) provident high resolution DOA estimation[3]. In this paper, we propose a new approach beamforming using a Bayesian approach, which improves robustness to uncertainty in the signal look direction. An algorithm combining the Bayesian method and the DOA estimation is proposed. The proposed method has increasing the accuracy of DOA estimation as well as reducing the computational complexity.

## 2 DOA Estimation with Bayesian Approach The

beamforming problem can be formulated as follow[4-6]

$$\min_{W} \nabla(W) = E[(d(t) - y(t))(\mathrm{d}(\mathrm{t}) - \mathrm{y}(\mathrm{t}))^H] \quad \text{subject to} \quad W=1 \tag{1}$$

Where $\mathrm{d}(\mathrm{t})$ is desired signal, $\mathrm{y}(\mathrm{t})$ is receive signal on array antenna and is an average steering vector averaged over $p(\theta|X)$.

$$\bar{a} = \int a(\theta)\ \bar{p}(\theta|X) \tag{2}$$

In order to finding an weight vector, we apply a cost function in Eq(11).

$$\nabla(W,\lambda) = \frac{1}{2}\left[E\left(d(t) - y(t)\right)\left(\mathrm{d}(\mathrm{t}) - \mathrm{y}(\mathrm{t})\right)^H\right] - \lambda(\bar{a}^H\ \mathrm{W} - 1) \tag{3}$$

Where is $\lambda$ a Largrange multiplier. $\mathrm{r}(\mathrm{t}) = \mathrm{E}[\mathrm{d}(\mathrm{t}) - \mathrm{y}(\mathrm{t})], \mathrm{R}_{rr} = E[r(t)r(t)^H]$ . we can obtain the optimal weight vector as follow

$$\mathrm{W_p} = \mathrm{R}_{rr}^{-1}E[X(t)r(t)^H] + \mathrm{R}_{rr}^{-1}\ a(\theta)\frac{1 - \{\mathrm{p}(\theta|\mathrm{X})\ \mathrm{a}(\theta)\,\mathrm{R}_{rr}^{-1}\ E[X(t)r^H(t)]\}}{\mathrm{p}(\theta|\mathrm{X})\ \mathrm{a}(\theta)^H\ \mathrm{p}(\theta|\mathrm{X})^H\ \mathrm{R}_{rr}^{-1}\ \mathrm{a}(\theta)} \tag{4}$$

## 3 Simulation

We perform a range of experiments to illustrate the performance of the proposed method. We compare the resolution performance of our method to those of MUSIC. We consider an uniform linear array antenna 12 sensors separated by half wavelength, zero mean narrowband Gaussian distributed and uncorrelated sources impinge on the array from far field with distinct DOA. The snapshots are fixed at 100 and sources are with equal SNR of 15dB.

We increase the number of source to 5 which locate at [-35$^o$ -25$_o$ $_{0o}$ 5$_o$ 15$^o$]. Fig. 1 showed a five direction of arrival[-35$^o$ -25$_o$ $_{0o}$ 5$_o$ 15$^o$] the proposal method in this paper. It showed correctly the five DOA estimation at [-35$^o$ -25$_o$ $_{0o}$ 5$_o$ 15$^o$] . Fig. 2 showed a graph a DOA estimation as the MUSIC at [-35$^o$ -25$_o$ $_{0o}$ 5$_o$ 15$^o$]. It showed an error about 2$^o$ when MUSUC method estimate DOA in Fig 2.

## 4 Conclusion

In this paper, we develop a enhance estimator for DOA, and extend it to a new approach called new DOA method for Bayesian and beamforming. We are proposed that is an adaptive beamforming with a Bayesian method. It is not necessary to detect the number of sources before estimation of DOA. A number of numerical examples clearly demonstrate that the adaptive beamforming algorithm with a Bayesian method described here yields considerably superior performance as compare with the other adaptive beamforming method. The results of computer simulation show that proposal method performs better than MUSIC for DOA.

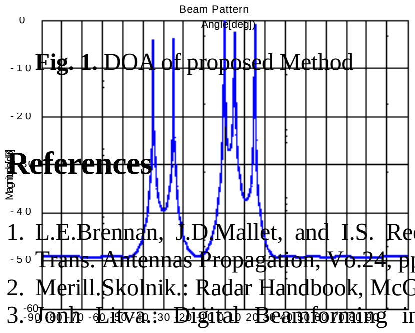


**Fig. 1.** DOA of proposed Method

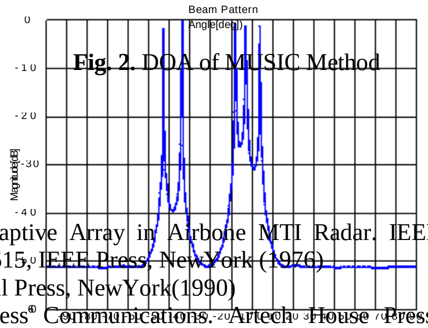


**Fig. 2.** DOA of MUSIC Method

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