# Consideration on initial values for parastic elements with multiport parastic array radiator antenna

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## 1 Introduction

The multiport parastic array radiator (MuPAR) antenna features multiple active elements connected with RF ports and multiple parastic elements loaded with variable reactance. Adaptive algorithm for the MuPAR antenna combines analog beamforming and digital beamforming (DBF). We considered fast convergence scheme of adaptive beamforming whose initial value is selected by Hi and Low. Hi and Low are empirically determined. In this paper, we investigate determination of initial values of the parameters by spatial cross correlation (SCC)[1] between two directivities by the MuPAR antenna. In this consideration, performance of adaptive beamforming with initial value selection is examined by the computer simulation.

## 2 Spatial cross correlation

Here, we will give the criterion on the parameter of initial value (reactance set). Two complex directivities are define as $D_1(\phi)$ and $D_2(\phi)$. Therefore, the SCC is written by

$$|\rho_{12}|^2 = \frac{|\int_0^{2\pi} D_1(\phi)D_2^*(\phi)d\phi|^2}{\int_0^{2\pi}|D_1(\phi)|^2 d\phi \int_0^{2\pi}|D_2(\phi)|^2 d\phi} \quad (1)$$

The two directivities are orthogonal when the SCC is $\rho_{12} = 0$. They can be called independent or orthogonal directivity. $D(\phi)$ is the complex directivity which can be given by

$$D(\phi) = \boldsymbol{w}^H \boldsymbol{I}_w^T \boldsymbol{a}(\phi) \quad (2)$$

where $^H$ and $^T$ denote the transpose and the complex conjugate-transpose, respectively. $\boldsymbol{w}$ is weight vector at active elements. $\boldsymbol{a}(\phi)$ is the steering vector of the MuPAR, and $\boldsymbol{I}_w$ is the equivalent weight matrix.

## 3 Reactance sets for orthogonal directivity

We will select initial values by SCC between reactance sets. Minimum mean square spatial cross correlation (MMSSCC) is defined as

$$\mathrm{MMSSCC} = (|\rho_{12}|^2 + |\rho_{13}|^2 + |\rho_{14}|^2 + |\rho_{23}|^2 + |\rho_{24}|^2 + |\rho_{34}|^2)/6$$

where orthogonal directivity is formed four dimensional spaces. In order to determine initial values, the reactance set is searched by the MMSSCC. 1) Select a reactance set of $D_1(\phi)$. then 2) Search reactance set of other directivity in the range from $-100$ to $+100[\Omega]$ by every $25[\Omega]$. The reactance sets and MMSSCC are shown in Table 1 as results of all search, and SCC is shown in Table 2. The reactance set of table 1 is determined as the initial value at parastic elements.

## 4 Simulation

We examine the adaptive beamforming performance of the MuPAR antenna with initial values through numerical evaluation. The considered MuPAR has two active elements and two parastic elements. We apply the steepest gradient algorithm to optimize the reactance, and apply RLS algorithm to perform DBF at the active elements. The angle of the one desired signal and the one or two interference signals are randomly generated according to uniform distribution over the azimuth plane as shown in Fig.1. Ten thousand trials are used to calculate the empirical complementary cumulative distribution function (CCDF) of the output SINR. As shown Fig.1, the MuPAR antenna is equivalent of output SINR when initial values with SCC are used.

## 5 Conclusions

In this report, we determine initial values of the parameters by spatial cross correlation. The simulation results show that adaptive beamforming performance is almost equivalent to the conventional one. Improvement by increasing the number of space dimensions will be the future work.

## References

[1] N. Sakai, H. Uehara, and T. Ohira, IEICE Technical Report, A·P2008-33, pp.23–28, June 2008.

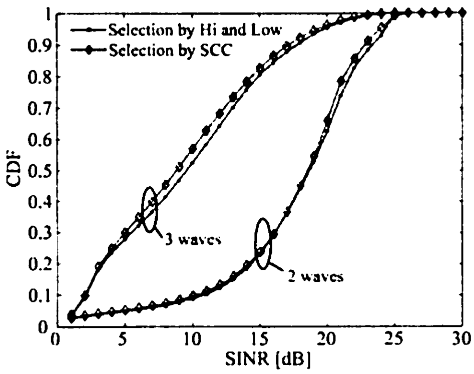


Figure 1 Statistical results

Table 1 Reactance sets for orthogonal directivity.

| | Set 1 | Set 2 | Set 3 | Set 4 | MMSSCC |
|---|---|---|---|---|---|
| $X_1$ | -75Ω | 75Ω | -50Ω | 25Ω | 0.25 |
| $X_2$ | 0Ω | -25Ω | -100Ω | 100Ω | |

Table 2 Spatial cross correlation.

| | $\lvert\rho_{12}\rvert^2$ | $\lvert\rho_{13}\rvert^2$ | $\lvert\rho_{14}\rvert^2$ | $\lvert\rho_{23}\rvert^2$ | $\lvert\rho_{24}\rvert^2$ | $\lvert\rho_{34}\rvert^2$ |
|---|---|---|---|---|---|---|
| SCC | 0.34 | 0.35 | 0.14 | 0.17 | 0.25 | 0.28 |