Stochastic Characteristics on Wireless Channel Created by Cavity-Excited Circular Array (CECA)

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1. Introduction

Cavity-Excited Circular Array (CECA) has proposed as spatial fading simulator by authors.\(^1\) In this paper, we show design methodology of CECA and its spatial stochastic characteristic.

2. CECA and Stochastic Characteristics

In CECA, the array is composed of six inductance-loaded element arranged concentrically for structural symmetry, and one feed pin at the center of the radial cavity. Table 1 shows comparison between theoretical and numerical value in structural dimensions and its error rates where cavity radius, the distance of antenna element from center, element length and cavity height are \(r_c, r_a, l, h\). The structure dimension of CECA, \(r_c\) and \(r_a\), are determined by the following equations, which we obtain from boundary condition. They are

\[
\begin{align*}
    r_c &= \frac{\rho_0}{\rho_0 - \rho_0^{'n}} (n = 1, 2, 3, \ldots, n' = 2) \\
    r_a &= \frac{\rho_1}{\rho_0} (n = 2, 3, 4, \ldots, n' = 2) 
\end{align*}
\]

The radial cavity plays the role as feed circuit. Therefore, the height of radial cavity is designed as low as possible so that the current distribution on array elements inside the cavity will almost be uniform on the \(z\)-axis unless the return loss becomes extremely worse. Rayleigh fading had shown in \(^1\). However AS was not evaluated.

AS has two key factors, diameter of CECA and measurement distance between transmitter and receiver. A commonly employed criterion for determining the minimum allowable separation between source and test antennas is to restrict phase deviation to \(\pi/8\) radian. This results in the restriction that \(R \geq 2D^2/\lambda\), where \(D\) is a antenna diameter and \(R\) is a separation\(^2\). Providing that the receiver is in Fraunhofer region and its diameter is 1m, \(r_a\) should be more than about 12.6\(\lambda\).

Table 1: Structural Dimensions of CECA with 2.41GHz

<table>
<thead>
<tr>
<th></th>
<th>(r_c)</th>
<th>(r_a)</th>
<th>(l)</th>
<th>(h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>numerical</td>
<td>1</td>
<td>0.694</td>
<td>0.25</td>
<td>0.1 (\lambda)</td>
</tr>
<tr>
<td>theoretical</td>
<td>0.972</td>
<td>0.675</td>
<td>0.2</td>
<td>0.1 (\lambda)</td>
</tr>
<tr>
<td>error</td>
<td>2.8</td>
<td>2.7</td>
<td>20</td>
<td>0 %</td>
</tr>
</tbody>
</table>

Figure 1: Spatial Cross-Correlation to obtain enough AS. However, it take too much time to calculate this size of cavity. We choose alternative region as measurement distance and it is a Fresnel region. An alternative criterion is to focus on the amplitude not on the phase so that a measurement can be performed successfully in Fresnel region\(^3\)[4]. The criterion is \(R \geq dD/0.3\lambda\) where \(d\) is the diameter of transmitter. Therefore we obtain \(R \geq 11.3\lambda\). Under previous assumption, Fig. 1 show AS which we observe at antenna array on base station in macro cell.

References


