Mode Selection Effect in Dual-Circular Polarized OAM Transmission

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An orbital angular momentum (OAM) for wireless communication is actively studied recently (O. Edfors et. al, IEEE Trans. Antennas Propagat., vol. 60, no. 2, pp. 1126-1131, 2012). The combination of the circular array antennas and discrete Fourier transform (DFT) circuit realizes the multiple OAM modes simultaneously only with the analog circuits (K. Murata et. al, IEEE Trans. Antennas Propagat., vol. 65, no. 12, pp. 6687-6702, 2017) since this antenna arrangement yields a circulant channel matrix which can be completely diagonalized by using the DFT circuit. However, the imperfect circulant channel matrix due to the manufacturing error, or pattern distortions, etc. causes the inter-mode interferences, which degrade the achievable rate seriously. To solve this problem, the authors has presented the mode selection method suitable for the analog OAM transmission (K. Yuri et al, IEEE Trans. Antennas Propagat., to be published), where the low-gain modes are not used for transmission since they do not contribute to the data-rate while causing the interference

In this paper, the performance of the proposed mode selection method is experimentally verified. Fig.1 (a) shows conceptual sketch of the analog OAM transmission dealt with in this study. Two circular microstrip arrays are faced, where each of arrays comprises four dual-circular microstrip antennas. The total number of transmission channels is 8. Since this study assumes all transmitters and receivers cannot cooperate each other, the inter-mode leakage interferes the signals. Fig.1 (b) shows the experiment setup for this study. Two arrays are parallelly fixed by the spacer made of the Styrofoam. All antennas and circuits are configured on the PTFE substrates. The 90-degree hybrids are used for giving 90-degree phase difference to the dual ports of the circular microstrip to generate the dual circular polarizations. Fig.2 shows the fabricated DFT network comprising four 180-degree hybrids (rat-race). The ports, #1~#4, are for the input / output the signals to this system, and the ports, #5~#8, are for the antenna sides. This circuit is used for both transmission and reception, and the system ideally offers the isolated multiple transmission channels.

The mode selection algorithm is used for this experiment. The number of the excluded modes is determined by searching the mode-selection pattern, which realizes the maximum rate. Fig. 3 shows the achievable rate versus the distance between two arrays. It is found that the proposed algorithm attains two-fold rate compared with the 8-stream OAM. This proves that the proposed technique is effective in enhancing the data-rate in the analog OAM transmission.

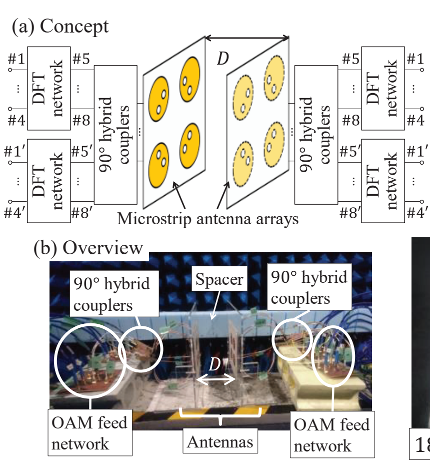

Figure 1. Analog OAM transmission

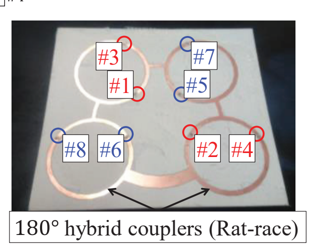

Figure 2. Fabricated circuit

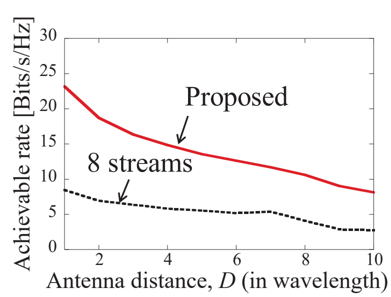

Figure 3. Achievable rate versus distance