Experimental Investigation of 2x2 MIMO Array Antenna for the Mobile WiMax by Measuring 3D Radiation Patterns

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Introduction

A conventional wireless communication system which is configured as a single-input-single-output (SISO) system has an upper limit of capacity due to the Shannon-Nyquist limit. In demanding of higher bit-rate wireless communication for various mobile services, multiple-input-multiple-output (MIMO) systems are being focused on. These systems use multiple antenna elements at the transmitter and receiver to improve the capacity over SISO system when operated in multipath environments. Identically, as increasing the number of antenna in MIMO systems, the capacity will be improved. But there is the size limitation for internal antennas in the case of handheld mobile terminals. And mutual orientations, the location and the mutual coupling between two or more antennas should be considered to design and develop MIMO antenna arrays [1-3]. In this paper, we show four types of array antennas for mobile broadband WiMax communication systems to find out the optimum design criteria from the viewpoint of MIMO systems.

Antenna Configurations and Placements

Fig.1(a) shows the configuration of the single antenna which has resonance at 2.6 GHz with size 10 x 4 x 1.2 mm^3 covering the band width of 200 MHz and fig.1(b) shows the test board for the single antenna. The size of a ground plane is 110 x 45 x 1 mm^3 considered as the practical mobile WiMax applications, and metal is printed on both surfaces of an FR-4 substrate with relative permittivity 4.6. The antennas are fed by a 50-Ω coaxial line and the inner conductor of the coaxial line is connected to the feed part through L-C matching circuit to achieve good impedance matching.

Four kinds of MIMO antenna arrays which consist of two chip antennas are considered in this paper. Three types of arrays shown in from fig.1(c) to fig.1(e) have two antennas which are placed at each corner of the ground plane. And two antennas shown in fig.1(f) are placed in the middle of top and bottom sides of ground plane with same orientation.

Measurement Results and Discussion

The mutual coupling between two antennas are measured and the envelop correlation coefficients are calculated using measured 3D radiation patterns[4]. The 3D radiation patterns are measured with 5° angular intervals over both azimuth and elevation in a ICU 3D antenna chamber. Figure 2 shows measured characteristics

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of each type of arrays. All antennas in each type of arrays have resonance at 2.6 GHz with bandwidth about 200 MHz from 2.5 GHz to 2.7 GHz at S_{11} < -10 dB. Figure 3 shows the measured 3D radiation patterns and maximum gain values at 2.6 GHz. Type B has better isolation characteristic and matching condition among them. Therefore, it has better gain (4.5, 5.2 dBi) at each port equally rather than other configurations. Table 1 shows the diversity performance results in terms of envelop correlation coefficient from 3D measured radiation patterns. All type of arrays has correlation coefficient less than 0.5.

Conclusion

This paper investigates four types of array configurations with two chip antennas by considering mutual coupling and envelop correlation coefficient from 3D radiation patterns. According to proper spacing and polarization between antennas, diversity performance may be determined. The envelop correlation coefficients calculated using scattering parameters may be inadequate because the uniform distribution of sources is assumed. The radiation-pattern-based method for the envelop correlation coefficients can include real environmental factors like angular density function.

Acknowledgments

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Table 1: The Envelop Correlation Coefficient of Each Array.

	Type B	Type C	Type D	Type E
Correlation	0.071529	0.005669	0.028656	0.114716

Figure 1: The geometry of the proposed 2x2 antenna arrays, (a)the geometry of the chip antenna (basic component), (b)the top and side view of Type A, (c)Type B, (d)Type C, (e)Type D, (f)Type E.

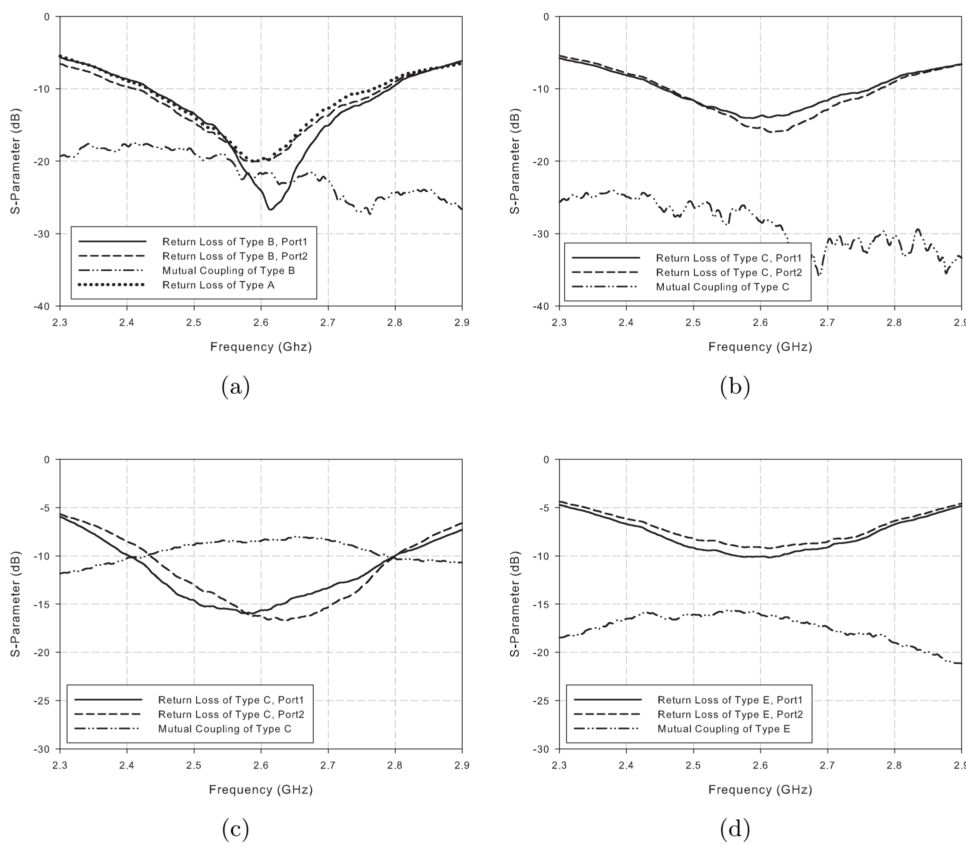

Figure 2: Measured characteristics of each type of arrays.

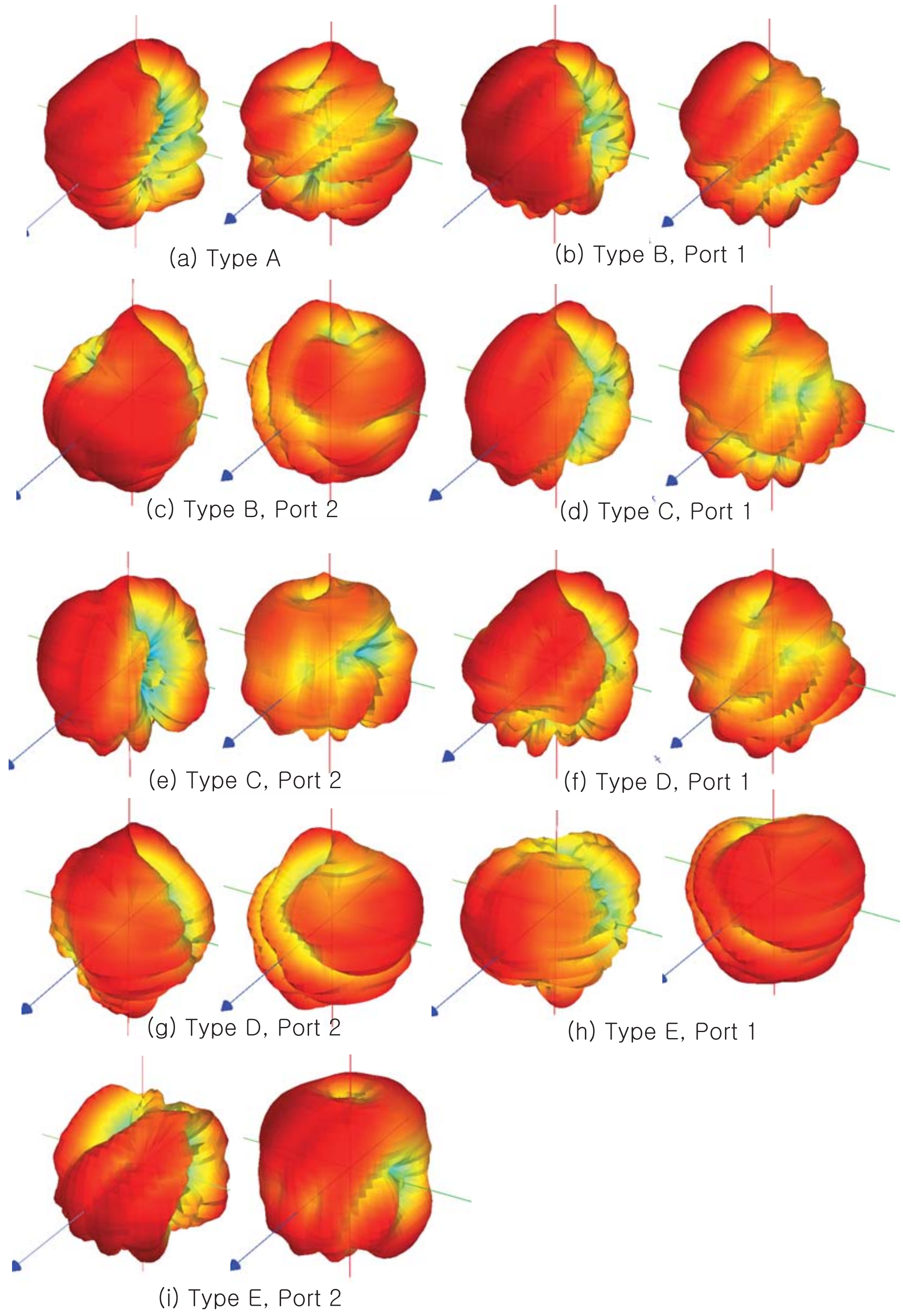

Figure 3: Measured 3D radiation patterns of each type of arrays, left side of each figure shows horizontal polarization component and right side of each figure shows vertical polarization component at 2.6 GHz, Maximum gains of H-Pol and V-Pol are (a)3.3 (b)2.9,4.5, (c)3.0,5.2, (d)3.0,3.1, (e)1.3,4.5, (f)-1.3,-0.12, (g)-2.2,1.1, (h)-0.2,3.6,(i)-2.2,1.6, unit is dBi.