Effect of Applying Meta-surface Reflector with Two Types Reflection Characteristics on 2×2 LOS MIMO

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***Abstract*— This paper proposes to applying meta-surface reflector with two types reflection phase characteristics to 2 × 2 MIMO. One of the two kinds suppresses edge effects of the other and contribute to improve the channel capacity. The performance of the proposed design is 2 times higher than conventional case, that has one type meta-surface reflector, in input power. The results are verified by the MoM and the possibility of improvement of the channel capacity is shown.**

Keywords*— *Meta-surface, LOS-MIMO, MIMO, Metamaterial antennas, MIMO antenna, Periodic structures

I. Introduction

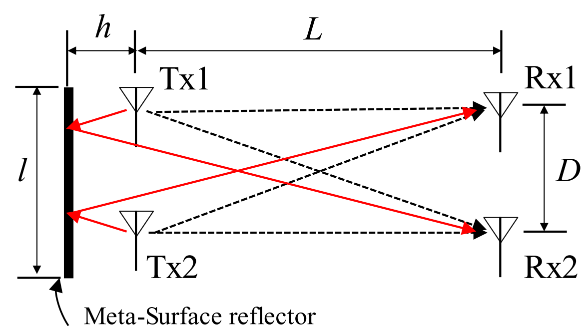
Multiple Input Multiple Output (MIMO) is an antenna technology for large capacity wireless communication. MIMO has been applied to wireless communication standards such as Wi-Fi, LTE. MIMO transmits multiple signal at the same time and the same frequency. The channel capacity can be enhanced by increasing the number of antennas when the spatial correlation is small enough [1]. Therefore, MIMO exhibits good performance in the multipath environment.

However, in the line of sight (LOS) environment, the direct waves are dominant. Therefore, the channel capacity deterioration is occurred by antennas placement [2].

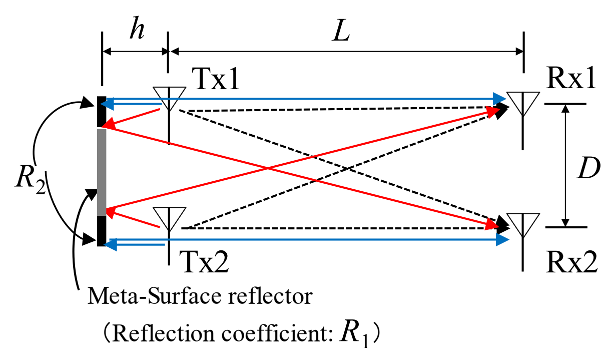
To solve the issue, the optimal position of transmitting and receiving antennas has been studied [3]. In addition, utilizing antennas with orthogonal polarizations has been proposed to improve the issue [4]. Optimal position is decided as a unique placement. Thus, the method is sometimes difficult to make up it to desired space. It means the method has a limitation about antennas placement. In addition, antennas for MIMO system with reflectors and covers have been proposed [5]. The method makes multipath-like environment around the antennas placed area surrounded by the reflectors and the covers. In this case, direct wave is prevented by the cover that is at front of antennas. To increase effective paths, placing meta surface reflector at the communication area has been proposed [6]. In short range (SR) MIMO, the antennas with side and back reflector have been proposed [7]. Those reflectors are made by metals. Therefore, the optimal antenna size that includes the reflector is decided as a unique structure.

Thus, a novel method of applying meta-surface reflector on 2 × 2 LOS-MIMO has been proposed to improve the channel capacity [8]. The method is expected to achieve the channel capacity that is 2 times greater than the case of applying metal reflectors, however, the performance is not enough due to the scattering waves from the edges of the meta-surface reflector.

This paper proposes applying a meta-surface reflector with two types reflection phase characteristics to prevent the effect of scattering waves from the edges of the meta-surface reflector. In addition, this paper shows that proposed meta-surface reflector is able to increase the channel capacity from [8]. Moreover, the results are verified with the MoM to show the possibility of increase in channel capacity.



(a) Applying conventional meta-surface reflector [8]



(b) Applying proposed meta-surface reflector

Fig. 1 Scheme of applying meta-surface reflector on 2×2 LOS-MIMO

II. Structure of 2×2 LOS MIMO Applied Meta-surface Reflector

Fig. 1 shows scheme of 2×2 LOS-MIMO that are applied a meta-surface reflector. Fig. 1 (a) and (b) shows the scheme that are applying a conventional meta-surface reflector[8] and a proposed meta-surface reflector, respectively. The surfaces are located in backside of the transmitting antennas. Here, D is the distance between transmitting/receiving antennas, L is the distance between transmitting antennas and receiving antennas, h is the distance between transmitting antennas and the meta-surface reflector, and λ is the designed wavelength.

In fig. 1(a), reflected wave paths, which are from Tx1/Tx2 to Rx2/Rx1 via the meta-surface reflector, are obtained. As the result, the channel capacity is able to increase. However, the scattering waves also occur from the edges of the meta-surface and the scattering waves interfere other waves on the path that are shown in fig. 1 (a).

Therefore, this paper proposes applying a meta-surface with two types reflection characteristics as shown in fig. 1 (b). At the design frequency, the surface of the proposed meta-surface has reflection coefficients of R_1 and R_2 on the center and both side, respectively.

III. Simulation Result

Fig. 2 shows an example of design of proposed scheme. Here, $D = 1.0\lambda$, $h = 0.25\lambda$, the interval of the metal elements $p = 0.20\lambda$, the width of the metal elements $w = 0.10\lambda$, the thickness of the meta-surface $h_m = 0.003\lambda$, and the gap on the border of the reflection coefficients $g = 0.0005\lambda$. Those parameters are chosen to compare with [8].

The channel capacity, that is calculated by Method of Moment (MOM), is shown in Fig. 3 as markers. Solid, broken, and dotted lines show the result of applying proposed meta-surface reflector, conventional method [8] and a metal (PEC) reflector, respectively, that are calculated by Ray Trace method (RT). Here, transmitting SNR = 40 [dB]. The result of MOM is in good agreement with RT when $L / \lambda < 4$. R_1 is effective for short range, especially. The proposed design's channel capacity is greater than [8] As the results, the possibility of improvement of the channel capacity is shown.

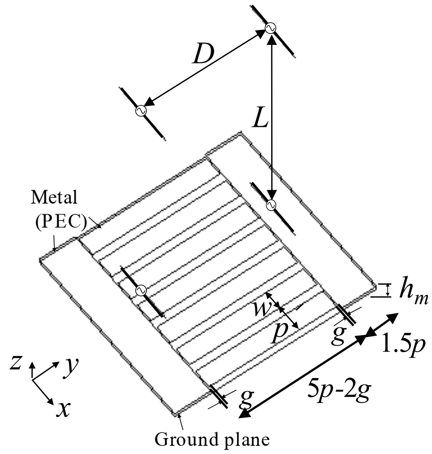


Fig. 2 Analysis model

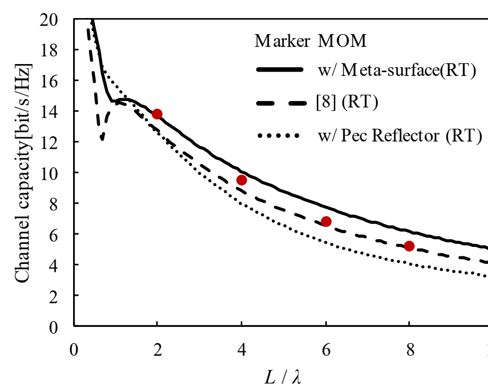


Fig. 3 Comparison of channel capacity

IV. Conclusion

This paper proposed applying meta-surface reflector with two types reflection phase characteristics on 2 × 2 MIMO to improve the channel capacity. One of the two kinds suppressed edge effects of the other and contributed to improve the channel capacity.

As the results, the channel capacity increased 1bit/s/Hz when of $1.7 < L / \lambda$. Especially, The result of MOM was in good agreement with RT when $L / \lambda < 4$.

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