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Study of an antenna system for inventory control of hardware by RF-ID

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1. Introduction

Recently, the efficiency improvement of the merchandise distribution system has been requested to control the stock of the commodity. The bar code tag and infrared reading device have been used for quantity of stock management conventionally. However, they are suitable for static stock management, but are unsuitable to do dynamic management of merchandise distribution. RF-ID appeared as the tool, which enabled dynamic management of merchandise distribution.

RF-ID is a generic name of the device that composes of a small IC chip that records information and metallic antenna. There are two kinds of types of RF-ID Tag. The passive type tag is the one that data reader/writer drives RF-ID tag only when there is transaction. On the other hand, the active type tag is always to transmit the microwave, and to communicate for the data reader.

Though this 'Hardware' is hard to be transported, necessity for merchandise distribution management is high because distribution quantity is large. Consequently, active RF-ID tag is installed in 'Hardware', and the system that traces them automatically is devised. 'Hardware' that exists in this research theme means a large-scale electronic consumer (refrigerator and washing machine, etc.). Concretely, the combination of small antenna system for 'Hardware' installation and sharp directivity antenna for reader/writer is devised. If the position of the antenna for reader/writer in the factory or the storehouse is defined, the position of 'Hardware' can be traced when active RF-ID tag is found at response area of reader/writer. Moreover, the delivery situation of 'Hardware' can be understood by the presence of active RF-ID tag. In this report, the antenna system for large-scale electronic consumer distribution management is described.

2. Stock management system structure

Fig.1 shows the outline of the stock management system that uses active tag. When active tag goes into the induction area of data reader/writer, reader/writer notices the existence of active tag. If coordinates of that area are clear, the mapping of active tag becomes possible.

The mapping resolution for active tag decreases when the induction area is wide. In addition, the mapping accuracy of active tag decreases when fringe of the induction area is indistinct. Therefore, the sharp directivity antenna is needed for data reader/writer. On the other hand, circular polarized antenna to which the transmission is steady is needed for active tag set up in 'Hardware'.

Accordingly, the development of the transmission antenna and the reader/writer antenna are shown as follows.

2.1 Development of reader antenna

This system is assuming application to the environment to which a large-scale, metallic object stands close together. It is necessary to consider scattering the microwave by those metallic object. It is necessary to develop the sharp directivity antenna to control the undesired microwave scattering. Thereupon, it is attempted to array patch antenna that is originally sharp directivity further. Concretely, four patch antenna elements are connected with MSL (Micro Strip Line), and array is composed. A structure and an analytical result of the antenna are shown as follows. The design frequency is set to 2.45GHz. The size of each part of antenna array are AH=12.2mm, AW=14.8mm, and d=3mm and AL=1/4λ (λ: wave length), respectively.

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In the design frequency, VSWR and the gain are 1.62 and 8.27dBi respectively. Additionally, the half power angle became 50 degrees. When one patch antenna element is used, the half power angle and the gain are 90 degrees and 5.0dBi respectively. The directivity increases sharpness by the array composition of the antenna.

2.2 Development of transmission antenna

Circular polarized antenna is adopted as a transmission antenna for the corresponding in any polarization. The size of the antenna is TW=48mm, TL=20mm, and TD=3mm. A structure and an analytical result of the antenna are shown as follows. The above-mentioned antenna data is all due to the numerical analysis by FDTD (Finite Difference Time Domain) method [1][2].

3. Analysis of the sensitive area

The pursuit accuracy of the metallic objects position depends on the directivity of the reader antenna. It is necessary to consider scattering the microwave by those metallic objects. Therefore, this chapter shows the result of comparing the electric field distribution which ordinary antenna (half wavelength dipole antenna) and sharp directivity antenna (array composition with four patch antennas) cause. The electric field distribution is analyzed with RapLab ver.3 [3], which is the propagation analysis software for the microwave. The antenna installation place selected three places where the influence of the building wall is different as shown in Fig. 8. Additionally, the electric field distribution when there are pillars in sensitive area (see model B and C of Fig. 8) is analyzed.

In the analytical results when there is no pillar, the sensitive area appears on a right under and a wall side away in half wavelength dipole antenna. In this case, active tag will have substance and the virtual image. With this, an accurate mapping of active tag is impossible. On the other hand, the sensitive area appears only in the right under in array antenna. This can be said by common to Model A, B, and C. However, even if array antenna is used, it is found that sensitive area shifted from the right under of reader antenna a little in Fig.11 ① reader antenna location. Hence, it is effective though sharpening the reader antenna directivity suppresses the gap of sensitive area by the environment in the room.

4. Conclusion

In this report, stock management system by the combination of sharp directivity antenna for reader/writer and active-tag installed in metallic objects was proposed. In the result of the propagation analysis, it has been understood to be able to reduce the positional detection error of active tag by the building wall when the directivity of the reader/writer antenna is sharpened. However, the indoor environmental dependency of the positional detection error of active tag was not completely suppressed. It is necessary to verify the positional detection error of active tag by the sharper directivity reader antenna. In addition, effectiveness of this system will be verified by the experiment in the future.

References

[1] A. Taflove and M. E. Brodwin, “Numerical solution of steady state electromagnetic scattering problem using the time dependent Maxwell’s equation,” IEEE Trans. Microwave Theory Tech., vol. 23, pp. 623-630, Aug. 1975.

[2] K. S. Kunz and R. J. Lubbers, “Finite difference time domain method for electromagnetics.” Boca Raton, FL: CRC Press, 1993.

[3] KOZO KEIKAKU ENGINEERING Inc. http://www.kke.co.jp/

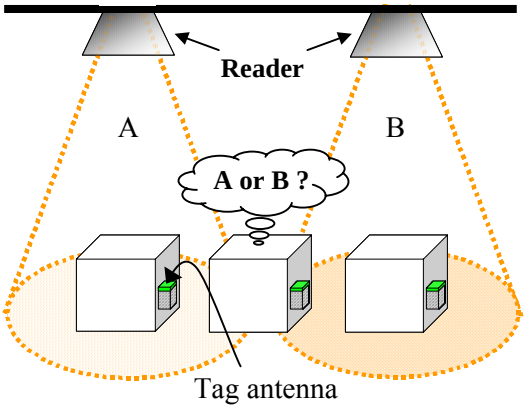


Fig.1 Stock control model by RF-tag

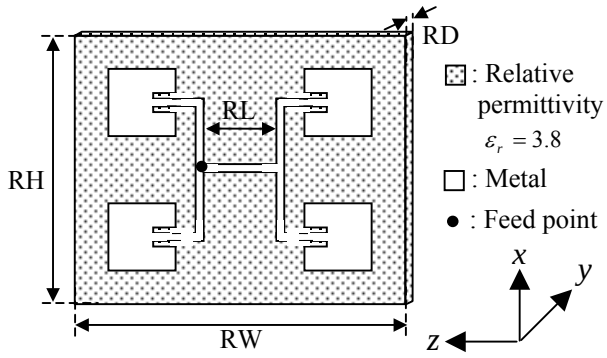


Fig.2 Array antenna that used four

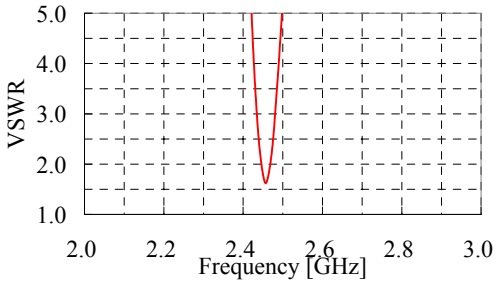


Fig.3 VSWR characteristic

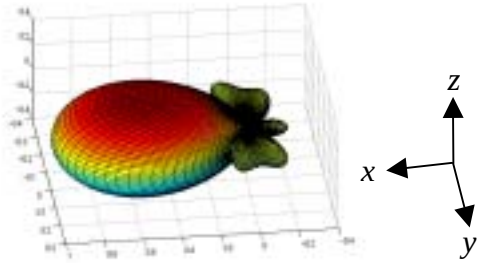


Fig.4 Radiation characteristic

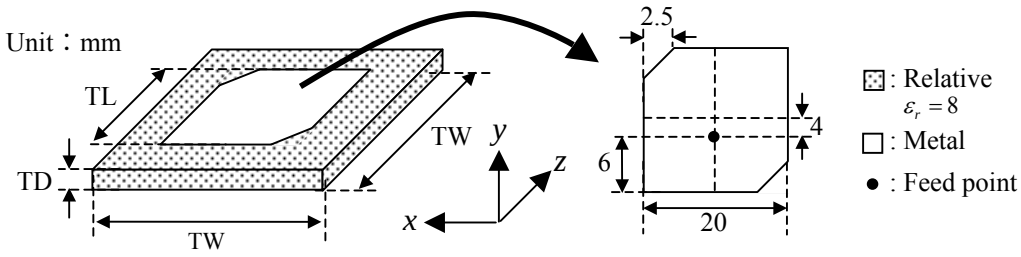


Fig.5 Array antenna that used four

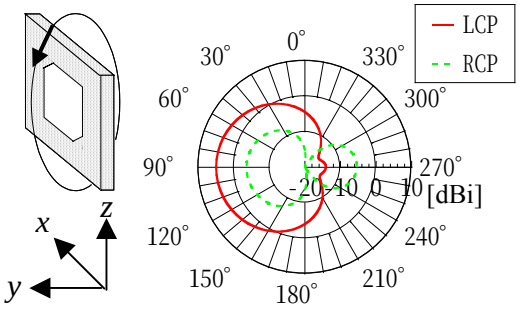


Fig.7 Radiation characteristic

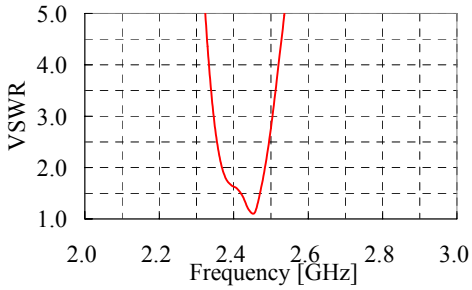
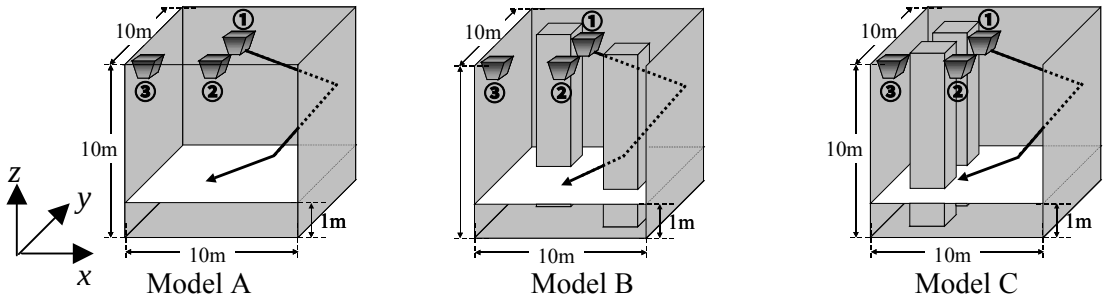
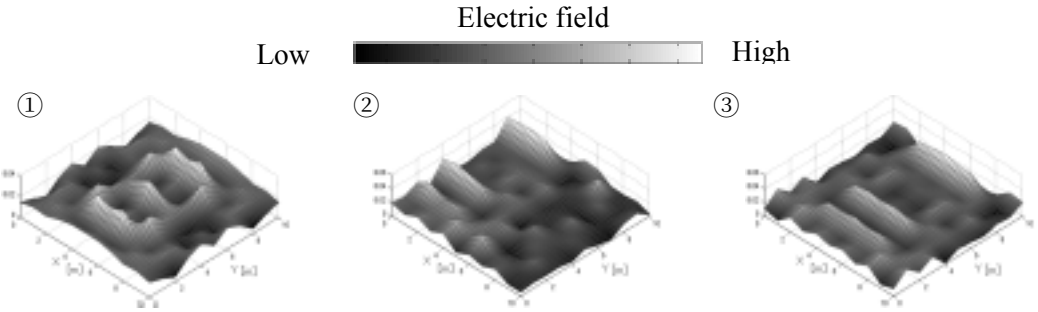


Fig.6 VSWR characteristic

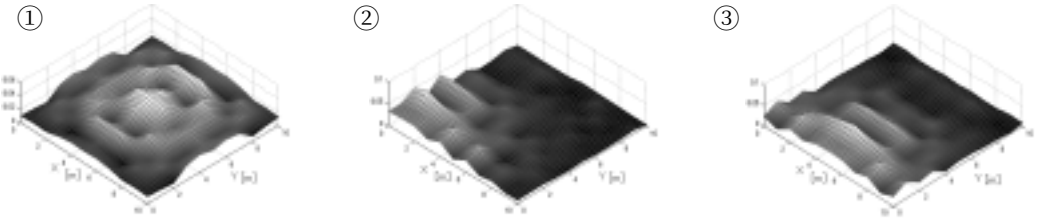


Model A Model B Model C

Fig.8 Analytical model

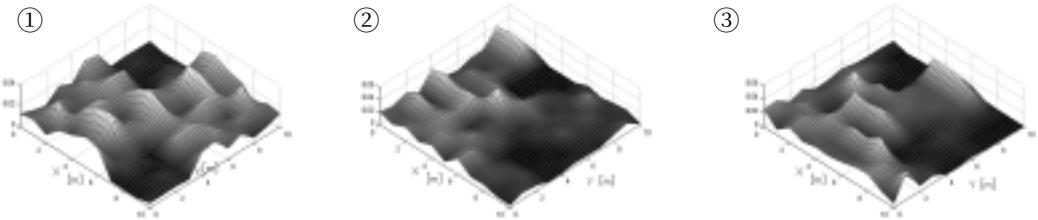


(a) Half wavelength dipole antenna

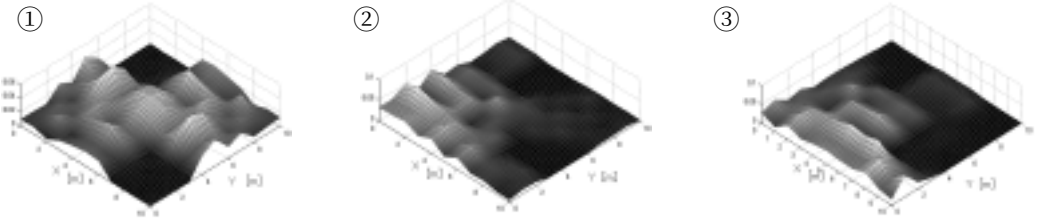


(b) Patch array antenna

Fig.9 Electric field distribution in Model A

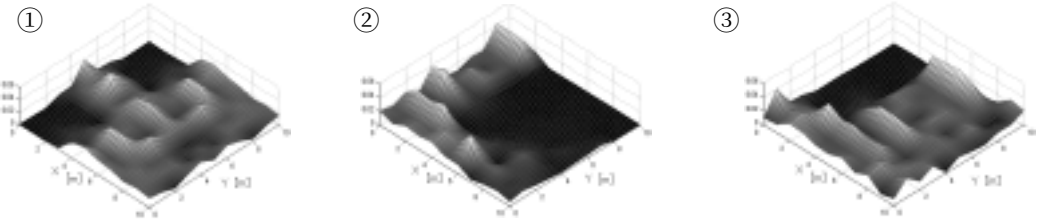


(a) Half wavelength dipole antenna

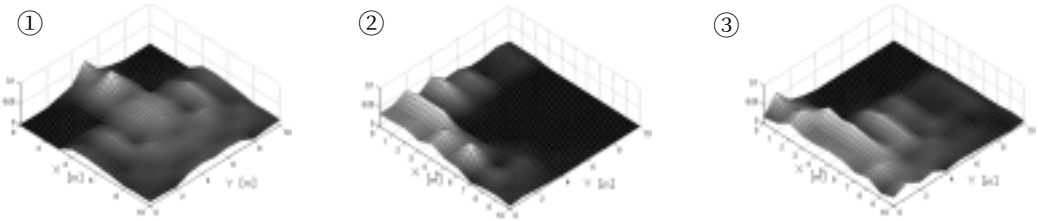


(b) Patch array antenna

Fig.10 Electric field distribution in Model B



(a) Half wavelength dipole antenna



(b) Patch array antenna

Fig.11 Electric field distribution in Model C