Development of Nearby Tags Detection Unit with UHF-RFID Technology

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***Abstract* — Recently, the system for closely-spaced tag management (at 13.56 MHz) and the system for the long distance identification (at 920 MHz) have been carried out to practical use. For continuous logistics, it is desired that those are integrated seamlessly. However, integration into the system, which uses the frequency band of 13.56 MHz, is disadvantageous to keep the feature of the long distance identification. In this paper, the system that identifies nearby cluttered tags by the frequency band for the long distance identification is described.**

Keywords — RFID, UHF band, RF-Tag, detector, the leaky coaxial cable

1. Introduction

Recently, radio frequency identification (RF-ID) system is noticed as a distribution management system that replaces the bar code. There are two types of present RFID systems (the electromagnetic coupling use type and the microwave-use type). The electromagnetic coupling use type system (HF-RFID) has the property to which the identification precision is steady for environmental changes. Therefore, this system is suitable for the detection of closely-spaced RF-tags. However, it is unsuitable for few meters distance or movement RF-Tag detection. In contrast, the microwave-use type system (UHF-RFID) is suitable for few meters distant or traveling RF-tags detection, because the detection signal transmission efficiency is high [1]. Though, the suppression technology of electromagnetic interference is necessary for the detection of closely-spaced RF-tags. In detailed management of a physical distribution, if closely-spaced tags detection and distant tags detection system are unified, that is so useful. Although, the integration of those systems are not easy. Improving the detection distance of the HF-RFID system is attended with a lot of technical difficulties. On the one hand, the electromagnetic interference suppression method for the UHF-RFID system exists variously. In this paper, these two systems are integrated by UHF-RFID. The proposed unit searches tags that are cluttered in two dimensions. In such industry segments, the distant or traveling RF-tags detection is required in the delivery confirmation, the detection of closely-spaced RF-tags are also required in the sales confirmation (refer to Figure 1). Accordingly, closely-spaced RF-tag detector unit that uses the UHF-RFID system will be demanded.

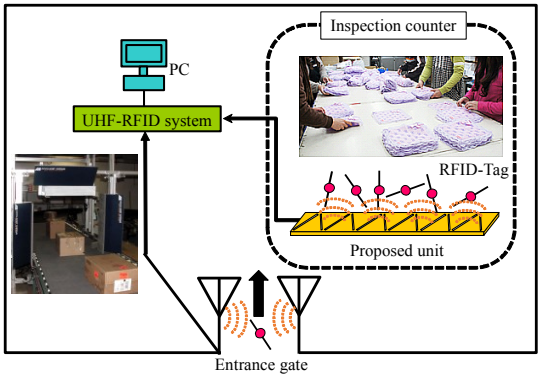


Fig. 1. Integration of a UHF band RFID system

2. Configuration of the proposed unit

The proposed unit is required to search cluttered tags without electromagnetic interference. If this proposal is realized, seamless management will become possible. The cluttered tags detector proposed in this paper referred to the leaky coaxial cable [2]. The proposal tag detector has flat shape that fitting to the commodity identification work desk is considered though general leaky coaxial cable's form is a cylindrical shape. The structure of the proposed unit is shown in Figure 2 in detail. A flat shape cable is called shielded type microstrip-line. The proposed unit is composed with putting slot apertures on the outside metal layer of shielded type microstrip-line.

In design or performance evaluation of the proposal cluttered tags detector, finite-difference time-domain (FDTD) method is used as numerical analysis [3]. The relative permittivity and the conductivity of the dielectric substrate in shielded microstrip-line is set to $\varepsilon_r = 3$, $\sigma = 0.0005$ [S/m].

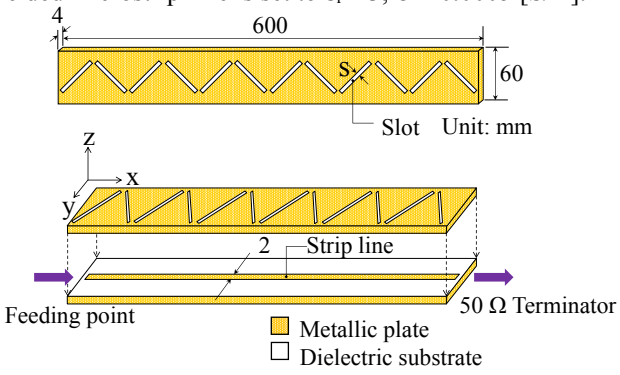
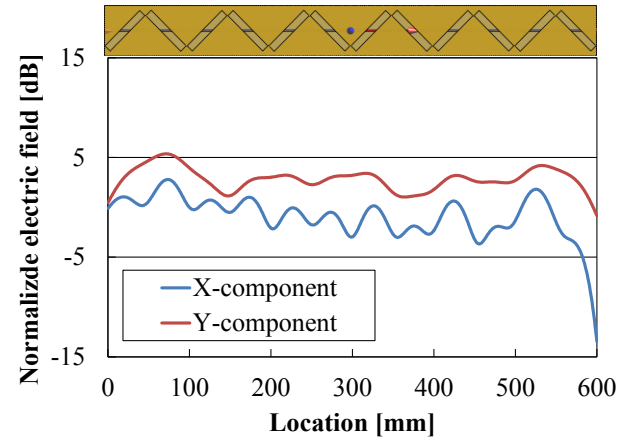


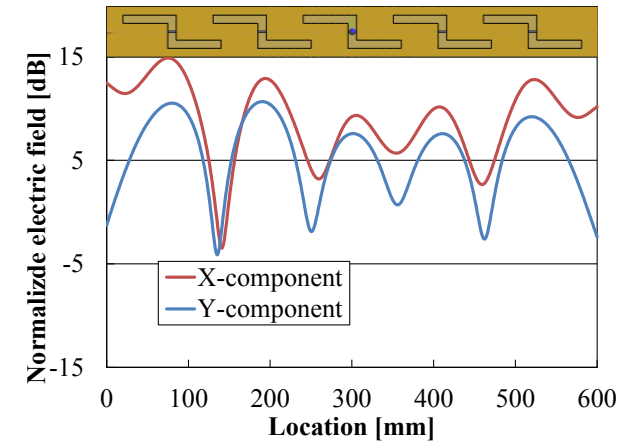
Fig. 2. Configuration of the cluttered tag detector unit.

3. Study on the slot shapes

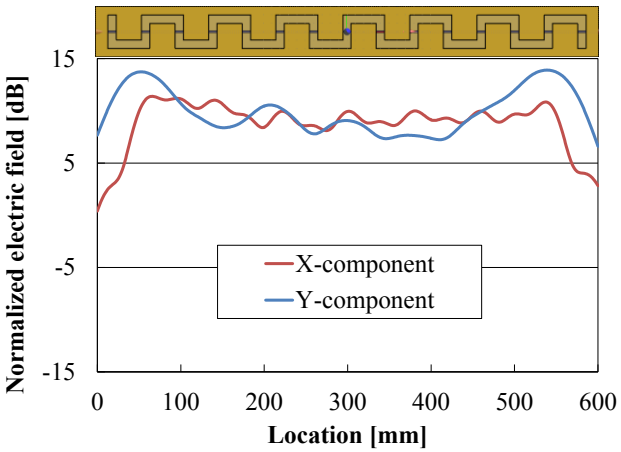
In this chapter, three types of slot shape are shown. Figure 3 shows the slot shapes and calculated results. The electric field on 50 mm (assumed thickness of folded clothes) away from the centerline of the detector unit is evaluated. The electromagnetic radiation from the antenna for long-range detector is used for the performance evaluation index of the proposed tag detection unit. Many of antennas for long-range Reader/Writer are enabled for tag to be detected by 90 % or more if the distance between it and a target tag is within 2 m. Consequently, the electric field for the performance evaluation index is normalized with the electric field of the high-gain patch antenna (around 8 dBi) above 2 m.



(a) "Λ" shape slot unit

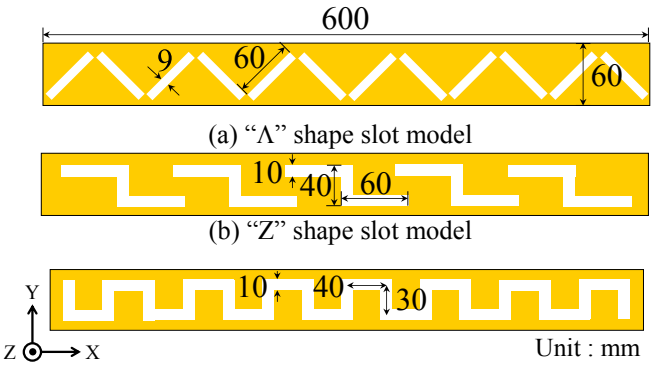


(b) "Z" shape slot unit



(c) "Snake" shape slot unit

Fig. 3. Normalized electric field of changing slot shapes



(a) "Λ" shape slot model

(b) "Z" shape slot model

(c) "Snake" shape slot model

Fig. 4. The dimension of the tag detector

Figure 4 shows the configuration and dimension of the tag detector of three types which has different slot aperture. The adjacent slots are axisymmetrical inclined each other because the radiation field should not slant in "Λ" shape slot unit. The "Λ" shape slot has 12 slots aperture, and each slots are set to 9 mm in width and 45 degrees in slot inclination angle. The feature of "Λ" slot unit is that it is possible to control the components of electric field by changing the slot inclination angle. The "Z" shape slot is designed as shape that the slot edge can be separated each other. The "Z" shape slot has 5 slots aperture, and each slots are set to 10 mm in width. It can be seen that "Z" shape slot radiation stronger than other unit. . However, getting depressed of radiation is confirmed to the gap part of "Z" shape slot.

"Snake" shape slot is one long slot unlike individual slot array like "Λ" or "Z" shape slots. Hereby, electromagnetic interference of the slot edges is improved. The width of "Snake" shape slot is set to 10 mm, and its winding width is set up to 30 mm. the result of Fig.3 predict that the "Snake" shape slot unit has high identification ability of tag in an arbitrary direction than any other units

4. Conclusion

In this paper, the detection system for UHF-RFID to detect nearby tags was proposed. The leaky coaxial cable that applied shielded type microstrip-line was adapted to the proposed system. Additionally, the radiation properties of the tag detector that had three different types slot aperture was evaluated. Consequently, the 'Snake' shape slot was confirmed the identification precision of tag was high compared with other individual slot.

References

[1] Gaetano Marrocco, "RFID Antennas for the UHF Remote Monitoring of Human Subjects," IEEE TRANCEACTION ON ANTENNA AND PROPAGATION, Vol.55, No.6, June 2007.

[2] *Radio Engineering*, New York: J. Wiley & Sons, 1980. Robert E. Collin and Franis J. Zucker, "Antenna Theory part II", chapter 20, McGraw-Hill Inc., 1969.

[3] A. Taflove and M. E. Brodwin, "Numerical solution of steady state electromagnetic scattering problem using the time dependent Maxwell's equation," IEEE Trans. On Microwave Theory and Techniques, vol. 23, pp. 623-630, Aug. 1975.

[4] Maiko Ochiai and Yoshinobu Okano, "Development of management system for gathered RFID-Tag with UHF band", APMC, 2009.