Miniaturized RFID Tag Antennas

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Abstract

This paper presents miniaturized RFID tag antennas. First, cubic and spherical RFID tag antennas are explained. These antennas have small size and 3-axes polarization. The application systems of these antennas are real-time specific absorption rate (SAR) measurement system and wireless sensor for biomedical systems. Second, small dual-band RFID tag antenna is designed for metallic object applications. This antenna is based on microstrip monopole antenna and parasitic elements are added for dual band operation. For miniaturization, the antenna is changed to 'S' shape. These miniaturized antennas would be useful for RFID system.

Keywords : RFID, Tag antennas, Miniaturization

1. Introduction

UHF band (860~960 MHz) passive RFID(Radio Frequency IDentification) system has been widely applied for wide range of applications such as asset identification, retail item management, and tracking applications because of low production cost with reasonable read range. The passive RFID system is consists of an integrator and a RFID tag. The tag antenna is composed of a microchip and an antenna and the readable range of the tag depends on performance of RFID tag antenna. RFID tag antennas are attached to various objects such as small and metallic objects. Therefore, the tag antenna RFID is miniaturized and performance of a tag antenna do not change on metallic surface.

In this paper, 3-axes polarization RFID tag antennas for independence of polarization [1-3] and dual-band RFID tag antenna [4] for metallic objects are presented. The 3-axes polarization RFID tag antenna is designed as cubic, meandered cubic and spherical shape for small size and 3-axes polarization. These antennas are based on dipole-typed RFID tag antenna. The dual-band RFID tag antenna for metallic object is designed by changing a microstrip line monopole antenna with parasitic element. The design tag antenna has 'S' shape and two parasitic elements. Details of the antenna characteristics are presented and discussed.

2. 3-axes polarization RFID tag antennas

Cubic and spherical RFID tag antennas are depicted in Figure 1. As shown in Figure 1(a), the basic antenna configuration is a half-wavelength dipole antenna composed of thin planar copper line of 1 mm. First of all, the cubic antenna (Figure 1(b)) is designed for the real-time SAR measurement system [1, 5]. The feed of the antenna is positioned a corner of cube and the left and right arms are bent on the surface of styrofoam (ε_r=1.06) which is used for supporting the thin copper line. The short stub is employed for RFID chip impedance matching. The size of the designed antenna is $0.052\lambda \times 0.052\lambda \times 0.052\lambda$ at 911.25 MHz. To reduce size of the antenna, meandered line is applied to cubic antenna as shown in Figure 1(c). The size of meandered antenna is $0.03\lambda \times 0.03\lambda \times 0.03\lambda$

Next, as portrayed in Figure 1(d), the dipole antenna is packed onto a sphere's surface where the diameter of the sphere is 25 mm (0.076λ). The left arm and the right arm of the antenna are bent differently at five junctions. The angle at each junction can be either 30° or 100°. Next, conjugate impedance matching between the RFID chip and the miniaturized tag antenna is achieved by tuning the short stub length and the overall dipole length. The short stub is connected between the first junction on the right.

In Figure 2, 3 and 4, measured readable range patterns of the designed antennas are depicted in xz, yz and xy plane. Maximum readable range of cubic, meandered cubic and spherical antennas was measured as 135cm, 80 cm and 132 cm, respectively. The patterns for the E_θ in the xz, yz and E_ϕ in the xy plane were tilted by approximately 45° because of complex currents due to coupling from each segment. In case of the E_ϕ pattern in the xz, yz and E_θ pattern in the xy plane, almost omni-directional pattern were shown. The designed antennas showed 3-axes polarization characteristics. These antennas are independent for polarization in regardless of the antenna's position.

3. Dual-band RFID tag antennas mountable on metallic surface

When the RFID tag antenna is mounted on conductive surface, its impedance change and bandwidth decreases. Therefore, a tag antenna is required with impedance characteristics which do not change even when it is attached to metallic materials and multi-band operation is needed. Figure 5 shows miniaturization process of dual-band RFID tag antennas mountable on metallic surface. The basic structure of the tag antenna is microstrip line monopole antenna as shown in Figure 5(a). The length of parasitic elements is controlled for dual-band operation as depicted in Figure 5(b). To reduce size of the antenna, the entire line was modified in to an S-shaped meandered structure, and the end of the feeding line was made into a spiral structure. Figure 5(c) indicates the miniaturized antenna. The size of the antenna is 20 mm in width, 33.5 mm in length, and 2mm in height, including the ground plane.

Figure 6(a) shows measured S_{11} for the miniaturized antenna. -10 dB bandwidth is 6 MHz (0.66%) in 911.25 MHz and 5 MHz in 866.5 MHz. It covers Korea and Europe RFID band. Measured readable range pattern is shown in Figure 6(b). For the measurement, a conductive plate of 300 mm×300 mm in size was attached to the tags. The maximum readable range was measured as 1.6 m in Korea band (EIRP: 4 W) and 0.75 m (EIRP: 1W)

4. Conclusion

In this paper, miniaturized RFID tag antennas were introduced. 3-axes polarization antennas based on dipole antenna was made of cubic shape and spherical shape for small size and 3-axes polarization. Also, dual-band RFID tag antenna was devised for metallic object applications. This antenna operate Korea and Europe RFID band. The designed antennas would be useful for real time SAR measurement system and metallic object RFID applications.

References

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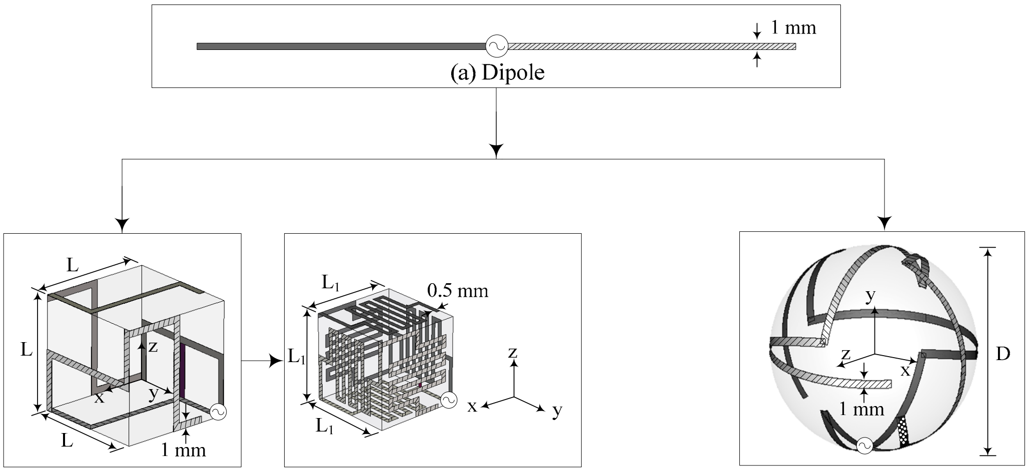
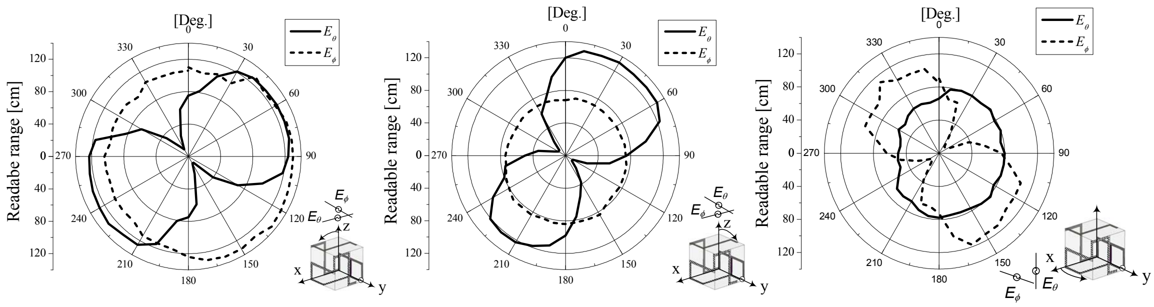


L: 17 mm (0.052λ) — (b) Cubic antenna

L: 10 mm (0.03λ) — (c) Cubic antenna : meandered type

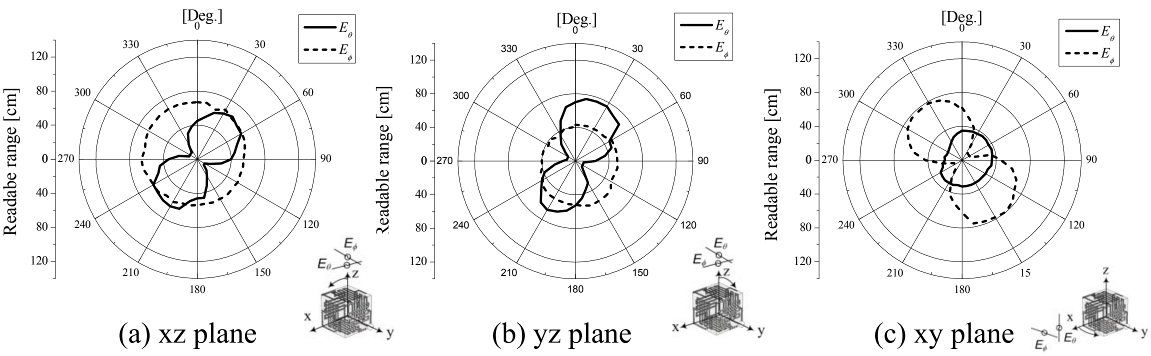
D: 25 mm (0.076λ) — (d) Spherical antenna

Figure 1: Cubic and spherical antennas



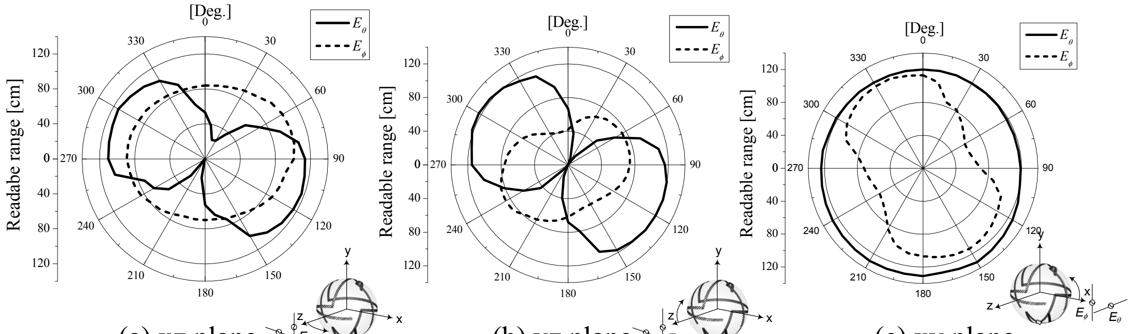
(a) xz plane (b) yz plane (c) xy plane

Figure 2: Radiation pattern of the cubic antenna



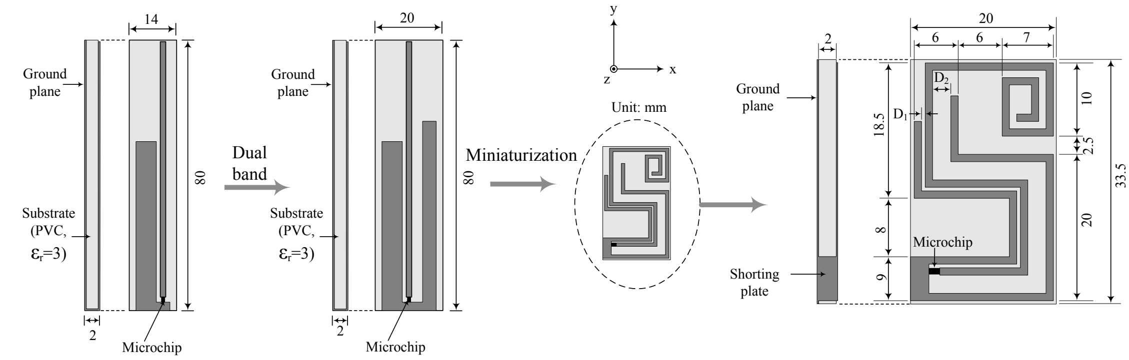
(a) xz plane (b) yz plane (c) xy plane

Figure 3: Radiation pattern of the cubic antenna applied meander line



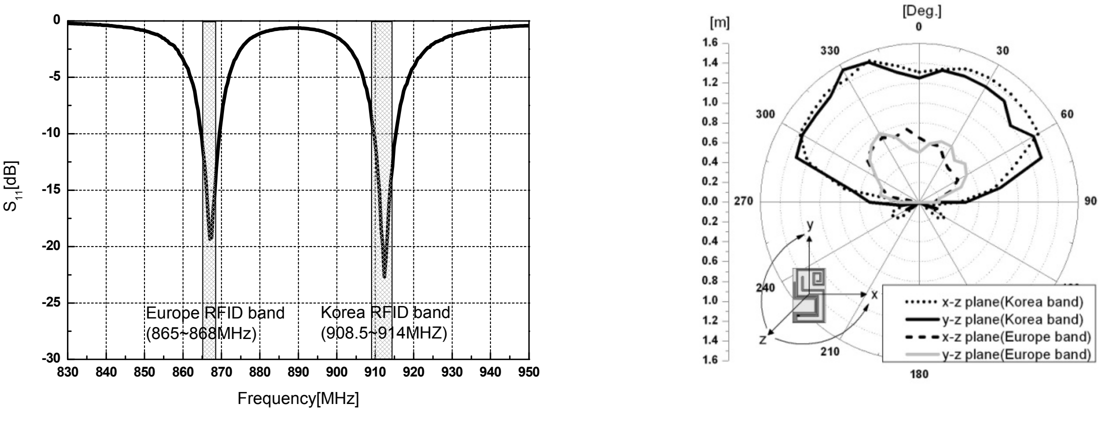
(a) xz plane (b) yz plane (c) xy plane

Figure 4: Radiation pattern of the spherical antenna



(a) Microstrip line monopole antenna (b) Microstrip line monopole antenna for dual band (c) Miniaturized dual-band RFID tag antenna

Figure 5: Miniaturization process of dual-band RFID tag antenna



(a) Return loss (b) Readable range pattern

Figure 6: Return loss and readable range pattern of dual-band RFID tag antenna