Design of Low Profile On-body Directional Antenna

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***Abstract*-This paper proposes a low profile on-body directional antenna, which suits for on-body system. The antenna generates surface wave along the body surface in the industrial, scientific, and medical (ISM) band. The proposed antenna has a size of 65 mm × 65 mm × 2mm. On the human body equivalent phantom with the proposed antenna, simulated S-parameters show that the impedance bandwidth is lower than - 10 dB. The proposed antenna is a good candidate for on-body applications.**

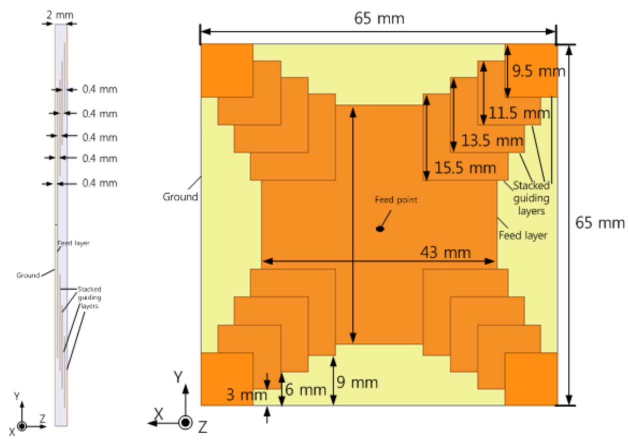
***Index Terms* —ISM band, On-body antenna, Wireless Body Area Network (WBAN), On body communication, Low profile antenna**

I. Introduction

People's interest on medical applications of microwave has been rapidly increased recently[1]. Brain neurostimulators, bladder pressure sensors, and pacemakers are good examples. The critical biomedical data obtained from medical devices need to be communicated in the form of microwave with monitoring devices. In order to achieve good communication link between on-body medical device and monitoring device, a directional antenna is necessary[2]. The low profile and mobility are key requirements for such directional antenna. Previously proposed on-body directional antenna has relatively thick thickness (around 8mm) that is inconvenient to install on a human body[2]. In this paper, we propose a low profile on-body directional antenna utilizing stacked guiding patches. The proposed antenna has low profile and generates electric field along the surface of a body to form a surface wave.

II. Antenna Design

Figure 1(a) shows the side view of the proposed low profile on-body directional antenna. The proposed antenna consists of stacked guiding patches, a feed layer, and a ground plane. The antenna occupies the volume of 65 mm×65 mm×2 mm, which can be easily installed on a human body. Figure 1(b) shows the top view of the proposed antenna which is fabricated with Taconic CER-10 substrates (εr = 10.1). The ground plane of the proposed antenna has the size of 65 mm×65 mm. The feed layer is printed on the top side of a 0.4 mm thickness Taconic CER-10 substrates with the size of 43 mm×43 mm. The stacked guiding patches are printed on each corner of four Taconic CER-10 substrates (0.4 mm thickness) with different sizes. The dimensions of guiding patches are 9.5 mm×9.5mm, 11.5 mm×11.5 mm, 13.5 mm×13.5 mm , and 15.5 mm×15.5 mm, respectively. The guiding patches are stacked as shown in Figure 1(b).



(a) (b)

Figure 1. Geometry of the proposed antenna:
(a) side view, (b) top view

III. Simulation Setup

Figure 2 shows the simulation set-up. Three proposed antennas are located 1 mm above the sphere shaped body tissue (ε_r = 52.5, σ = 1.78 S/m) having the radius of 100 mm. Figure 3 shows E-field distribution near the surface of body tissue.

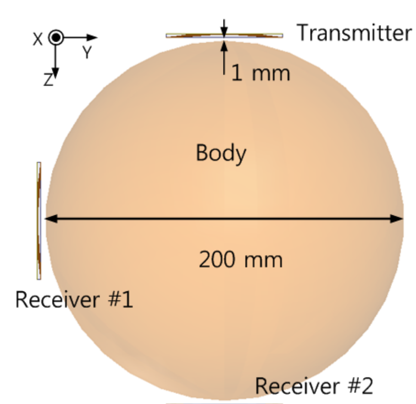


Figure 2. Simulation set-up of the proposed antennas with body tissue

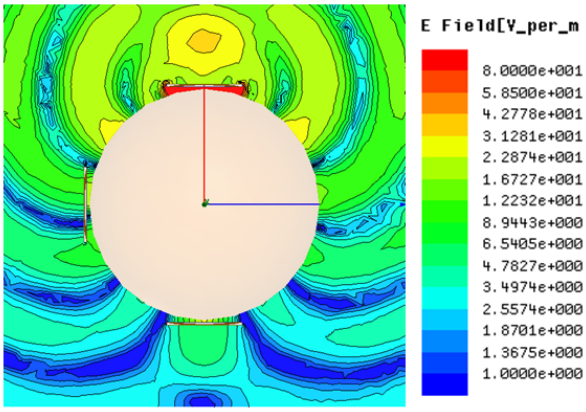
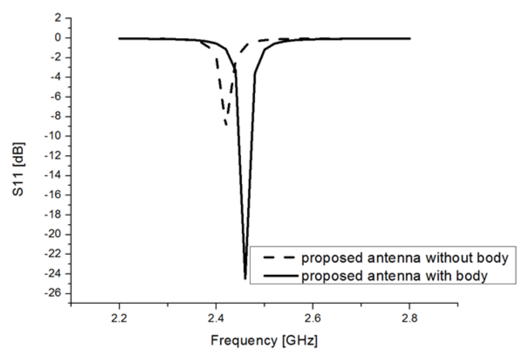


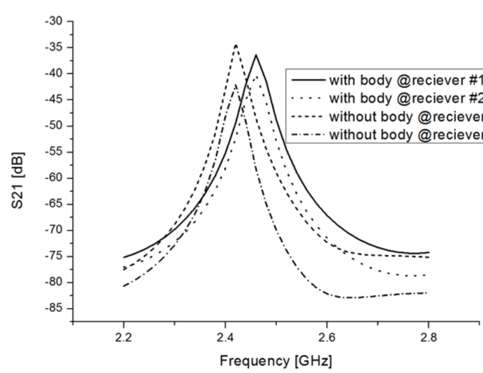
Figure 3. Simulated E- field distribution of the proposed antennas with body tissue (2.465GHz)

IV. Simulation Result

Figure 4 shows simulated S-parameters of the proposed antenna with and without body tissue. The proposed antenna with body has S11 around -25 dB at 2.46 GHz. In addition, S21 of receiver #2 is about 3dB higher then that without body since the proposed antenna generates surface wave along the body tissue.



(a)



(b)

Figure 4. Simulated S11 and S21 characteristic of the proposed antenna

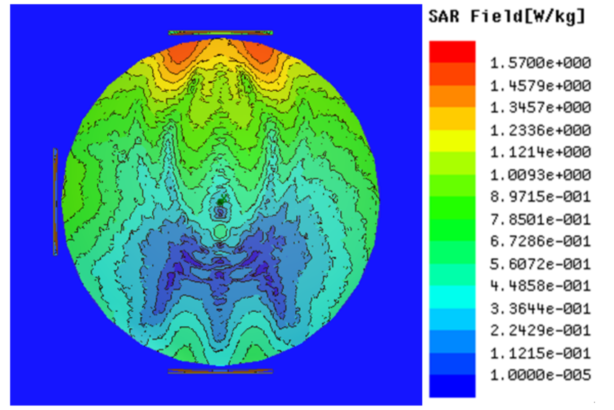


Figure 5. Simulated SAR distribution of the proposed antenna (2.465 GHz)

The simulated SAR distribution is shown in Figure 5. The SAR was simulated with ANSYS HFSS 14.0. The input power to the proposed antenna was 250mW,which is usually used for SAR measurement of mobile application devices, is used to measure SAR. Hot spots are observed around edge of the proposed antenna where the stacked guiding patches are located. The maximum SAR value was 1.57 W/kg at 2.465 GHz. Although a high input power of 250mW was delivered to the antenna, the maximum value of the measured SAR was still below the regulated SAR limitation (1.6W/kg) of the American International Journal of Antennas and Propagation 5 National Standards Institute (ANSI/IEEE) for short-distance biotelemetry [4].

V. Conclusion

This paper proposed a low profile on-body directional antenna for medical devices. The proposed antenna operates in the ISM band. The antenna is modeled with stacked structure for low profile and used guiding patches to generate E-field along the desired direction. In addition, the E-field distribution of the antenna is advantageous for communication between on-body medical devices in the ISM band. The simulated maximum SAR value was low enough to conform to the SAR limitation of the ANSI. Consequently, the proposed antenna shows good performances as a suitable candidate for on-body system owing to the low profile structure and E-field distribution.

Acknowledgment

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