Planar Monopole Antenna for WBAN

Ebrahim Sailan Aabidi, **M. R. Kamarudin**, **T. A. Rahman**, **and Mohsen Khalily**
Wireless Communication Centre (WCC), Faculty of Electrical Engineering
Universiti Teknologi Malaysia, UTM Skudai, Johor 81310, Malaysia

Abstract— This paper presents circular-shape monopole antenna for wireless body area network (WBAN) applications at 3.1 to 5.1 GHz and 6.5 to 8 GHz. The design and simulation of proposed antenna for WBAN applications in the free space and close proximity of body surface has been done by using CST Microwave Studio. The proposed antenna was designed on FR4 substrate with dielectric constant (ε_r) of 4.4 and thickness of 1.6 mm. The final optimized design is $50 \times 40\,\mathrm{mm}^2$. The simulated current distribution on the radiating patch for the proposed circular-shaped monopole antenna frequencies of 3.3 and 7.5 GHz in the free space is presented. The size of circular-shape monopole antenna it is suitable for WBAN application.

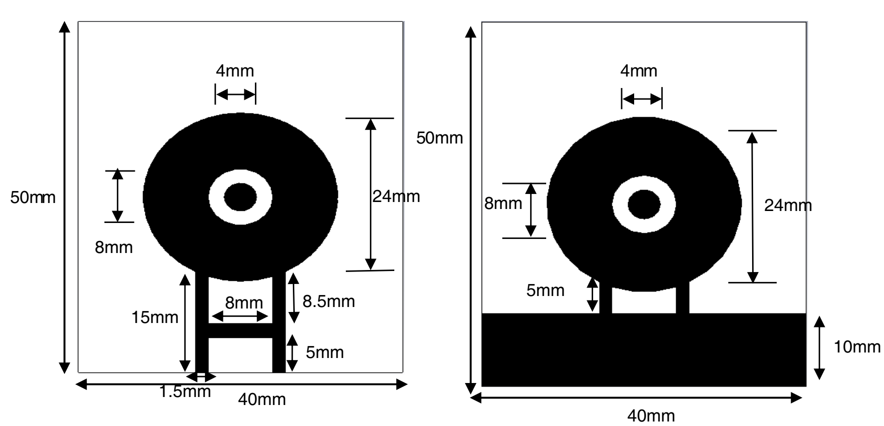
1. INTRODUCTION

The UWB technology has loaded much attention and experienced considerable growth a few years ago due to its distinctive characteristics. One of the most promising areas of UWB applications is WBAN, where the wireless connectivity between body centric units is provided through the deployment of light weight and compact UWB antennas [1–3]. The Federal Communications Commission (FCC) about one decade ago prescribed the frequency range for UWB to be 3.1–10.6 GHz [4]. The FCC also described in its initial report and order, huge absolute bandwidth to be structures that is more than 500 MHz in bandwidth.

This paper presents Circular-shaped monopole antenna for WBAN application for the lower frequency band from 3.1 to 5.1 GHz and the higher frequency band from 6.5 GHz to 8 GHz of the UWB band. The simulation results of the Circular-shaped monopole antenna in free space and close proximity to body tissues has been presented. The organized of this paper as follows. In Section 2, the antenna geometry and design are described. The results and discussion the antenna performance are explained in Section 3. Finally, some conclusions are given in Section 4.

2. ANTENNA DESIGN

In this paper, Circular-shape monopole antenna operating from 3.1 GHz to 5.1 GHz and 6.5 GHz to 8 GHz frequency band has been presented. The antenna is printed on the FR4 substrate with dielectric constant of 4.4, loss tangent of 0.02 a thickness of 1.6 mm. The optimized dimension of the propose antenna is $50 \times 40 \times 1.6\,\mathrm{mm}^3$. The geometry and dimension of proposed Circular -shaped monopole antenna is shown in Figure 1.

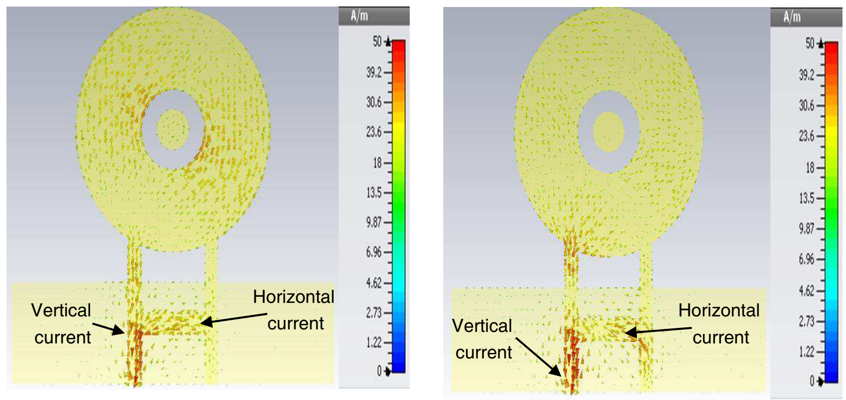


(a) Front view (b) Back view

Figure 1: The geometry of the proposed circular-shaped monopole antenna.

2.1. Surface Current Distribution

Current surface distribution determines how the current flow on the patch of antenna. Hence, the most significantly part of the patch can determine the current flow of the proposed antenna. The simulated current distribution on the radiating patch for the presented Circular-shaped monopole Antenna frequencies of 3.3 and 7.5 GHz in the free space is presented in Figure 2. It can be observed on Figure 2(a) that the current concentrated on the edges of the exterior and interior of the circular-shaped on the radiating patch and circular-shaped element is connected to the ground plane on the back view at 3.3 GHz. The vertical current is most concentrated near the patch edges and Circular-shaped element rather than distributed on the antenna surface at 7.5 GHz and this cause the decrement of the intensity of vertical electrical current on antenna surface. The horizontal current mode occurs on the ground plane on the back view as indicated in the Figure 2.

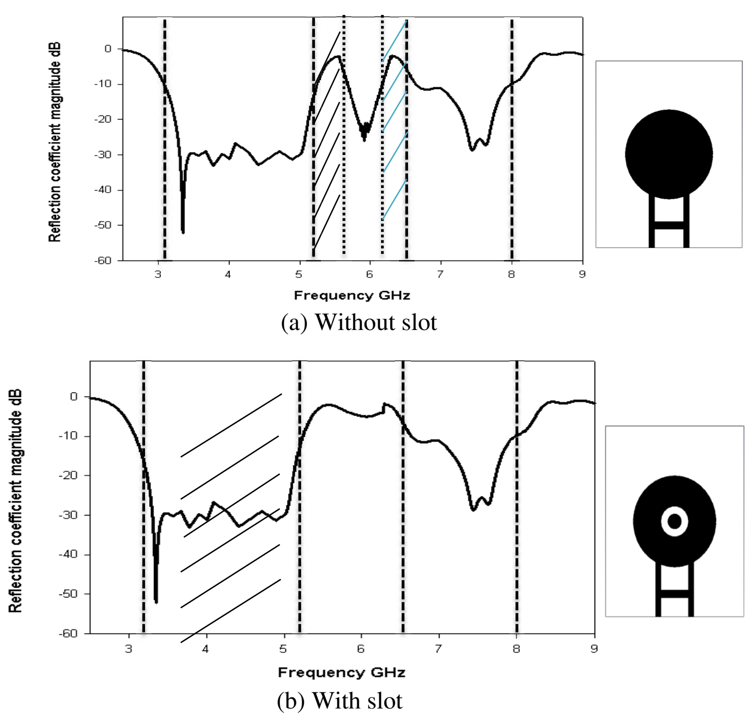


(a) Current distribution at 3.3 GHz (b) Current distribution at 7.5 GHz

Figure 2: Surface current distributions of the proposed antenna.

3. RESULTS AND DISCUSSION

The parametric studies were carried out to investigate different antenna parameters in order to achieve the optimized design. The effect of the slot on the patch has been investigated. The



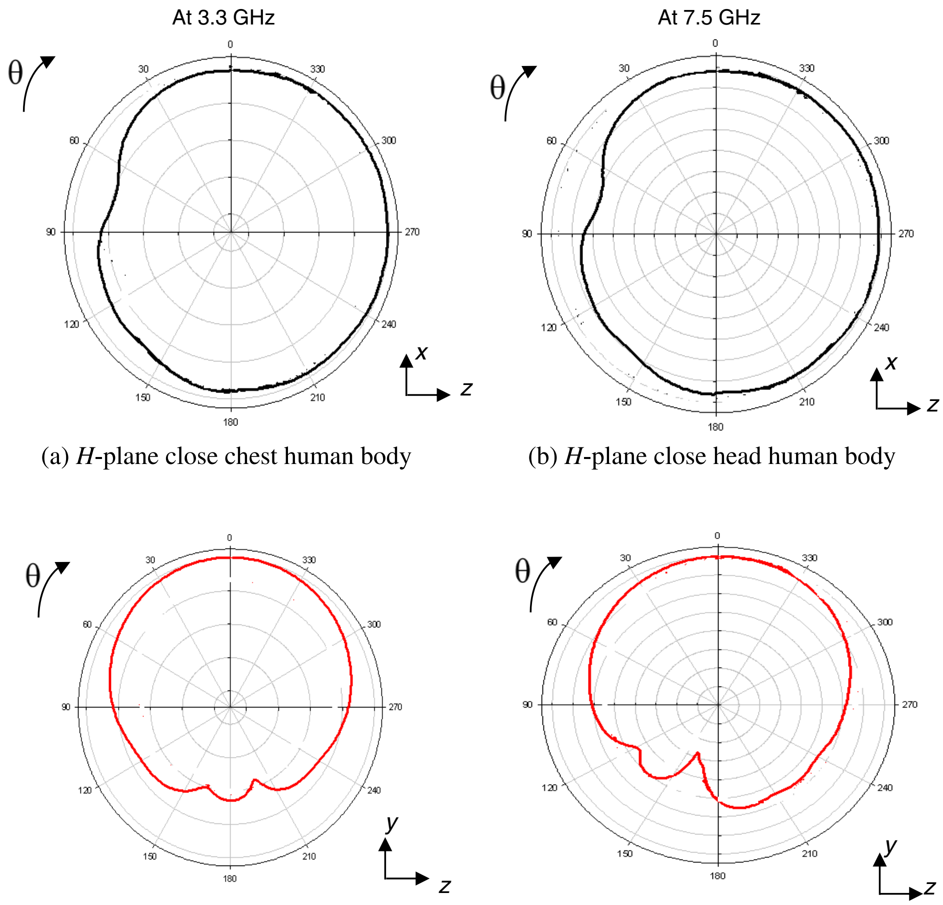
(a) Without slot

(b) With slot

Figure 3: The reflection coefficient magnitude result of the proposed antenna.

proposed circular-shaped antenna with and without the slot on the radiating element is shown in Figure 3. The simulated reflection coefficient magnitude is operate at (3.1–5.1 GHz), (5.55–6.28 GHz) and (6.5–8 GHz) without the implementation as illustrated in Figure 3(a). While the reflection coefficient magnitude results of the proposed antenna with the slot is (3.1–5.1 GHz) and (6.5–8 GHz) as indicated Figure 3(b). The dimension of the slot on the proposed antenna is 8 mm as shown in Figure 3(a). It can be seen that in section of the slot on the patch of the proposed antenna resulted from 5.55 to 6.28 GHz band rejection. The circular-shaped antenna with slot is introduced that resulted to avoid interference with WLAN at 5.8 GHz.

Figure 4 shows that the E- and H-plane patterns in 3.3 and 7.5 GHz of the proposed antenna in the close to human body tissues. It can be seen that the E-plane and H-plane radiation pattern is affected when the antenna placed close to the body.



(a) H-plane close chest human body (b) H-plane close head human body

(c) E-plane close chest human body (d) E-plane close chest human body

Figure 4: Simulated radiation pattern of the proposed antenna.

4. CONCLUSION

In this paper, Circular-shaped monopole antenna has been presented investigating the surface current distributions, the slot on the radiating element and radiation patterns in the free space and close proximity of the human body. The Circular-shaped antenna with slot is introduced that resulted to avoid interference with WLAN at 5.8 GHz. The simulated results show that the proposed antenna provides good performance when placed close human body in term of reflection coefficient magnitude and radiation pattern for WBAN applications.

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