Bidirectional Antenna on Flambeau-Shape

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1. Introduction

Presently, GPR system has brought to apply widely in several types of work. Mostly, it is used to investigate with no damage cause such as objects exploring, underground gas pipes, underground tank, tree root, electric cable and waste water pipe which those objects may be destroyed if there is the digging operation in that area surface without prior investigation. The antenna used in GPR system according to FCC standard has set the antenna into 2 lengths which are the low antenna lower than 960 MHz and the high length will set at antenna 3.1 - 10.6 GHz [1-2]. Besides as stated, UWB (Ultra-wideband) was also brought to apply in wireless communication by technology standard IEEE 802.15.3a [3], which is the new technology of communication that becomes very popular because of its wide bandwidth [4], so that the transmitting of large amount of information is enhanced with high speed. For GPR system and wireless communication according to IEEE 802.15.3a standard, the important equipment that makes both systems work effectively is the antenna that response to the 3.1 - 10.6 GHz frequency range and another part that help to support an antenna for good transmitting. The input signal that feeds to CPW-fed can be done in several ways. But one way that popular applied is Coplanar Waveguide (CPW) technique that is found low loss in the form of wave distribution and no via-hole for linking to ground in order to a ground antenna is on the same side[5]. Another good point of CPW-fed is the matching impedance can be done easily so, there was the research and application of CPW-fed technique with a monopole antenna to reduce the size of antenna [6-8]. This research presents the new form of a monopole antenna with CPW feed-line as the idea in [9-12] to apply the new structure of a Flambeau-shape antenna. The CST program is used for optimized the proposed parameters to have the most effectiveness.

2. Antenna design

The design of Flambeau-shape monopole antenna structure begins from bringing the U-shape antenna to adjust the size by optimization on the CST program as shown in figure 1. The structure of the proposed antenna is created on the material FR4 which its relative dielectric constant (ε_r) and a thickness (h) are 4.3 and 0.764 mm, respectively. The return loss, the radiation patterns and bandwidth of the proposed antenna are produced by adjusting structure of the antenna. It is found that the varying of width and length of the proposed antenna cause the response in the required frequency range.

First, the stub of the Flambeau-shape antenna at point (X) is varied by adjusting the length W_5. It is found that when the W_5 is 2.6 mm, the frequency response is produced the wide bandwidth of 126.86% (2.95 - 11.45 GHz) as shown in figure 2(a). The length from the antenna to ground plane has a stable value, L_8 of 0.3 mm.

Then the space between the Flambeau-shape stub, W_1 which on the top end of the proposed antenna as point Y is adjusted. It is found when W_1 is around 13 mm; the bandwidth is increased of 127.58% (2.80 - 12.05 GHz) and made the return loss reduced in both high and low frequency edges. The increasing of the bandwidth is 0.72% more than the adjusting of W_5 as shown in figure 2(b).

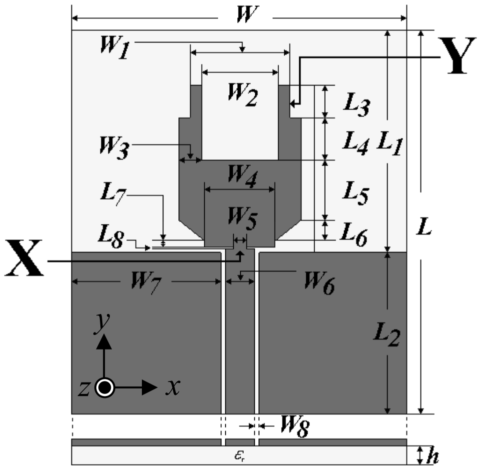
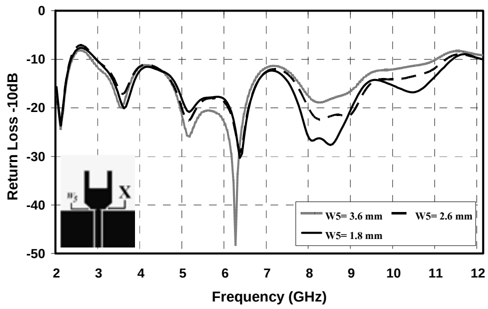
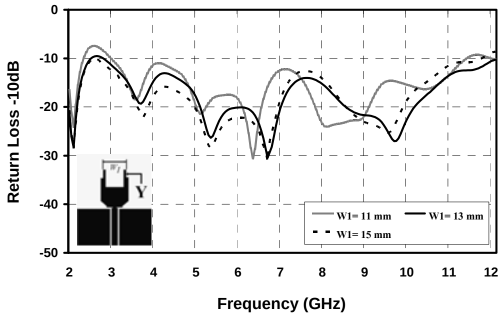


Figure 1: Layout of the proposed antenna.



(a)



(b)

Figure 2: The frequency response (S_{11}) when (a) W_5 (b) W_1 is varied.

Its optimized dimension has been determined. The antenna parameters were obtained in the followings: L_1 = 28.2 mm, L_2 = 21.8 mm, L_3 = 3.7 mm, L_4 = 5.9 mm, L_5 = 7.8 mm, L_6 = 2.8 mm, L_7 = 0.85 mm, L_8 = 0.3 mm, W_1 = 13 mm, W_2 = 10 mm, W_3 = 3 mm, W_4 = 9.2 mm, W_5 = 2.6 mm, W_6 = 3.8 mm, W_7 = 17.5 mm and W_8 = 0.6 mm. Nevertheless, the feed-line is exactly equal to 50 ohm. The total dimension is equal to 50 x 40 mm^2.

3. Creation and result of measurement

Base on the discussion above the physical antenna prototype is then fabricated as shown in figure 1. Then, the Flambeau-shape antenna is fabricated as shown in figure 3. In the part of the measurement result of the return loss and bandwidth of the antenna, it is found that both results from the model and real measurement are in the same direction which is be able to support the use of the frequencies range from 2.7 GHz to 12.05 GHz as shown in figure 4(a). By the responding result to the frequencies in the using range is in the fraction form of Voltage Standing Wave Ratio: VSWR) from the outcome of VSWR value. Figure 4(b) shows the comparison of simulated and measured gain in the frequency range of 3 to 11 GHz. It found that the expanding gain is around 2. 91to 3. 07dBi.

To confirm that the proposed antenna is generated the bidirectional pattern so that figure 5 and 6 show the radiation patterns in E- and H- plane at 3.5, 7.1 and 11.2 GHz. It can be noticed that all the responses are activated as a monopole antenna with the bidirectional pattern.

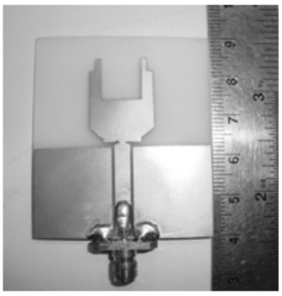
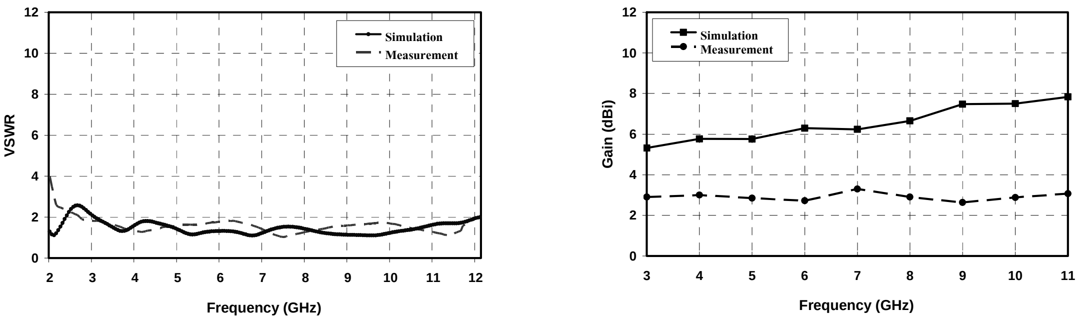
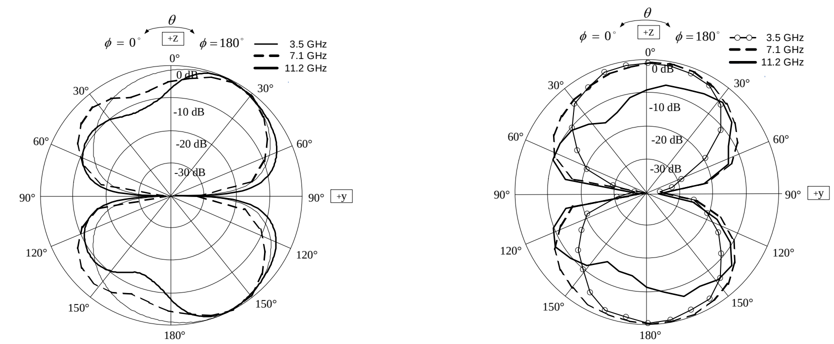


Figure 3: A photograph of the Flambeau-shape antenna.



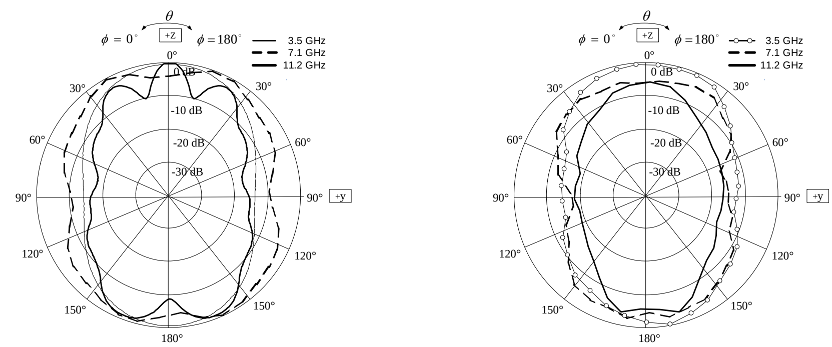
(a) (b)

Figure 4: Comparison of simulation and measurement of the proposed antenna (a) VSWR (b) Gain



(a) (b)

Figure 5: The radiation pattern at the frequencies of 3.5 GHz, 7.1 GHz and 11.20 GHz on E-plane (a) Simulation (b) Measurement.



(a) (b)

Figure 6: The radiation pattern at the frequencies of 3.5 GHz, 7.1 GHz and 11.20 GHz on H-plane (a) Simulation (b) Measurement.

4. Conclusion

This paper propose the Flambeau-shape monopole antenna to apply in the UWB in GPR system and wireless communication system IEEE 802.15.3a in the frequencies range of 3.1 -10.6 GHz. The result of the simulation and measurement are agreed very well. The proposed dimension is 40 x 50 mm^2 and fabricated on FR-4 PCB substrate, which its VSWR is less than 2 and the percentage of bandwidth is 132.41%. For the radiation pattern, it is the Bidirectional with the gain of 3 dBi all the frequency range.

Acknowledgement

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