Design of an Omnidirectional and High-Gain Dual-Mode Dipole Antenna

Wen-Hsiu Hsu[1], Huan-Yu Jheng[1], Shan-Cheng Pan[1], Chia-Lun Tang[2]
[1]Department of Computer and Communication, Shu-Te University
No. 59, Hengshan Rd., Yanchao Dist., Kaohsiung, 82445 Taiwan
[2] Technological Research Center, Auden Techno Corp.
No.19, Lane 772, Ho-Ping Rd., Bade City, Taoyuan Hsien, Taiwan, R.O.C

***Abstract* —This paper presents an omnidirectional high-gain dual-mode dipole antenna design with simple architecture. The proposed antenna system was composed of a rectangular antenna main body and a reflective ground plane. The antennas was "H" shaped and fabricated on a single-sided FR4 substrate. The area of the antenna system was 53 x 31 mm^2, and a 50Ω micro-strip was used as a feeding pin at the center of the rectangular antenna main body. This antenna design included two frequency band ranges. For the Global Positioning System (GPS), the 1.57542 GHz frequency band was used. For WLAN, the 2.4 – 2.485 GHz frequency band was used. In the GPS frequency band the proposed antenna exhibited good omnidirectional properties and gain of 1.6–1.7 dBi. In the WLAN frequency band the proposed antenna exhibited good directional properties and gain of 6.2–6.3 dBi. This antenna design showed excellent performance when used for GPS and WLAN.**

Index Terms —Dipole, WLAN, directivity, GPS, omni directivity.

I. Introduction

With the advance of technology, the development and application of wireless communication technologies have become more diverse and comprehensive. From daily life applications to medical care devices, wireless communication technologies have been widely adopted, and one of the most critical parts in wireless communications are antennas. Thus, how to increase the efficiency and connection quality of antennas has always been an important issue in discussions of wireless communications. In [1–3], the antenna system designs are concerned with improving the impedance by adjusting frequency bandwidth with several simple methods. Discussions of structures similar to the one presented here are not involved, and the enhanced antenna directivity has never been mentioned. The antenna system design in [4] resembles that proposed in this research. With impedance frequency bandwidth ranging 1–8 GHz, the proposed antenna had more complex architecture, and could support the electromagnetic wave transmission of wireless communication systems. However, the proposed system suffered from the following deficiencies: 1) A larger structure and 2) impedance bandwidth that could be easily interfered. Therefore, in the study, a method was developed to enhance antenna gain by using a rectangular antenna main body and a reflective ground plane to enhance the gain, resulting in good directivity in radiation patterns. The rectangular main body was connected to the reflective ground plane. The connection contributed to the creation of a second frequency band, which was used for the Global Positioning System (GPS) and had a frequency of 1.57542GHz. The radiation pattern of this frequency band displayed good omnidirectivity.in this document concerning, but not limited to, font size, margin size, page limits, file size, etc.

II. Antenna Design

Fig. 1 shows the design architecture of the proposed omnidirectional high-gain dual-mode dipole antenna. The substrate was implemented using a single-sided FR4 plate with a thickness of h = 0.8 mm, a dielectric constant (ε_r) of 4.4 and a loss tangent of 0.0245. The H-shaped dipole antenna main body had a width of W = 53 mm and a length of L = 33 mm. The width of the central feeding pin was W_f = 1 mm, and the dipole antenna main body had a width of W_1= 3 mm. The distance between the dipole antenna main body and the reflective ground plane was L_1= 21 mm, and the width of the reflective ground plane was W_2= 5 mm. Moreover, a 50Ω micro-strip with a line width of 1.5 mm was coupled with the dipole antenna main body as a feeding pin.

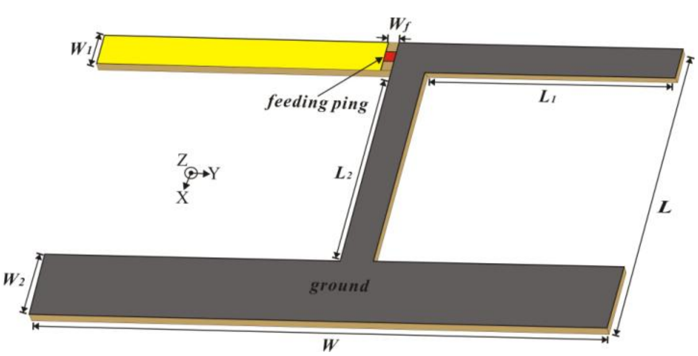

Fig. 1. Design of the proposed Omnidirectional and High-Gain Dual-Mode Dipole Antenna

III. Results and Discussion

In this chapter, an experiment was conducted to examine the gain and parameters of the proposed antenna. Fig.2 As a result of an analysis on the parameters illustrates a comparison between the return loss curve actually measured by a network analyzer and the curve simulated by SEMCAD X. The results showed that at 2.4 GHz, the measured impedance matching characteristic was 22 dB whereas the simulation value was 16 dB. Therefore, the return loss values of the two impedance matching characteristics were extremely close. At 1.57542 GHz, the measured impedance matching characteristic was approximately 24 dB whereas the simulated value was 26 dB. The results indicated that for the proposed dipole antenna the measured and simulated impedance matching characteristics produced two return loss curves that were almost identical.

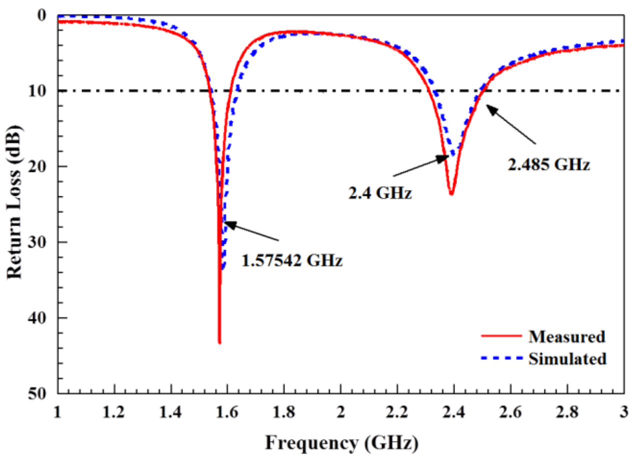

Fig. 2. Curve of return loss with measured and simulated antennas.

Fig.3 is the measured 2D pattern at 1.57542 GHz. According to the measured data, the gain on the xy-plane was approximately 1.9 dBi, that on the zy-plae was approximately 2.19 dBi, and that on the zx-plane was approximately 1.94 dBi. Based on the three patterns, the proposed omnidirectional high-gain dual-mode dipole antenna showed a tendency towards omnidirectivity at 1.57542 GHz.

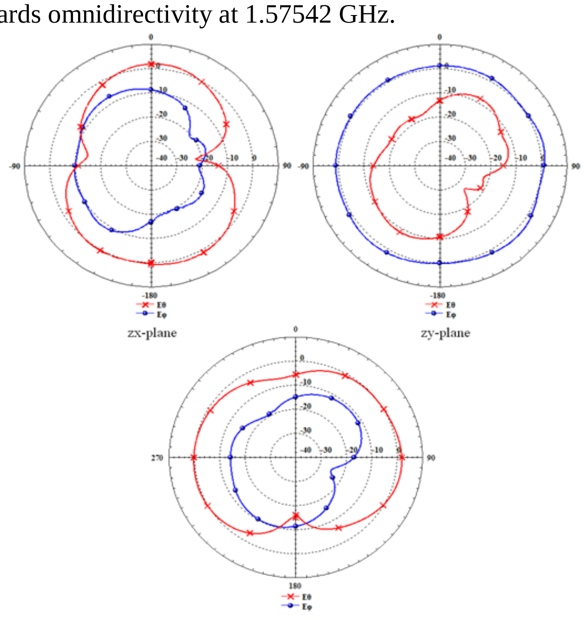

Fig. 3. Measured 2D pattern of the proposed antenna at *f* = 1.57542 GHz.

Fig. 4 is the measured 2D pattern at 2.4 GHz. According to the measured data, the gain on the xy-plane was approximately 6.47 dBi, that on the zy-plae was approximately -1.77 dBi, and that on the zx-plane was approximately 6.3 dBi. Based on the three patterns, the proposed omnidirectional high-gain dual-mode dipole antenna showed a tendency towards directivity at 2.4 GHz.

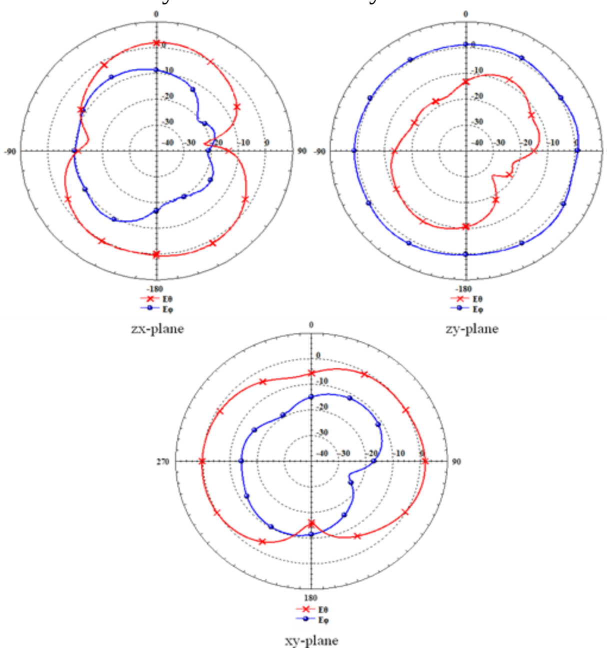

Fig. 5. Measured 2D pattern of the proposed antenna at *f* = 2.4 GHz .

The more experimental results and analysis will be described

REFERENCES

[1] Saou-Wen Su, Jui-Hung Chou, Yung-Tao Liu, "Realization Of Dual-Dipoleantenna System for Concurrent Dual-Radio Operation Using Polarization Diversity," *Microwave and Optical Technology Letters.*, vol. 51, pp. 1725-1729, July 2009.

[2] Yun-Wen Chi, Kin-Lu Wong, Shih-Huang Yeh, "End-Fed Modified Planar Dipole Antenna For Dtv Signal Reception," *Microwave and Optical Technology Letters.*, vol. 49, pp. 676-680, March 2007.

[3] Z.-X. Yuan, Y.-Z. Yin, Y. Ding, B. Li, J. J. Xie, "Multiband Printed And Double-Sided Dipole Antenna for Wlan/Wimax Applications," *Microwave and Optical Technology Letters.*, vol. 54, pp. 1019-1022, April 2012.

[4] Junho Yeo, Jong-Ig Lee, "Planar Log-Periodic Bow-Tie Dipole Array Antenna With Reduced Size and Enhanced Front-Back Ratio," *Microwave and Optical Technology Letters.*, vol. 54, pp. 1435-1441, June 2012.