

UWB Planar Dipole Antenna with Notched Band

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Abstract - An ultra-wideband planar dipole antenna with notched band is proposed in this paper. The dipole consists of one pair of elliptical-arc dipole arm and a parallel microstrip-feed. Whole structure is printed on a low-cost glass fiber substrate. Instead of complex feeding network, only structural parameter adjustments are used to achieve desired impedance bandwidth. Also, one perturbation is appropriately added to stop certain band. Experimental results indicate that the 10-dB impedance bandwidth is over 2.48 ~ 12 GHz with a notched band 5 ~ 6 GHz.

Index Terms — Dipole Antenna, UWB Antenna, Band-Notched Antenna.

I. INTRODUCTION

The antenna is an important element in the microwave imaging system. To effectively emission and receive microwave signals, the antenna requires large bandwidth, high gain, high directivity and good pulse response. The characteristics of ultra-wideband (UWB) system meet these requirements [1]. Many disclosed literatures proposed the monopole antenna, bow-tie antenna, and tapered slot antenna (Tapered Slot Antenna, TSA) for the microwave imaging system [2-4]. However, UWB transmitters should not cause any electromagnetic interference (EMI) on nearby communication systems such as wireless LAN systems (5.3 ~ 5.875 MHz). Therefore, a UWB antenna having a frequency band notch characteristic is desirable. To stop the specific frequency bands, two techniques are usually used. One is embedding filter into the feeding network [5], and another is embedding perturbations into the radiator of the antenna [6]. In this paper, an UWB planar dipole antenna is proposed. Also, one pair of perturbations are added to stop the frequency band of 5 ~ 6 GHz.

II. ANTENNA DESIGN

Fig. 1 shows the structure of ultra-wideband dipole antenna. One set, which consists of an elliptical-arc dipole arm and a tapered microstrip line, is spread on the upper layer of an FR4 substrate (thickness $h = 1.6$ mm, permittivity $\epsilon_r = 4.4$). Another set is spread toward opposite direction on the lower layer. The included angle between the dipole arms is denoted as θ_1 . Such structure forms a parallel microstrip feed for the dipole antenna. In addition, two metal strips ($W_s \times L_s$) are respectively added on both layers of substrate and along the dipole edge. As shown in the figure, d_x represents the distance between the strip and substrate edge, while d_y is

between the strip and dipole edge. Here, the metal strips function as the perturbation of certain frequency band.

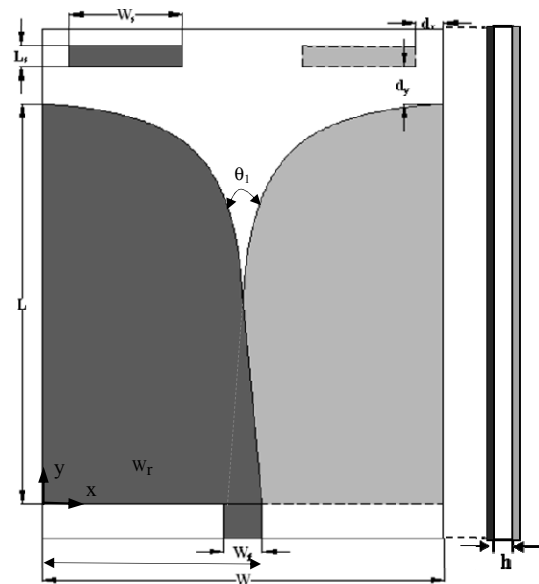


Fig. 1 Configuration of the proposed antenna

III. EXPERIMENTAL RESULTS AND DISCUSSIONS

The original structure parameters for UWB operation are decided by the following equations [6]. The detail structure parameters are listed on Table I. Here, $f = 3.1$ GHz and $z_0 = 50 \Omega$.

$$W = L = \frac{c}{f} \sqrt{\frac{2}{\epsilon_r + 1}}; \quad W_f = \frac{h}{z_0} \frac{120\pi}{\sqrt{\epsilon_r}}$$

$$W_r = \frac{W}{2} + \frac{W_f}{2}$$

Table I. Structure parameters of the proposed antenna. (Unit: mm).

W	L	W_r	W_s	W_f	L_s	d_x	d_y
59	59	32	17	5.8	3	4	5.5

Fig. 2 shows the reflection coefficient S_{11} against frequency of the studied antennas. For clear comparison, the case without perturbation noted as reference is studied firstly. Fig. 2(a) presents the effect of θ_1 on S_{11} . It indicates that θ_1 is a key factor to adjust impedance matching between the 50- Ω

feeding port and the antenna. From Fig. (b), the measured is similar to the simulated, that is, expected multi-resonances for UWB operation are observed in all cases. The measured 10 dB impedance bandwidth of the reference antenna is from 2.48 GHz to larger than 12 GHz. In addition, it is noted that the proposed (notched) antenna successfully stop the frequency band of 5 ~ 6 GHz.

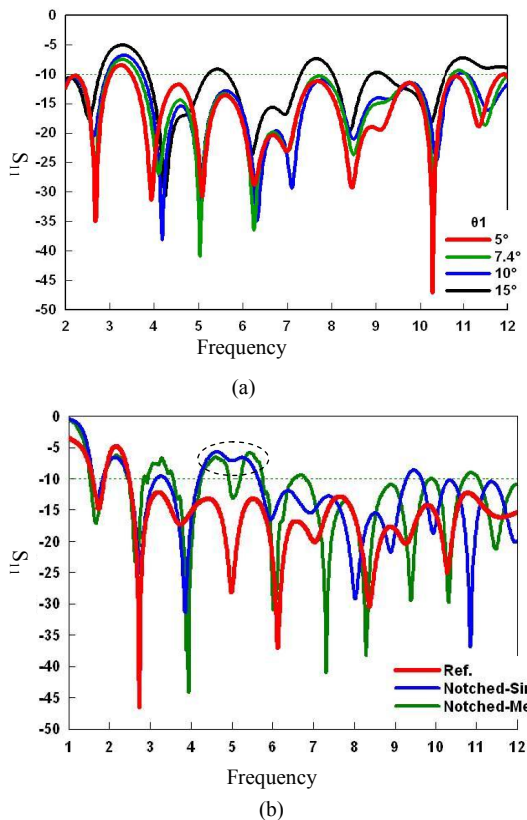


Fig. 2. (a) Simulated S_{11} of reference antenna with varying θ ; (b) Measured and theoretical S_{11} against frequency of the proposed antennas.

Fig. 3 shows the simulated current distribution on dipole arm of the reference antenna at resonance. It is observed that large current distributes along the top edge at 5.5 GHz. According to this characteristic, the metal strip length is set to be about half wavelength of 5.5 GHz and placed parallel to the dipole top edge closely. Such arrangement can induce inverse current on the strip.

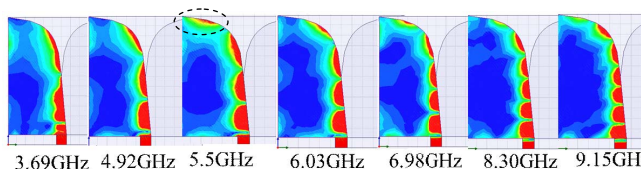


Fig. 3. Simulated current distribution on dipole arm of the reference antenna at resonance.

Fig. 4 presents the mentioned feature. It introduces the field cancellation around 5.5 GHz, and the degradation on antenna gain around 5.5 GHz is expected. Fig. 5 presents the antenna gain toward y-axis ($\phi = 90^\circ$) over the range 5.0 ~ 6.0 GHz. Firstly, the reference antenna gain is almost constant of about 5 dBi over frequency band. However, the proposed antenna has 5~23 dB degradation in antenna gain. These

features indicate that the additional metal strips successfully suppress the radiation over 5.0 ~ 6.0 GHz of the proposed UWB antenna.

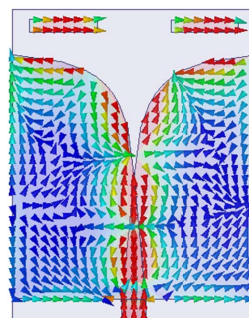


Fig. 4 The current distribution of the UWB band notched dipole antenna at 5.5 GHz.

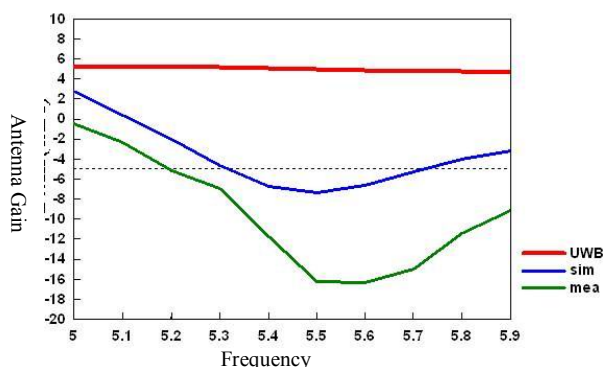


Fig. 5 Measured and theoretical antenna gain at $\phi = 90^\circ$ over 5~6 GHz of the proposed antennas.

III. CONCLUSIONS

This paper presents a simple dipole antenna design. By simple structure parameter adjustment, the operating bandwidth of the antenna reaches 2.48GHz-12GHz with a notched band of 5~6 GHz. The design of ultra-wideband antenna with directivity and appropriate gain value is suitable for the microwave imaging system to scan cancerous tissue.

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