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A Novel Smiley Fractal Antenna Design With Notch Filter for UWB Wireless Application

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ABSTRACT

This paper presents a Smiley Fractal Antenna (SFA), employed with U-notch feed and modified ground plane, it is designed for ultra wide band applications. Ultra Wideband (UWB) has been deliberated as a promising technology for short-range wireless communication with large unlicensed frequency band for commercial, enterprise private and public uses. The proposed antenna is of compact size with dimensions of 34×32×1.6 mm, designed with FR-4 substrate with relative permittivity of 4.4. HFSS is used to conduct simulation, calculation so as to get various performance parameter of the antenna.

Keywords— Ultra-wide band, Fractal antenna, Notch filter, HFSS

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I. INTRODUCTION

Ultra-wideband (UWB) wireless communication technology has been receiving wide attention from both academy and industry since the Federal Communication Commission (FCC) released of the frequency band from 3.1 to 10.6 GHz for commercial communication applications in February 2002 [1]. UWB communication systems have many advantages, including high speed data rate, extremely low spectral power density, high precision ranging, and low cost. So the study of ultra-wideband antenna is always a hot spot [2].Antenna is an important part of UWB comm- unication systems, and it is a challenge to design then antenna suitable for such a wide frequency band applications. Fractal antenna, due to the simple structure, desirable bandwidth & nearly omni-directional radiation patterns, has beens widely used in UWB antenna design. Many antenna designs have been widely used in the UWB system [3].Recently, the ultra–wide band (UWB) comm- unication systems have gained much attention because of their many advantages including low power spectral density radiated power and potential for accommodating higher data rate. To avoid interference between the UWB systems and the wireless local area network system (WLAN) with center frequency of 5.8 GHz, a notch filter in the UWB system is necessary [4].

In this paper, a compact UWB smiley fractal antenna with a band notched characteristics has been proposed. The proposed antenna's radiating patch fed by 50 ohm micro-strip line and a rectangular shaped ground plane. To achieve the band notched characteristics, a pair of L-shaped slots forming U-Shape and symmetrical step slot is etched on the ground plane to obtain the centre frequency of 5.8 GHz band notched characteristics. The proposed antenna is simulated by HFSS 13 Software which is electromagnetic solver.

II. DESIGN OF THE ANTENNA

The geometry of proposed antenna is shown in Fig.1 and Fig.2. It is fed by 50 ohm micro-strip line. Radiating patch is designed on 1.6mm thick FR4 substrate with the relative permittivity and loss tangent of substrate is 4.4 and 0.02, respectively.

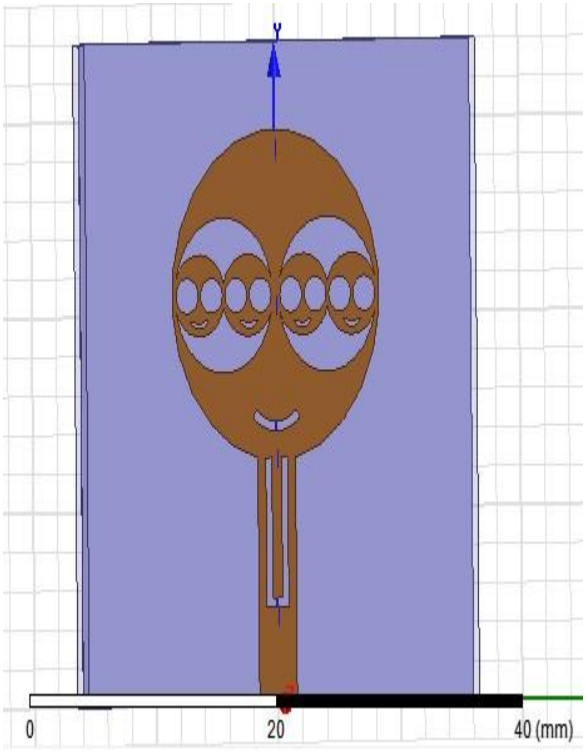

Fig.1. Front view of proposed antenna

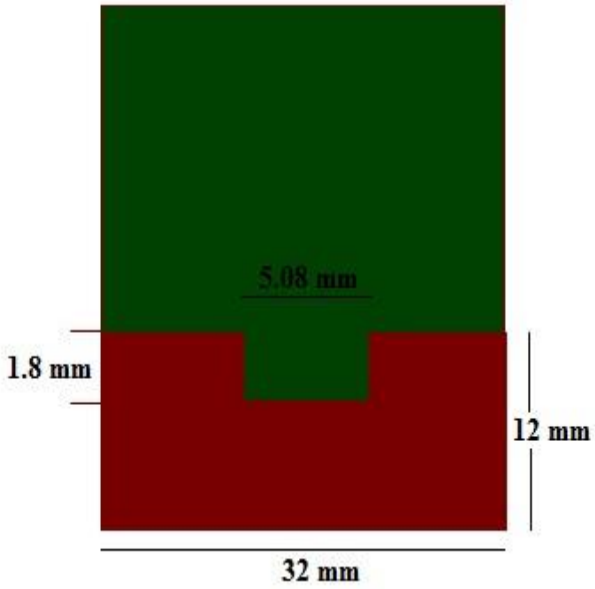

Fig.2. Back view of the antenna

In antenna design, we analyze and simulate this antenna by using Ansoft HFSS 13 software. For better matching of input impedance the radiating patch is placed in the position with respect to ground plane of the antenna. The Radiating patch of the antenna is designed by iterations.

The first iteration of the proposed antenna is created by removing two circles of radius 4 mm whose centre lies on the diameter of the main radiating patch (8.5mm) i.e., the zeroth iteration. An arc of thickness 0.5mm is introduced by subtracting it from main patch, and the length of the arc is 4.187mm. This is the first iteration which resembles a smiling human face as shown in Figure 1. For the second iteration, the circle representing the face is drawn with radius 2.1mm with its centre on the diameter of the main radiating patch. Two circles of radius 0.9 mm representing the eyes and the arc of thickness 0.25 mm are removed from the circle and the length of the arc is 1.7 mm.

The shape of the ground plane as rectangle with dimension 32 mm × 12 mm. It Exhibits a better results. Dimensions of rectangular ground plane have been optimized to exhibits best gain and bandwidth. These optimized dimensions are obtained after a good number of simulations.

III. THE SIMULATION AND ANALYSIS OF THE ANTENNA

In this paper, we use Ansoft HFSS 13 to simulate the UWB monopole antenna. The return loss S11 of the simulation result is shown in Fig. 3. Proposed antenna transmit from 2.1 GHz to 15 Ghz. Its Ultra-Wide Band. It blocks WLAN Band of centre frequency 5.8 GHz because of U slot. Blocked frequencies 5.1 to 6.2 GHz with maximum rejection at 5.8 GHz.

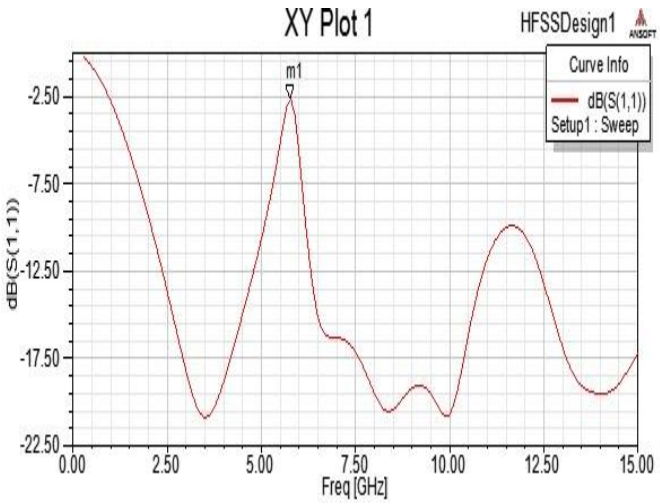

Fig.3.The simulated return loss S11 of the antenna

The voltage standing-wave ratio (VSWR) is shown in Fig. 4. It can be seen that when the bandwidth is in 6.5-15 GHz, the VSWR value is less than or equal to 2. Here we got VSWR very close to 1 in pass band. Greater than 2 in stop band. VSWR is large 6.51 at 5.8 GHz. indicating maximum rejection. So the bandwidth is larger than the FCC's requirement.

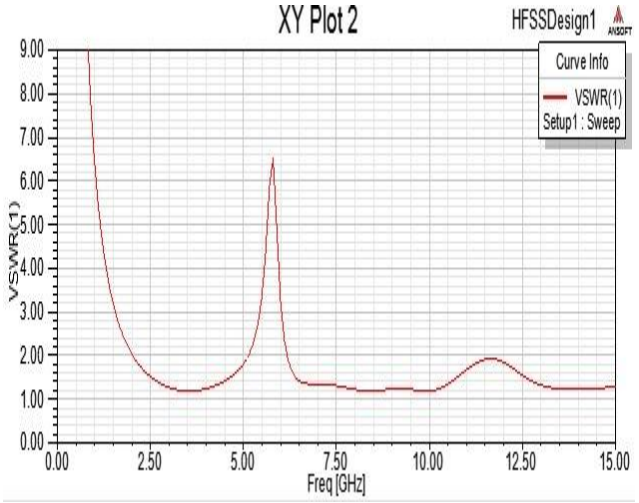

Fig.4. The simulated voltage standing-wave ratio (VSWR) of the antenna

The proposed UWB fractal antenna will radiates from 2.1 GHz to 15 GHz. Fig.5 and Fig.6. shows the 2D and 3D radiation pattern of antenna. We have added notch filter in the design. The radiation characteristics of the antenna in the whole bandwidth are suitable for UWB communication system requirements.

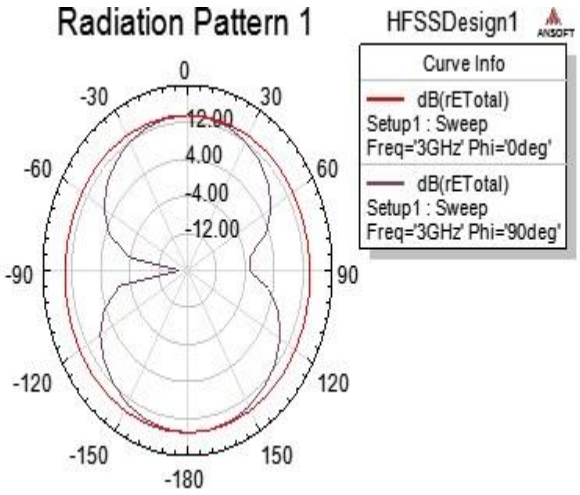

Fig.5. The simulated radiation pattern of antenna

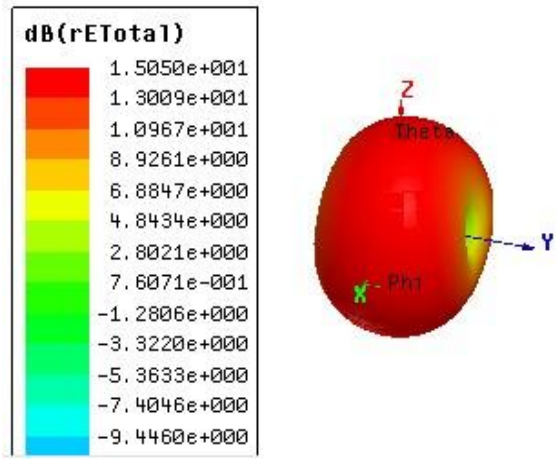

Fig.6. The simulated 3D radiation pattern of the antenna

Gain achieved for proposed antenna is almost constant for all frequencies. The Fig.7 shows the gain of the antenna. Maximum value of gain is 4.42 dBm.

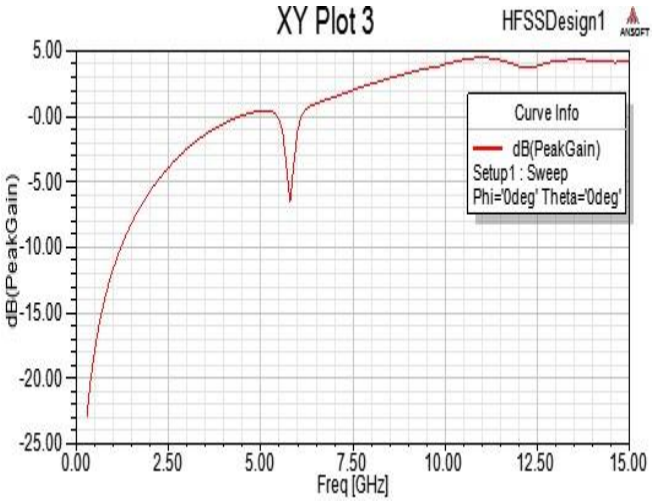

Fig.7. Gain of the proposed antenna

IV. CONCLUSION

The proposed antenna has nearly omni directional radiation pattern and operating band ranging from 2.1 GHz to 15 GHz. A rectangular slit in the ground plane and 'U' notch in feed has been introduced in order to improve the better return loss, bandwidth and to eliminate the operation of the antenna in higher frequency bands. This antenna can be a good candidate for UWB wireless communication applications which are going to proliferate in wide variety of ways in all wireless scenarios.

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