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A Novel Human Face Fractal Antenna with U-Notch Filter for UWB Application

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ABSTRACT: The design, optimization, simulation and fabrication of a Human Face Fractal Antenna for Ultra band operation. 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. A human face Fractal Antenna, employed with U-notch feed and modified ground plane, is design and will develop to achieve the desired characteristics.The areas of applications are medical imaging, wireless communication, vehicular radar, Defense systems, mobile, radio-determination, etc.

KEYWORDS : Fractal Antenna, U- Notch feed, UWB Application, HFSS Software.

I. INTRODUCTION

Ultra wideband (UWB) communication systems can be broadly classified as any communication system whose instantaneous bandwidth is many times greater than the minimum required to deliver particular information [1]. This excess bandwidth is the defining characteristic of UWB. Understanding how this characteristic affects system performance and design is critical to making informed engineering design decisions regarding UWB implementation [2].

Antenna is an important part of UWB communication systems, and it is a challenge to design then antenna suitablefor such a wide frequency band applications. Fractal antenna, due to the simple structure, desirable bandwidth &nearly Omni-directional radiation patterns, has been widely used in UWB antenna design. Many antenna designs have been widely used in the UWB system [3].

Recently, the ultra–wide band (UWB) communication 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 Human Face 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 bandnotched characteristics. The proposed antenna is simulated by HFSS 13 Software which is electromagnetic solver. In this paper, we have blocked WLAN frequency.

II. RELATED WORK

In [1] authors presents a design of compact elliptical-shaped CPW-fedplaner UWB fractal antenna. A novel planer UWB antenna using a fifth iterationelliptical fractal shape is presented in this paper. The frequency characteristics ofantenna consist of UWB properties in the range 2.0–16 GHz that corresponds tothe impedance bandwidth of 140 %. The antenna has nearly good Omni-directionalradiation pattern and peak gain of 4.9 dBi. The group delay profile of the

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proposedantenna lies within 1 ns. The areas of applications are medical imaging, wirelesscommunication, and vehicular radar.

In [2] author Multiband and wideband monopoles constitute aresearch topic strongly motivated by the growing frequencyspectrum needs in the area of wireless communicationapplications. In this paper, a multi-band, multiple rhombusshaped, monopole antenna is proposed as an alternative to thecircular/elliptical disk/ring monopoles for broadbandapplication. The simulation results are in good agreement withthe measurement, showing a multiband behavior with goodradiative properties. The scattering parameter S11 exhibits fourresonant frequencies close to f=1.68 GHz, 3.38 GHz, 6.58 and13.85 GHz. The measured gain at these resonant frequency arerespectively G= 3.1 dB, 4 dB, 6.3 dB, 6.9 dB.

In [3] author presents a compact third iteration inner tapered tree-shaped fractal antenna for ultra wideband applications is presented. The bandwidth is enhanced by using CPW ground plane and increasing the number of iterations. An impedance bandwidth of 4.3– 15.5 GHz (113%) is achieved. The proposed third iteration antenna has nearly Omni-directional patterns at its resonance frequencies with an acceptable value of gain. The experimental and simulation results are found to be in good agreement. The proposed antenna has improved return loss performance and miniaturized size.

III. PROPOSED DESIGN OF THE ANTENNA

The geometry of proposed antenna is shown in Fig.1 and Fig.2. Basically we have used sierpinski carpet concept. It is fed by 50 ohm micro-strip line. Radiating patch is designed on 1.6mm thick FR4 substrate with the relative permittivity andloss tangent of substrate is 4.4 and 0.02, respectively.In antenna design, we analyze and simulate this antenna by using Ansoft HFSS13 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 4mmwhose 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 0.9mm representing the eyes and the arc of thickness 0.25mm are removed from the circle and the length of the arc is 1.7 mm. We have decreased each circles diameter at every iteration to create Human Face shown in Fig.3. The dimensions of all circles on patch and how we have taken all iterations of circles shown in Fig. 3.

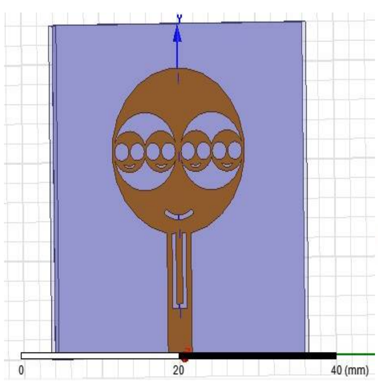

Fig.1. Front view of proposed antenna

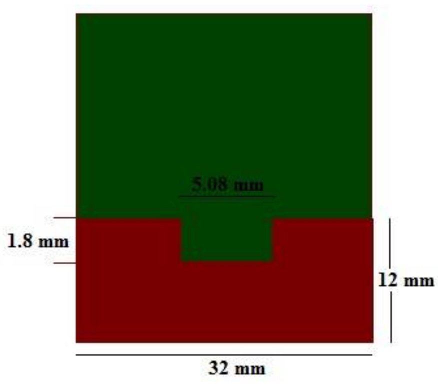

Fig.2. Back view of the Antenna.

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The shape of the ground plane as rectangle with dimension 32 mm × 12 mm. It exhibits 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. Design Fig. 4 and Fig. 5 shows the configuration of the proposed antenna. The proposed antenna is designed using low cost glass epoxy (FR4) substrate material having thickness (h) of 1.6 mm, permittivity Dr= 4.4.

IV. THE SIMULATION AND ANALYSIS OF THE ANTENNA

In this paper, we have use Ansoft HFSS 13 to simulate the UWB monopole antenna. The simulation study determines the various important parameters of antenna. The simulation results are obtained in structural simulator. Fig.6 shows the gain of the antenna.The measured peak gains versus the frequency of the antenna, as can be found, significant gain reduction has been received at designed stop band at 5.8 GHz, and stable gain variation across the pass band also can be achieved. Maximum gain is obtained at 4.42 GHz. The Fig.6 shows simulated gain of antenna. The proposed compact antenna with good band-rejected property and stable gain variation is well suited for UWB applications.

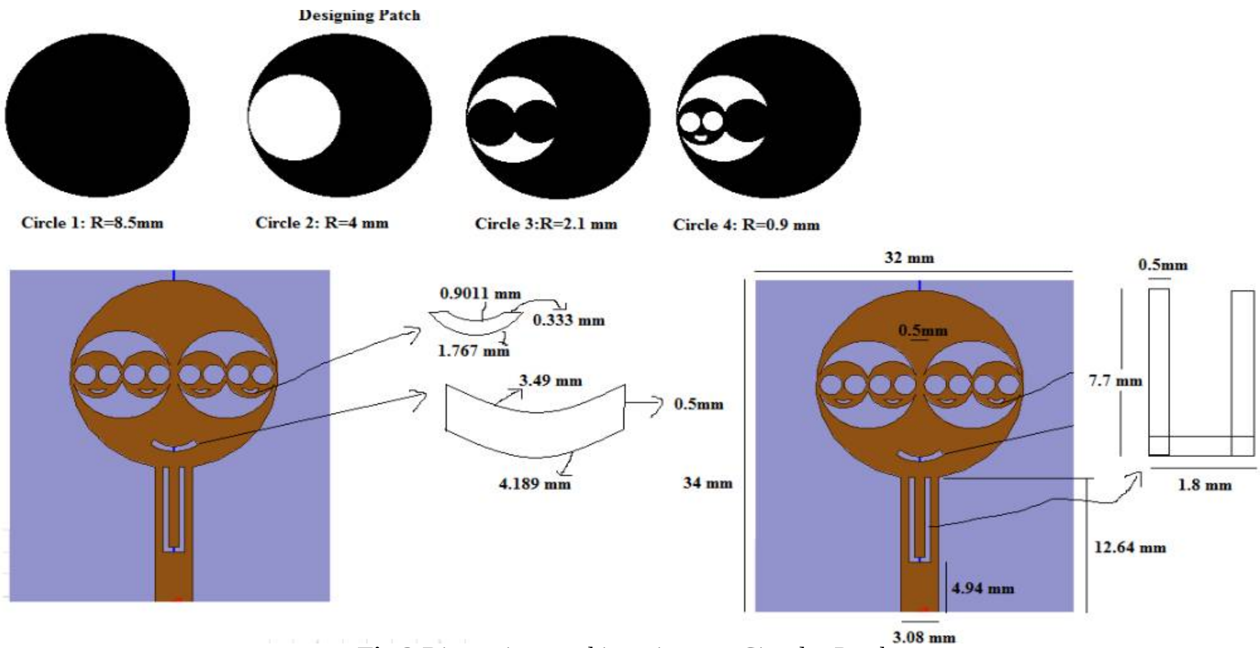

Fig.3 Dimensions and iterations on Circular Patch.

Fig.4 Radiating patch of proposed antenna

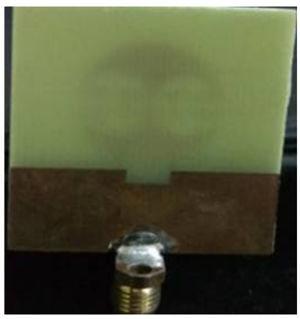

Fig.5 Ground plane of proposed antenna.

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The Fig. 7(a) and Fig. 7(b) shows the 2D & 3D radiation pattern of antenna in xz plane respectively, it exhibits a far field radiation. Antenna radiates from 2.1 to 15 GHz. Radiation of antenna is improved and it is up to the mark. To avoid interference between the UWB systems and the wireless local area network system (WLAN) with 5.15- 6.2 GHz frequency band, a band notch filter in the UWB system is necessary.

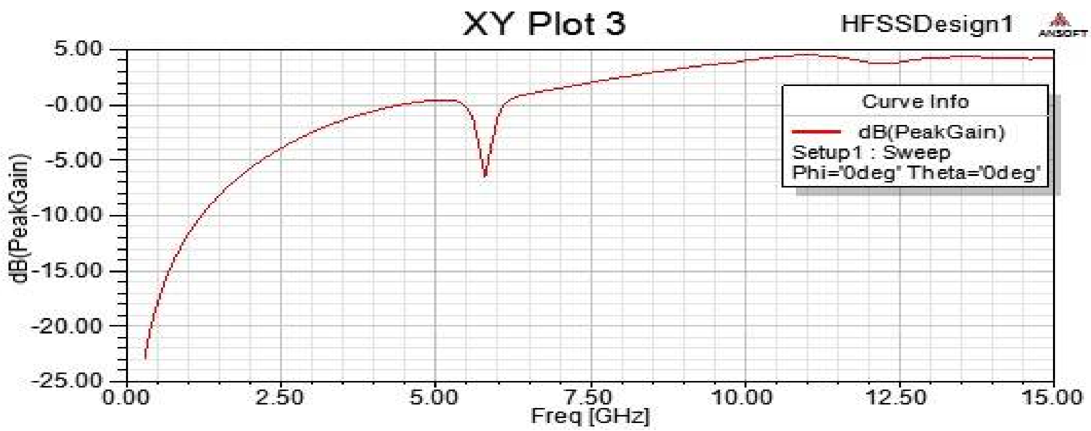
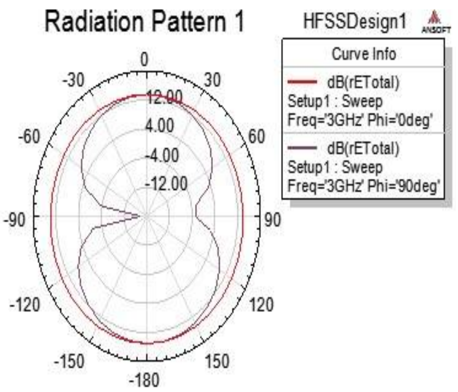


Fig.6. Gain of the proposed antenna.

Thus we have added notch filter at 5.8 GHz. Hence, antenna will not radiate from 5.1 GHz to 5.6 GHz with center frequency of 5.8 GHz which is WLAN frequency. The radiation characteristics of the antenna in the whole bandwidth are suitable for UWB communication system requirements.



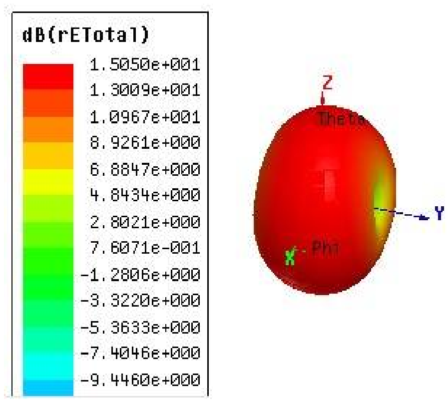


Fig.7(a) 2D Radiation pattern of antenna (b) 3D Radiation pattern of antenna

The voltage standing-wave ratio (VSWR) is shown in Fig.8. It can be seen that when the bandwidth is in 5.5- 15GHz, the VSWR value is less than or equal to 2. The bandwidth of proposed antenna is larger than the FCC's requirement. VSWR is 6.51 at 5.8 GHz indicates strong rejection.

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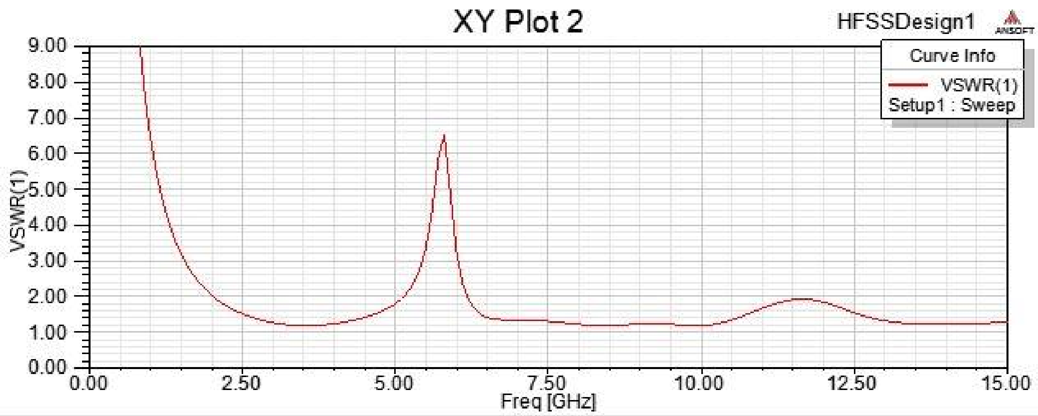

Fig.8. The simulated voltage standing-wave ratio (VSWR) of the antenna

Return loss of antenna is represented by S-parameter (S11) that determines the how much power is reflected from the antenna. The return loss S11 of the simulation result is shown in Fig 9. Proposed antenna transmits from 2.1 GHz to 15 GHz. Its Ultra Wideband. It blocks WLAN Band of centre frequency 5.8 GHz because of U slot. Fig.9. shows antenna blocked frequencies 5.1 to 6.2 GHz with maximum rejection at 5.8 GHz.

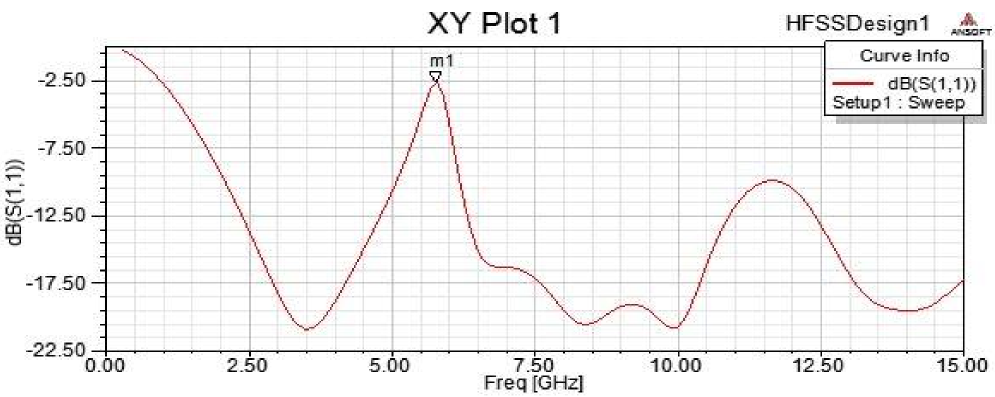

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Fig.9.The simulated return loss S11 of the antenna.

V. EXPERIMENTAL RESULTS

After the final fabrication of antenna, measurement took place with help of Network analyzer. It is an instrument that is used to measure the network parameters of the various electrical circuits. For antenna, we can make an analysis of S-parameter (Return loss) and VSWR. Fig.10 & Fig.11 shows the Voltage standing wave ratio (VSWR) and Return loss of antenna. The simulated and measured results are in good agreement for antenna parameters. The little mismatch between simulated and measured results may be due to the measurement process and fabrication tolerance.

VI. CONCLUSION

The Human Face Fractal 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 orderto improve the better return loss, bandwidth and to eliminate the operation of the antenna in higher frequency bands. The presented

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antenna is very simple, low profile, small in size, easy to fabricate, low cost and can be integrated with MMIC/MICs. This antenna can be used in UWB wireless communication systems, Wireless Personal Area network(WPAN), Home network application and Wireless Body Area Network(WBAN).

Future Scope: Future scope of the proposed work is, it can be used in many wireless applications by changing the parameters of antenna, which will increase antenna frequency. The antenna with good band rejection and undesired interference to enhance the radiation performance.

Fig.10. VSWR Measured on Network Analyzer

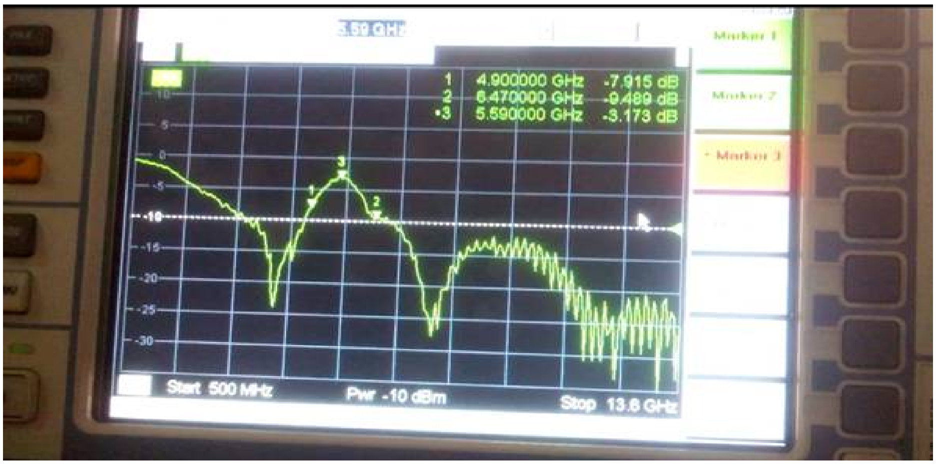

Fig.11. Return loss Measured on Network Analyzer

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