A Miniaturized Octagonal Shaped Antenna for Spectrum Sensing Applications

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***Abstract*— A miniaturized octagonal shaped antenna for Spectrum sensing application is presented. The proposed antenna is an octagonal shaped monopole with rectangular ground plane, fed by a semi ring arm followed by tapered CPW transmission line. The antenna with modified feeding technique covers an extremely large impedance bandwidth from 2.8 GHz to 29.2 GHz with percentage of bandwidth of 190.35% which satisfying the UWB criteria as defined by FCC. In addition stable omnidirectional radiation patterns are also obtained at desired frequencies which makes it suitable for spectrum sensing application in Cognitive radio system. The antenna has an overall dimension of 15.96 mm x 16mm treating it as a compact antenna.**

Keywords*— *Ultra wideband, coplanar waveguide, Federal communications commission

I. INTRODUCTION

THE increasing demand of wireless communication supporting flexibility in cognitive radio(CR) system which in turn enforced greater requirement of antenna design. UWB sensing antenna is one of the important unit in basic CR architecture that continuously monitor the unused spectrum. This paper basically focusing on spectrum sensing antenna design. The important features of sensing antenna design includes their ability to operate at extreme wide bandwidth over UWB range, compatibility and radiation pattern stability at all operating frequencies. As per the regulation released by FCC in 2002[1] UWB technology utilizes the frequency spectrum that ranges from 3.1 GHz -10.6 GHz. Aiming to such facts many miniaturized UWB antenna have been proposed in the frequency range of 3.1GHz to 10.6GHz to the date[2-5]. But miniaturization of antenna with enhancement in bandwidth is a challenging task at the same time. in this paper we proposed a very compact antenna with extremely wide impedance bandwidth. Here the impedance bandwidth is achieved by tapered semi-ring feeding arrangement. Basically the design started with an octagonal monopole with simple rectangular feed which covers impedance bandwidth of 3.5 GHz to 13.6GHz . Then the bandwidth is improved by a modified feeding structure which consists of a tapered CPW transmission line followed by a semicircular arm as inspired from[5]. With such compact dimension and modified feeding technique the posed antenna covers bandwidth ranges from 2.7GHz to 28.2 GHz with stable radiation pattern which ensure it a potential candidate for spectrum sensing application. The overall work has simulated using ANSYS High frequency Structure Simulator(HFSS) version 14[6].

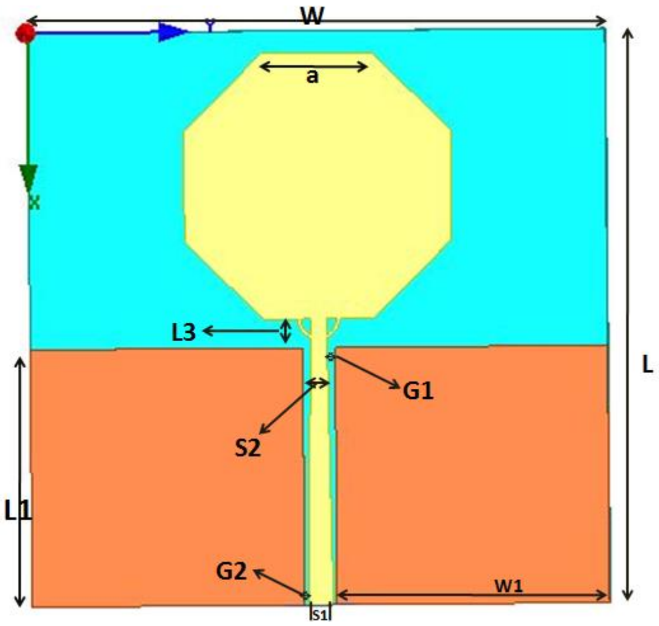

Fig.1.Geometry of the proposed antenna

TABLE. 1.Dimension of proposed antenna.(parameters are in mm)

W	L	W_1	L_1	S_1	S_2	L_3	G_1	G_2
16	15.96	7.5	7.4	0.6	0.4	0.46	0.27	1.15

3. RESULT AND DISCUSSION

The proposed design is simulated using commercially available High Frequency Structure Simulator(HFSS)[6]. In order to analyze the feeding arrangement on antenna performance two corresponding antenna were investigated . One has a tapered CPW transmission line(without semi-ring) and other antenna has simple rectangular uniform feed. The comparison among the three antenna is demonstrated in Fig.2. From the simulated result it is observed that the impedance bandwidth of tapered feed followed by semi-ring arrangement significantly wider than other two antenna. The result also indicates that the feeding arrangement mainly affects the upper limit of impedance bandwidth than that of lower limit. However the overall simulated reflection coefficient(S_{11}) of different feeding arrangement is depicted on Table 2.

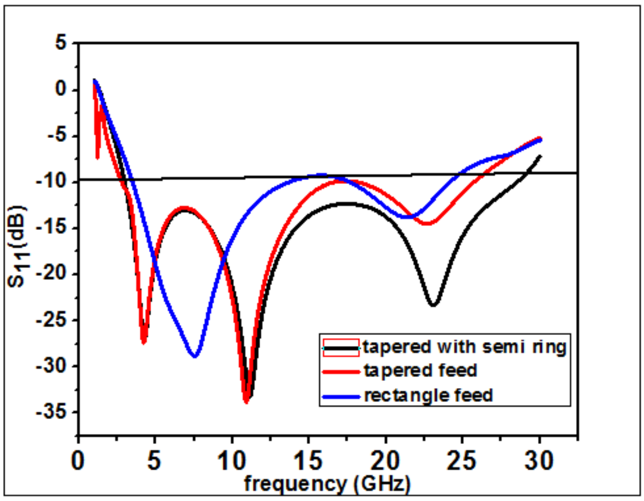

Fig-2. Return loss of proposed antenna

TABLE.2. overall result analysis

Feed Arrangement	Bandwidth Covered(GHz)
Simple rectangular	3.5 - 13.6
Tapered	2.7 - 25.6
Tapered with semi-ring	2.7 - 28.2

The simulated radiation patterns of the proposed antenna at three resonating frequencies like 4.2 GHz, 11.1 GHz and 23.1 GHz is depicted in *Fig.3.*

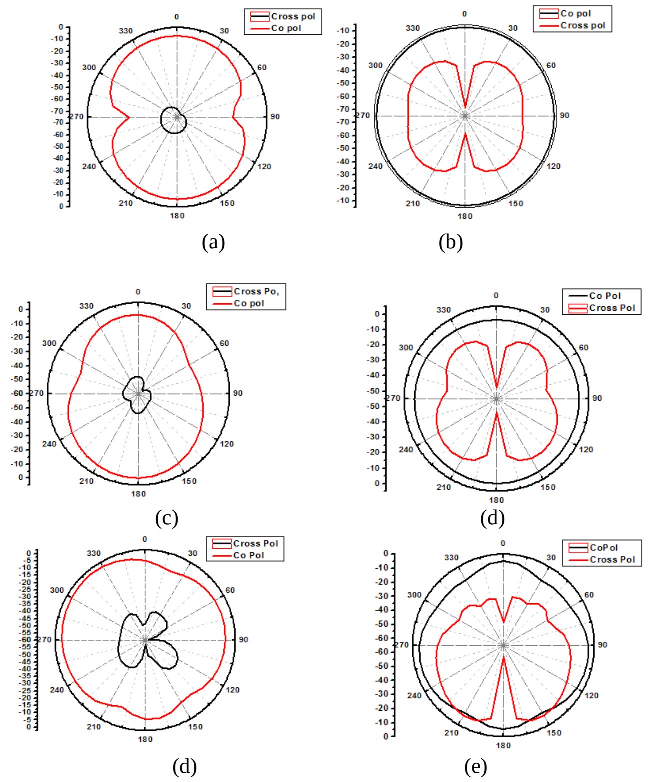

Fig.3. Simulated radiation patterns of proposed antenna

(a) E plane at 4.2GHz (b) H plane at 4.2 GHZ
(c) E plane at 11.1GHz (d) H plane at 11.1GHz
(e) E plane at 23.1 GHz (f) H plane at 23.1GHZ

From the simulated radiation pattern it is observed that the pattern shows omnidirectional radiation pattern at H plane even at high frequency. The surface current distribution at 13.8 GHz and 25.8 GHz is depicted in *Fig.4.* There is uniform current distribution in the ground plane which indicates good impedance matching. Maximum amount of current couples in the edges of radiator than the top surface.

TABLE.3. Comparative study with previous work.

Reference	Substrate	Bandwidth range(GHz)	Dimension(mm)
Reference[5]	Teflon (ϵ_r =3.2 & tanδ=0.0002)	0.67-12	68x33
Our work	FR_4 (ϵ_r =4.4 & tanδ=0.02)	2.7-28.2	15.96 x16

A comparative analysis was conducted in Table.3 which clearly indicates that there is improvement in impedance bandwidth by using tapered feed followed by a semicircular ring with a very compact dimension. The 3dB gain of proposed antenna at 4.2 GHz,13.8GHz and 25.8 GHz is depicted in Fig.5. The gain at 4.2 GHz is 7dB, at 13.8 GHz is about 9dB and at 25.GHz about to be 4dB.

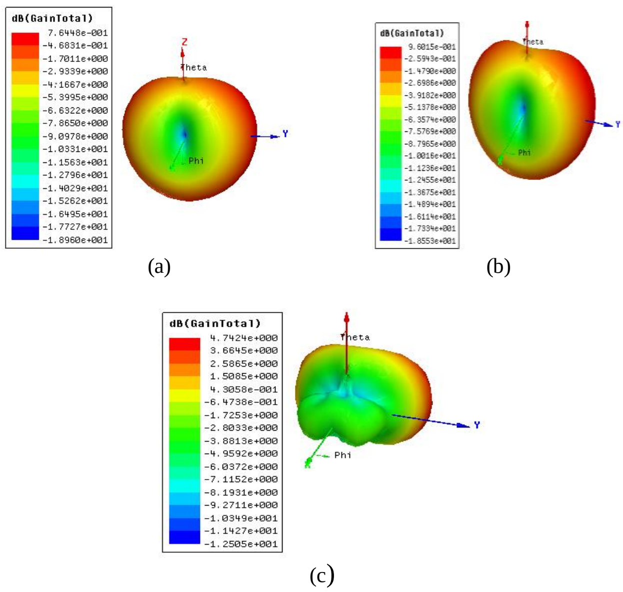

Fig.5. Simulated gain of proposed antenna (a) 4.2GHz, (b)13.8GHZ and (c) 25.8GHz.

4. CONCLUSION

In this paper a miniaturized octagonal shaped antenna with extremely wide impedance bandwidth for UWB sensing application is presented and analyzed in detail. The proposed design presents very compact dimension than earlier published reference[5] and also yields very good enhancement in bandwidth in the UWB range by the utilization of a new feeding technique. In addition the radiation pattern remains stable in both E plane and H plane. Therefore such miniaturized antenna is a potential candidate for spectrum sensing application in CR system.

5. REFERENCES

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