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Design of CPW-Fed Strips Patch Antenna for Wireless Communication Applications

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ABSTRACT
This paper presents a microstrip antenna using Coplanar Waveguide Feed (CPW) for WLAN/WIMAX applications. The proposed antenna consists of strips shaped patch and occupies a total area of 20.825× 27 mm^2. The parametric study is performed to understand the characteristics of the proposed antenna. The antenna exhibits two frequency bands and impedance bandwidth of lower frequency band is 0.29 GHz from 3.42 GHz to 3.71 GHz and of higher frequency band is 1.81 GHz from 4.89 GHz to 6.70 GHz covering wireless local area network (WLAN) and worldwide interoperability for microwave access (WiMAX) bands. The various antenna parameters like S-parameters, current distribution and radiation pattern are studied.

KEYWORDS
Microstrip Antenna, WLAN, Wi-MAX, CPW feed.

1. INTRODUCTION
Antenna is the most important key element in wireless communication. In modern wireless communication systems, the multiband antenna has become one of the most important circuit elements and attracted much interest. To satisfy the IEEE 802.11 WLAN standards in the 2.4/5.2/5.8 GHz operating bands or the worldwide interoperability for microwave access (WiMAX) 2.5/3.5/5.5 GHz bands, multiple bands antenna with low cost, compact size, easy fabrication, and higher performance are required [1-2]. Microstrip Antenna fulfills these requirements. These antennas are low profile, comfortable to planar & non planar surfaces, simple, inexpensive & compatible with every patch shape. With increasing requirements for personal and mobile communications, the demand for smaller and low profile antennas has brought the MSA to the forefront [3]. Micro-strip patch antenna is widely considered to be suitable for many wireless applications, even though it usually has a narrow bandwidth. The bandwidth limitation can be addressed by using thick substrates, cutting slots in the metallic patch. The fast growing WLAN protocols operating bands are at 2.4 GHz (2400–2484 MHz), 5.2 GHz (5150–5350 MHz) and 5.8 GHz (5725–5825 MHz), the operating bands of WiMAX is 2.5/3.5/5.5GHz (2500–2690/3400–3600/ 5250–5850 MHz) bands. Multi-band antennas with simple structure and superior radiation performance for WLAN/WiMAX applications have been increasingly appealing [4-10]. These antennas usually cover the WLAN 2.4/5.2/5.8 GHz and WiMAX 2.5/5.5/5.8 GHz bands. The size of the antenna has a great influence on the frequency bands. There is generally a trade-off between the size and performance of antenna because the characteristics of the antenna are closely concerned with its size.
The proposed antenna design satisfies WLAN/WiMAX standards. The details of the proposed antenna geometry are presented and discussed in section 2. Simulated results and discussions are provided in section 3, and conclusions are presented in section 4.

2. ANTENNA GEOMETRY
The geometry of the proposed monopole antenna is shown in Fig. 1. The total size of the proposed antenna is 20.825 mm x 27 mm. As shown in the figure, the antenna consists of strips shaped patch. The antenna is constructed with the above described patch and fed by Coplanar Waveguide Feed (CPW) feeding. The ground size of the proposed antenna is 7.025 mm x 8 mm. The ground plane is symmetrical at the base line of the feeding strip line. To obtain the optimal parameters of the proposed antenna for WLAN/WiMAX application, IE3D, 14.10 version of Zeland that can simulate a finite substrate and a finite ground structure, is used. Thus, the proposed antenna design can provide a wide bandwidth while retaining stable performance via the optimized geometrical parameters. The parameters of proposed antenna are shown in Table 1. The distance between patch and ground is 1 mm and between feed and ground is 1 mm. The rectangular strip feed line has dimensions of 8.025 mm × 4 mm.

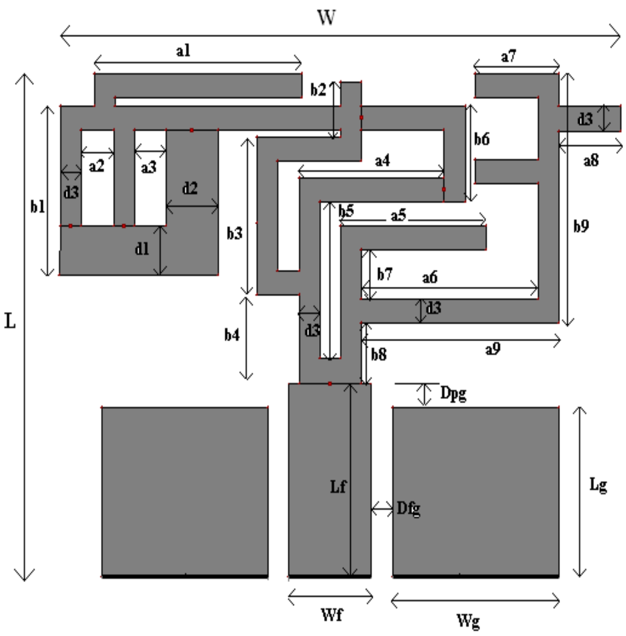

Fig 1: Geometry of proposed Antenna

Table 1: Parameters of the proposed antenna

Param-eter	Size (in mm)	Param-eter	Size (in mm)	Param-eter	Size (in mm)
L	20.825	d_2	2.5	a_9	9.5

W	27	d_3	1	b_1	7
L_g	7.025	a_1	10	b_2	2.275
W_g	8	a_2	1.6	b_3, b_5	6.5
L_f	8.025	a_3	1.525	b_4	3.675
W_f	4	a_4, a_5	7	b_6	4
D_{pg}	1	a_6	8.5	b_7	2
D_{fg}	1	a_7	4	b_8	2.5
d_1	2	a_8	3	b_9	10.3

3. SIMULATED RESULTS AND DISCUSSIONS

The simulated return losses and other parameter results are obtained. The return losses of the proposed antenna are shown in Fig. 2. The result shows that the antenna exhibits two frequency bands and impedance bandwidth of lower frequency band is 0.29 GHz ranging from 3.42 GHz to 3.71 GHz and of higher frequency band is 1.81 GHz ranging from 4.89 GHz to 6.70 GHz. This implies that it covers WLAN band from 5.15-5.35/ 5.75-5.85 GHz, Wi-MAX band from 3.4-3.7/5.15-5.35/5.47-5.725/5.725-5.825 GHz.

Fig. 3 shows the parametric study of the proposed antenna. It shows the comparison graph of return losses when distance between patch and ground, distance between feed and ground is varied. By doing variations in D_{pg} , the return losses are increased. Similarly on changing the value of D_{fg} , the return losses and bandwidth are increased. In this way optimum results are obtained.

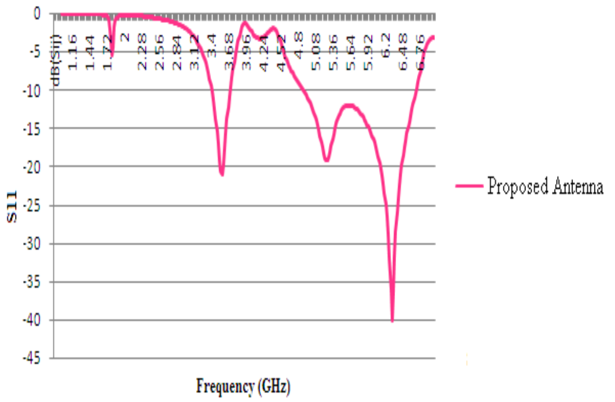

Fig. 2: Return loss of proposed antenna

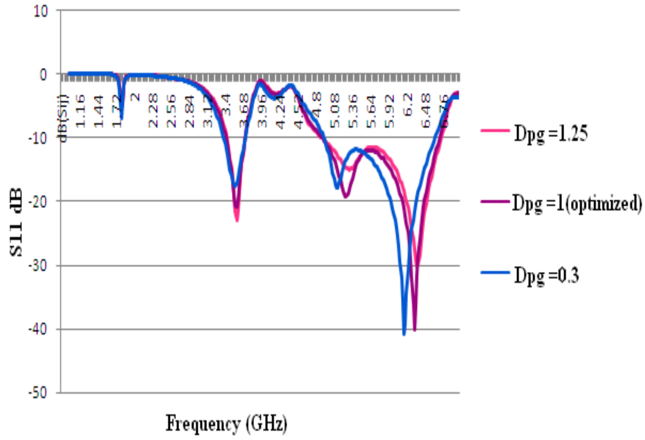

Fig 3(a): Effect of variation of D_{pg} on Antenna Performance

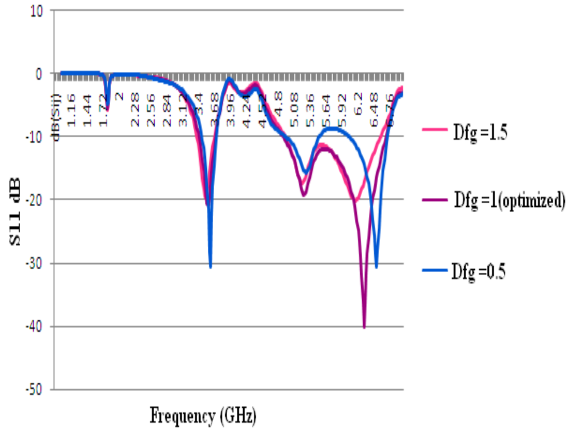

Fig 3(b): Effect of variation of D_{fg} on Antenna Performance

The proposed antenna has three resonant frequencies: 3.56, 5.26, 6.32 GHz. In figure 4 and 5 simulated 2D radiation patterns for elevation and azimuthal plane near at resonant frequencies 3.56 GHz and 6.32 GHz respectively are shown. Radiation pattern presents the graphical representation of radiation properties of antenna as a function of space co-ordinates. Figure 6 shows three dimensional radiation pattern of proposed antenna at 3.56 GHz and 6.32 GHz.

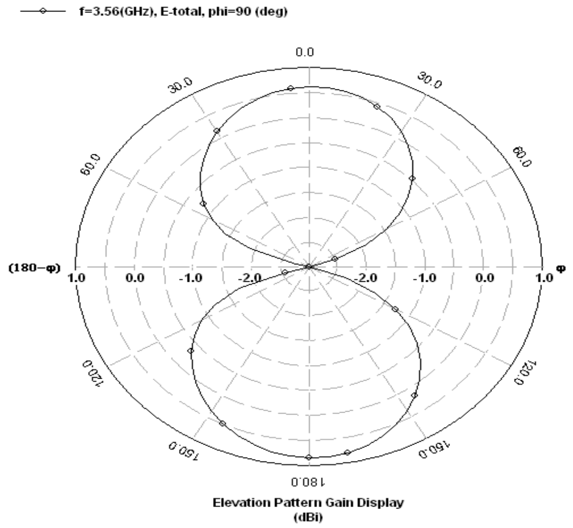

Fig. 4(a): Elevation pattern at 3.56 GHz

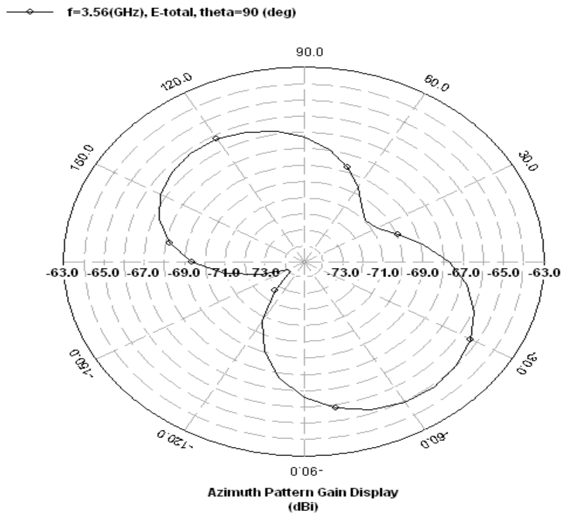

Fig. 4(b): Azimuthal pattern at 3.56 GHz

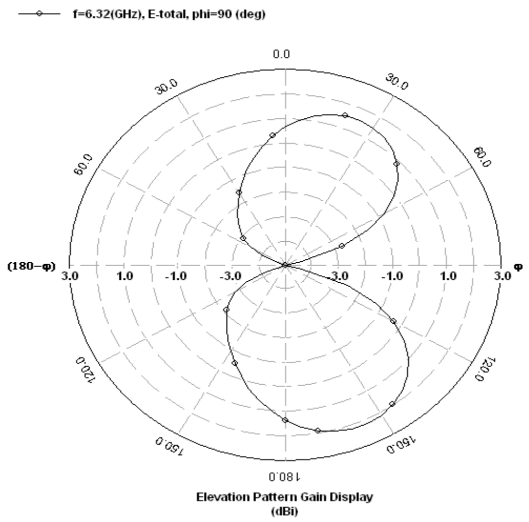

Fig. 5(a): Elevation pattern at 6.32 GHz

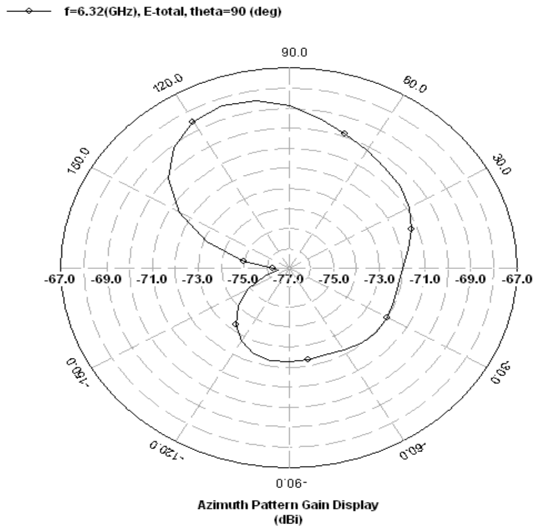

Fig. 5(b): Azimuthal pattern at 6.32 GHz

The formation of the lower and upper frequency resonances can be explained by observing the surface currents on the conductors of the antenna at 3.56 GHz, 5.26 GHz and 6.32 GHz as shown in Fig.7. Current distribution is changed by changing the length and dimensions of patch. The maximum E-current at 3.56 GHz is 28.235 A/m, at 5.26 GHz is 17.981 A/m and the maximum E-current at 6.32 GHz is 20.998 A/m.

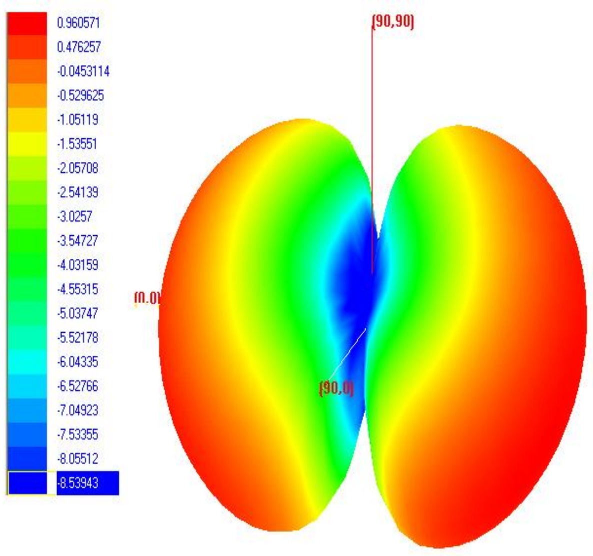

Fig.6 (a): 3-Dimensional Pattern of Proposed Antenna at 3.56 GHz

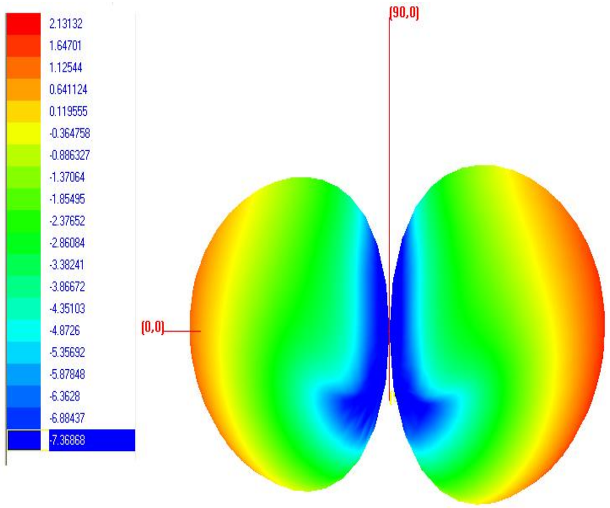

Fig.6 (b): 3-Dimensional Pattern of Proposed Antenna at 6.32 GHz

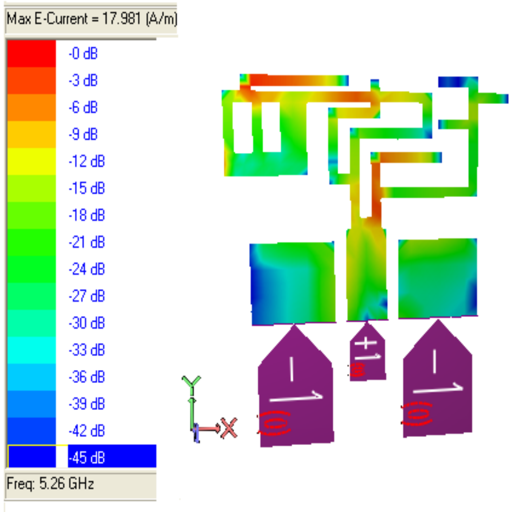

Fig 7(a): Current distribution of proposed Antenna at 5.26 GHz

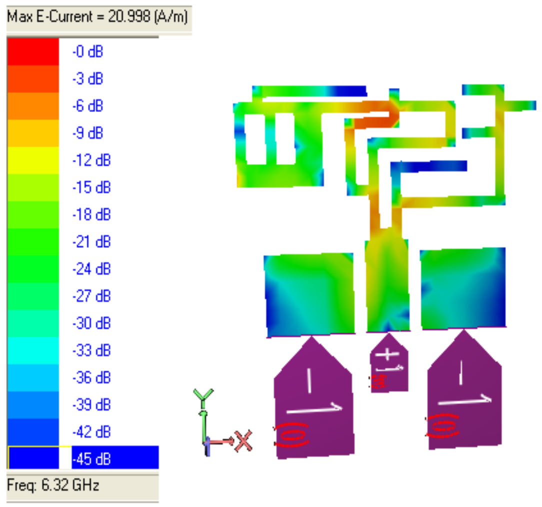

Fig 7(b): Current distribution of proposed Antenna at 6.32 GHz

The graph for VSWR (Voltage Standing Wave Ratio) is shown in Fig.8.

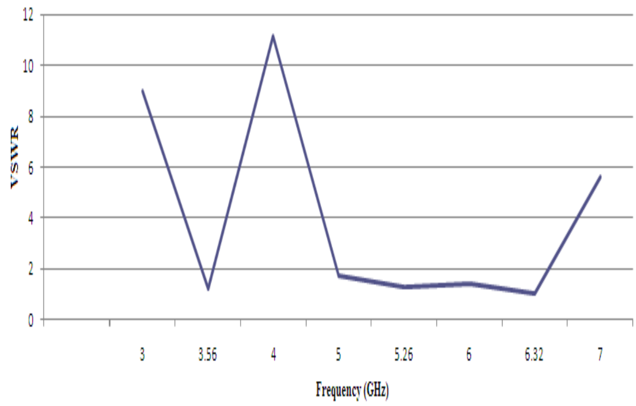

Fig 8: VSWR versus Frequency

4. CONCLUSION

It is observed that a CPW-fed, strips shaped patch antenna is presented. The proposed antenna has compact size of 20.825×27×1.6 mm^3 and achieves lower and higher frequency band of impedance bandwidth 0.29 GHz and 1.81 GHz respectively, covering wireless local area network (WLAN) and worldwide interoperability for microwave access (WiMAX) bands. The various antenna parameters like S-parameters, current distribution and radiation pattern are studied. It can be concluded from the results that the designed antenna has satisfactory performance and hence can be used for wireless applications.

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