Design and Analysis of Dual Band Microstrip Patch Antenna with Microstrip feed line and slot for Multiband Application in Wireless Communication

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***Abstract*— A Microstrip patch antenna for WLAN, Wi-Max and GSM application is proposed. The antenna has a frequency bandwidth of 400 MHz (2.3768 GHz – 2.8225GHz) for WLAN and 700 MHz (4.7913 GHz –5.503 GHz) for Wimax application. The antenna design is an improvement from a previous research, simulated using CST Microwave Studio 2010 software. The performance of the designed antenna is analyzed in term of bandwidth, gain, return loss, VSWR, and radiation pattern.**

Keywords-Microstrip Antenna, Multiband, CST Microwave Studio 2010

I. INTRODUCTION

The microstrip patch antennas have many advantages such as small size, low-cost fabrication, low profile, light weight, conformability, ease of installation and integration with feed networks but it has one serious limitations i.e. these antennas have very narrow bandwidth characteristics as it limits the frequency ranges over which the antenna can perform satisfactorily [2]. These features of patch antennas are major designing considerations of practical patch antenna. In wireless communication systems, the IEEE 802.11 standard was proposed in 1997 for WLANs application. The bands for WLAN application are 2.4 GHz (2.400 GHz to 2.484 GHz), 5.2 GHz (5.150 GHz to 5.350 GHz) and 5.8 GHz (5.725 GHz to 5.825 GHz). The name WiMAX was created by the WiMAX forum which was formed in June 2001 to promote conformity and interoperability of the standard. The WiMAX Forum has published three licensed spectrum profiles: 2.5 GHz (2.5-2.69 GHZ), 3.5 GHz (3.4-3.69 GHZ) and 5.5 GHz (5.25-5.85 GHZ). Worldwide Interoperability for Microwave Access (Wi-MAX) technology[3] is the most rapidly growing area in the modern wireless communication[1].

II.GEOMETRY OF MICROSTRIP PATCH ANTENNA

In this antenna, the substrate has a thickness h=0.05 mm and a relative permittivity εr = 4.4. The length and width of patch are L=28 mm and W=28 mm respectively. The length and width of substrate are L=70 mm and W=70 mm respectively, The initial parameter of this design can be calculated using transmission line model (TEM) approximation in which microstrip radiating element is viewed as transmission line resonator with no transverse field variation [4]. The approximation states that length and width of patch can be modeled according to the specified target central frequency.

A. Calculation of Width:

The width of microstrip antenna is given by

$$W = \frac{C}{2\, fo \sqrt{\left(\frac{\in r + 1}{2}\right)}}$$

B. Calculation of Effective dielectric constant:

$$\in reff = \frac{\in r+1}{2} + \frac{\in r-1}{2}\left[1+12\frac{h}{w}\right]^{1/2}$$

C. Calculation of Length Extension (ΔL)

$$\Delta L = 0.412 \frac{\left(\in reff \pm 0.3\right)\left(\frac{w}{h}+0.264\right)}{\left(\in reff - 0.258\right)\left(\frac{w}{h}+0.8\right)}$$

D. Calculation of actual Length of Patch (L)

The actual length of radiating patch is obtained by

$$L_{eff} = L - 2\Delta L$$

E. Calculation of Effective Length (Leff)

The effective length is

$$L_{eff} = \frac{c}{2 f_o \sqrt{\epsilon_{eff}}}$$

F. Calculation of Ground Dimensions (Lg, Wg)

$$L_g = 6h + L$$

$$W_g = 6h + W$$

III. DESIGN PARAMETERS

Figure 1(a) shows the front view geometry and the structure designed on CST Microwave Studio software of proposed microstrip line feed patch antenna with dual band operation for WLAN/WiMax. The dimensions and feed point location for proposed antenna have been optimized to get the best possible impedance match to the antenna.[5]

The following parameters are used for design of proposed antenna.

Substrate permittivity = 4.4
Thickness of substrate = 0.05 mm
Length of patch (L) = 28 mm
Width of patch (W) = 28 mm
Length of Substrate (Ls) = 70 mm
Width of Substrate (Ws) = 70 mm
Length Feed =10
Inset Feed =11
Length of Slot =2
Width Feed =4
Length of Second slot=14

In this paper several parameters have been investigated using CST Microwave Studio software.

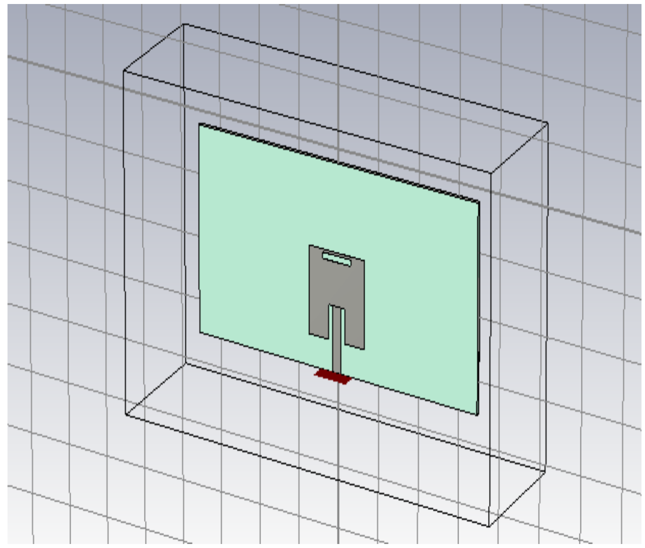

Figure 1 (a): Front view geometry of proposed antenna

IV. SIMULATED RESULTS

The parameters for the designed antenna were calculated and the simulated return loss results are shown in Figure 2. The bandwidth of 400 MHz (2.3768 GHz – 2.8225GHz) for IMT and WLAN has been achieved as shown in Figure 3(a) and the bandwidth of 700MHz (4.7913 GHz –5.503 GHz)for WLAN / WiMax has been achieved as shown in Figure 3(b) resonating at 5.2 GHz .The antenna covers the WLAN standard (5.2 GHz and 5.8 GHz band) / WiMax standard .

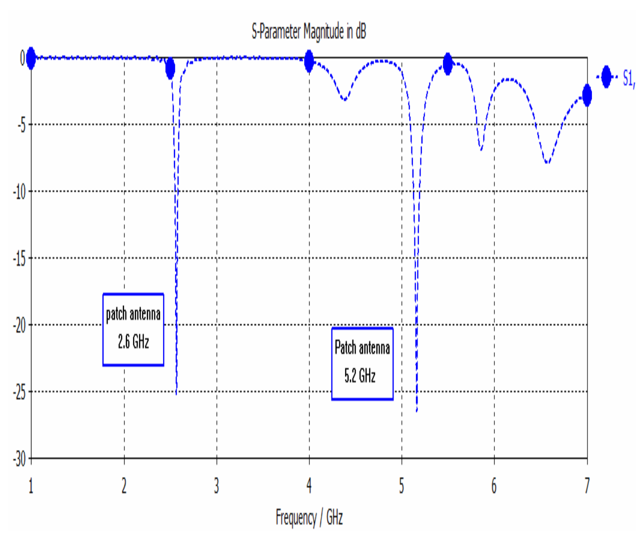

Figure 2: Simulated Return Loss Curve

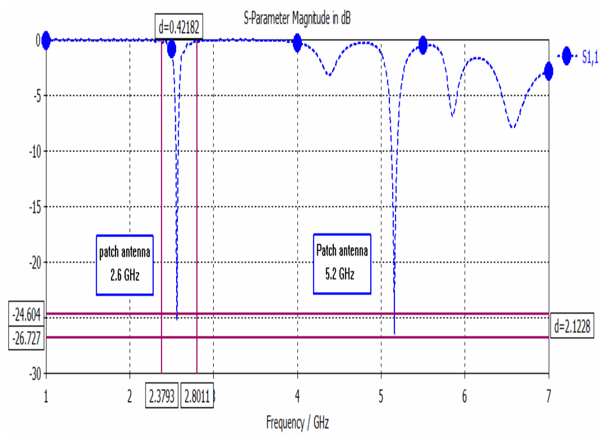

Figure 3(a): Bandwidth plot for IMT and WLAN

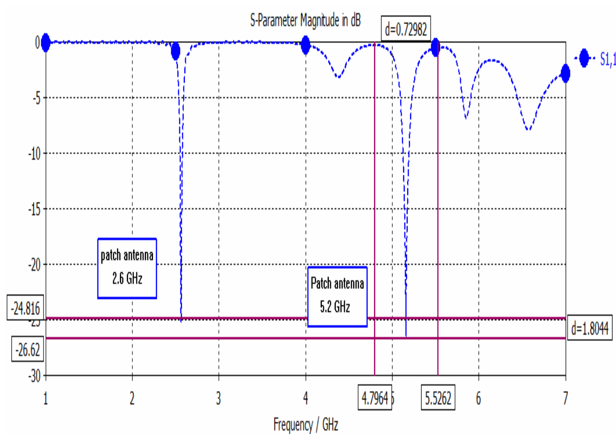

Figure 3(b): Bandwidth plot for Wimax

The achieved value of return loss is good enough and frequency is closed enough to the specified frequency band 2.6 GHz for IMT, WLAN application / 5.2 GHz and 5.85GHz for WLAN application and Wimax Application. The return loss value for 2.6 GHz is -24.816 dB, and for 5.5 GHz is -26.62 dB suggests that there is good matching at the frequency points below the -10 dB region. The maximum achievable gain over the entire frequency band of and for 2.6GHz is 1.732dB 5.2 GHz is 4.262 dB.

V. INPUT IMPEDANCE LOCUS:

The achieved antenna impedance is 50 ohm as shown in Figure 5(a), which is exact to the required impedance of 50 ohm. The VSWR ratio at 2.6GHz frequency is 1:27.459 is shown in Figure 5(a), the VSWR ratio at 5.2 GHz frequency is 1:5.520 is shown in Figure 5(b), it should lie in between 1 and 2. The optimum feed positions have been determined for good impedance matching shown in the figure 4, because the input impedance is controlled by the position of the feed to patch connection point. The used microstrip feed line is designed of microstrip patch antenna made of impedance 50 ohm.

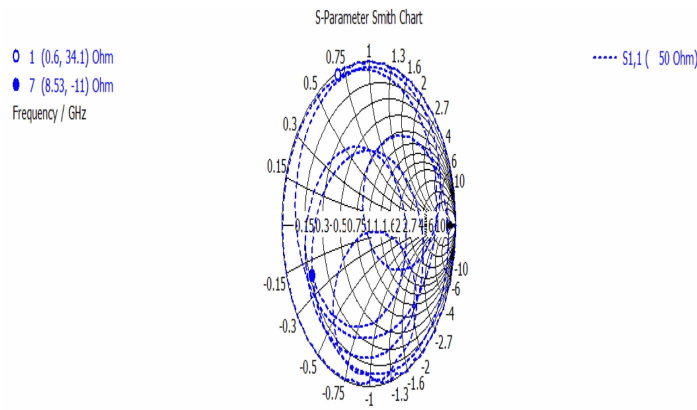

Figure 4: Curve showing antenna characteristic impedance

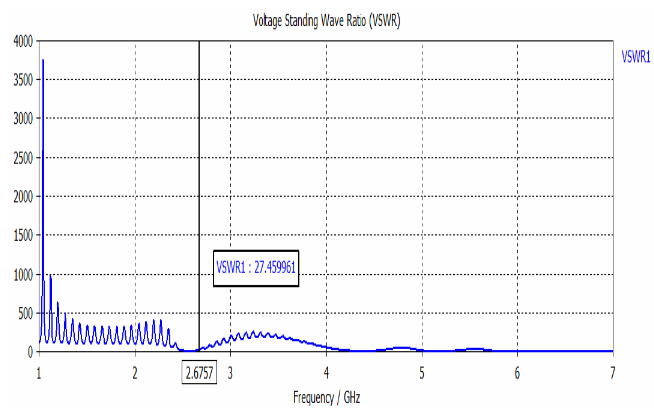

Figure 5(a): VSWR curve at 2.6 GHz frequency

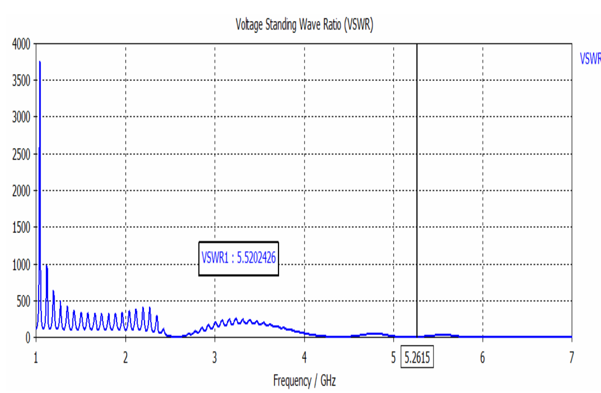

Figure 5(b): VSWR curve at 5.5GHz frequency

VI.RESULT AND DISSCUSSION

The dual band characteristics of the proposed antenna are achieved.

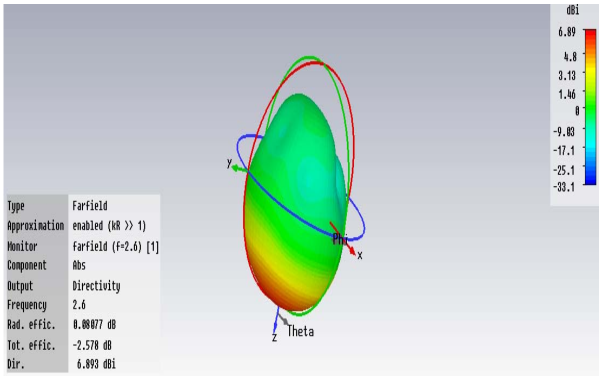

Figure 6(a): 3-D Radiation Pattern of Patch antenna showing directivity at 2.6 GHz

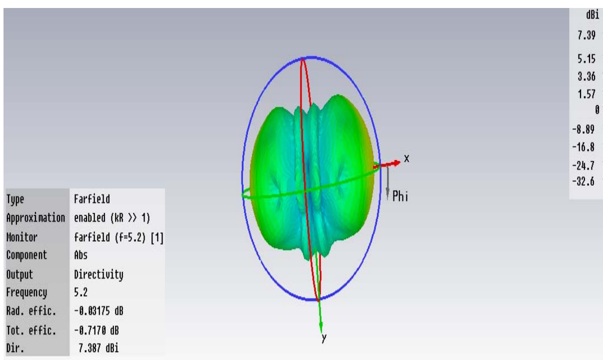

Figure 6(b): 3-D Radiation Pattern of Patch antenna showing directivity at 5.2 GHz

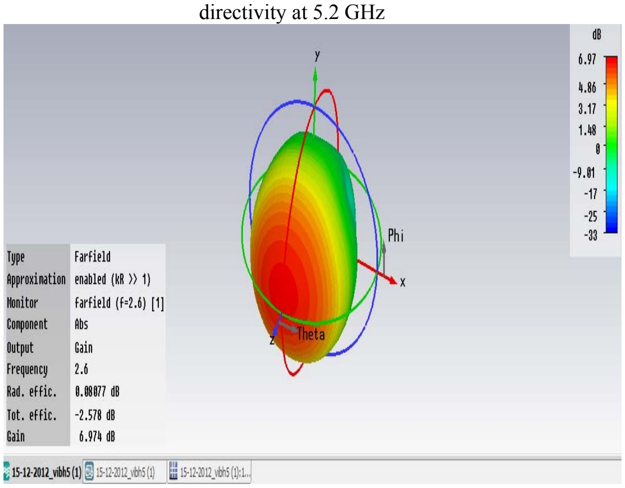

Figure 6(c): 3-D Radiation Pattern of Patch antenna showing Gain at 2.6 GHz

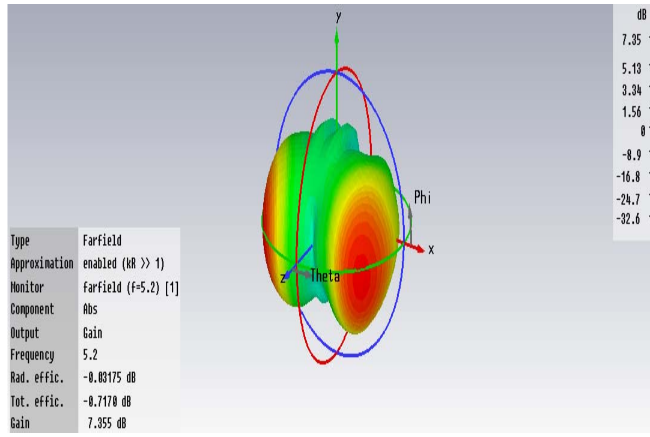

Figure 6(d): 3-D Radiation Pattern of Patch antenna showing Gain at 5.5 GHz

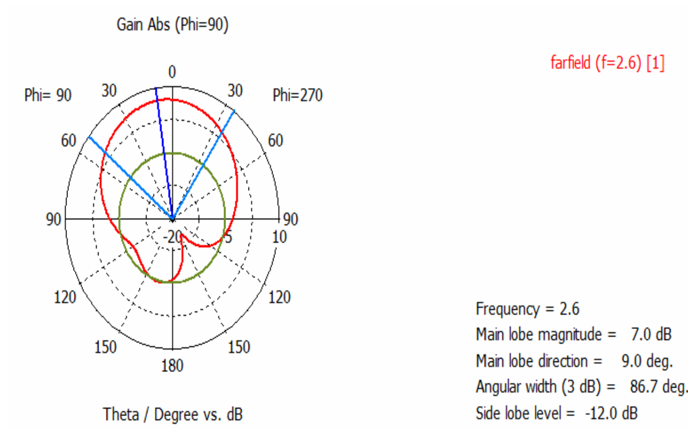

Figure 6(e): 2-D Radiation Pattern of Patch antenna showing directivity at 2.6 GHz

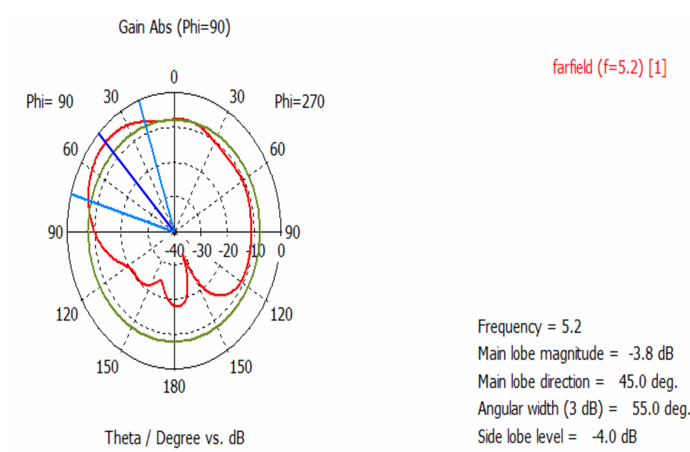

Figure 6(f): 2-D Radiation Pattern of Patch antenna showing directivity at 5.5 GHz

VII. CONCLUSION

A Microstrip line feed dual frequency microstrip patch antenna has been designed and simulated using CST Microwave Studio software. This antenna resonates for IMT and WLAN band of (2.3768 GHz – 2.8225GHz). The frequency band of 4.7913 GHz-5.503GHz covering WLAN standa band, the frequency band of (4.7913 GHz –5.503 GHz) covering WLAN communication standard and 5.5 GHz WiMax standard. The simulated impedance bandwidth at the 2.6 GHz is 400 MHz with corresponding return loss as-24.816 and for 5.2GHz the bandwidth is 700 MHz with the corresponding value of return loss as -26.62 dB which is enough for matching and frequency is closed enough to the specified frequency band feasible for WiMax/WLAN applications. However, the size of the microstrip antenna is not very small .In this the gain of this antenna is small but it can be increased using gain enhancement techniques. Work is going on to achieve even better results with good axial ratio over a wide bandwidth.

VIII. ACKNOWLEDGEMENTS

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VII. REFERENCES

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