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Analysis of Effect on Bandwidth of Inverted L Slotted Stack Antenna for Slot Dimension Variation of Stack Patch Slot

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Abstract: In this work a stack antenna at 3 GHz is designed at the stack height of 75 mm where both the layers stack and fed patch have inverted L slots of different dimension and dimensions of stack patch L slot is varied once length and other is width by 0.5mm and the shift in higher resonance frequency is obtained and effect on bandwidth is different for length and width variation.

Keywords: L slot, enhanced bandwidth, stack antenna, gain, proximity feed.

I. INTRODUCTION

The exploding growth of wireless communications systems requires broadband services for high speed internet and other multimedia communication leads to a continuous demand for integrated compact low-cost, multiband, high bandwidth efficient antenna. A thick dielectric substrate having a low dielectric constant is desirable for better radiation efficiency and larger bandwidth. It also leads to a larger antenna size so designing a compact microstrip patch antenna, higher dielectric constants must be used which are less efficient and result in narrower bandwidth [1]. These are some of the limitations of micro strip patch antenna in spite its low weight, light volume and profile.

A common approach for improving the bandwidth performance of a patch antenna is to add parasitic elements to the antenna structure, e.g., a stacked patch [2-4]. As a result, multilayer technology becoming very popular as it decreases combined effective dielectric constant and increases thickness of antenna which directly enhance bandwidth of antenna ([3],[5]-[6]).A stack microstrip antenna with two parasitic elements is investigated experimentally by E. Nishiyama and etal. for increased bandwidth and enhanced gain [7] stack antenna increases gain and directivity for small area and volume in comparison to microstrip antenna [7] So it is a reasonable choice for better radiation parameters if stack patch layer includes different slots like U W and C .here I tried to investigate the effect of slot dimensions(length and width) variation on the bandwidth without changing height of stack on L slotted stack antenna, we can get different frequency band by varying length or width of stacked L Slot here in the concerned design lower resonant frequency is fixed.

II. RELATED WORK

Firstly the aperture coupled micro strip antenna first proposed by D.M. Pozar [8] in 1985 since then many paper on stack antenna were investigated earlier shown stacking different size of patches improves bandwidth[9].In [10] enhancing the bandwidth of a Micro strip Patch Antenna using Slots Shaped Patch is presented. Analysis of two parasitic layer stack antenna is given in [11] shows bandwidth depends upon thickness and separation between layers.

In [12] a new approach was given to get dual band and triple band antennas is verified using U-slots and also in [13] U-Slot Stacked Patch Antenna Using High and Low Dielectric Constant Material Combinations is analysed. Where it is shown that If dielectric constant and thickness of both the layer (fed patch and stack patch) are different and thickness of fed patch layer is less than that of stack patch layer then the bandwidth is highly improved [13].In [14] W slotted dual band stacked antenna shows increased bandwidth up to 5.28%.

III. STACK ANTENNA

In this work two layer stack antenna with inverted L slot loaded separated by an air gap h_a between them is introduced and analysed at 76.6 mm value of stack height in this study changes in bandwidth and higher resonant frequency of the proposed stack antenna are observed with changing stack patch slot dimension.

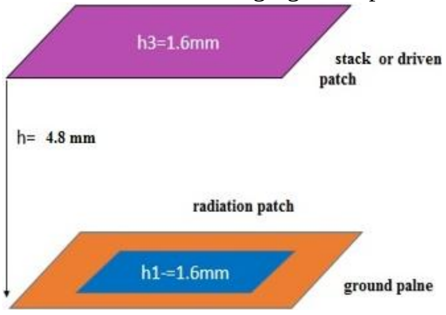

Fig.1 Stack antenna patches structure

The proposed slot loaded stack antenna is shown in Figure 1. The stack antenna has been designed on glass epoxy substrate (ε_r=4.4 & $\tan\delta = 0.0013$) of thickness h=1.6mm as substrate material has large influence in determining the size and bandwidth of a stack antenna [15]. Stacking of antenna gives multiband operation at different frequency band with small size [16].

IV. ANTENNA DESIGN

For designing a rectangular Microstrip patch antenna, the length and width are calculated as below [17].

$$w=\frac{c}{2fr}\sqrt{\frac{2}{\varepsilon_r+1}} \qquad (1)$$

Where c is the velocity of light, ε_r is the dielectric constant of substrate, f_r is the antenna design frequency, W is the patch width, and the effective dielectric constant ε_{reff} is given as [17]

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2}+\frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}} \qquad (2)$$

At h=1.6mm

The extension length ΔL is calculated as [17]

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff}+0.3)(\frac{W}{h}+.264)}{(\varepsilon_{reff}-.258)(\frac{W}{h}+0.8)} \qquad (3)$$

By using the above mentioned equation we can find the value of actual length of the patch as [17]

$$L = \frac{c}{2fr\sqrt{\varepsilon reff}} - 2\Delta L \qquad (4)$$

The length and the width of the ground plane can be calculated a [17]

$$L_g=6h+L \qquad (5)$$

$$W_g=6h+W \qquad (6)$$

And height of the substrate given as

$$h \le \frac{0.3c}{2\pi fo\sqrt{\varepsilon_r}} \qquad (7)$$

Bandwidth of the patch antenna an empirical formula by Jackson and Alexopolus for the (VSWR<2) is given as [18]

$$BW = 3.77\left(\frac{W}{L}\right)\left(\frac{h}{\lambda o}\right)\left(\frac{\varepsilon_r-1}{\varepsilon_r 2}\right) \qquad (8)$$

A. Antenna design specifications

The design of proposed antenna and L slots dimension are shown in figure2 and figure3. The proposed antenna is designed by using glass epoxy substrate which has a dielectric constant 4.4 and the design frequency 3 GHz is taken. The calculated fed patch width and length are 30 mm and 33 mm respectively and ground plane length and width are taken 33 mm and 40 mm respectively. Length and width of stack patch are 22 mm and 28 mm respectively. Height and loss tangent of both the layers are1.6 mm and 0.0013 Antenna is fed through proximity coupling for improved bandwidth [19]. All the specifications are given in the Table I (all lengths in mm and frequency in GHz).

Table I Antenna Design Specifications

S.No.	**Parameters**	**Value(mm)**
1.	Design Frequency f_r	3
2.	Dielectric Constant ε_r	4.4
3.	Substrate Height(h)	1.6
4.	Fed Patch Width(W_f)	30
5.	Fed Patch Length(L_f)	23
6.	Ground Plane Width(W_g)	40
7.	Ground Plane Length(L_g)	33
8.	Stack Patch Width(W_p)	28
9.	Stack Patch Length(L_p)	22
10.	Analysis Height (h_a)	76.6

B. Antenna Design Procedure

Parameters of proposed antenna should be calculated very carefully by using the equations 1, 2, 3, 4, 5 and 6. During the designing of proposed antenna on IE3D ground plane is starting from (0.2, 0.2) at lower left corner. Feed is placed at point (X=18.75, Y =25.375) to achieve maximum bandwidth. Slots are cuts mainly near from edges of patch and feed is given near the joints of L slot for better result.

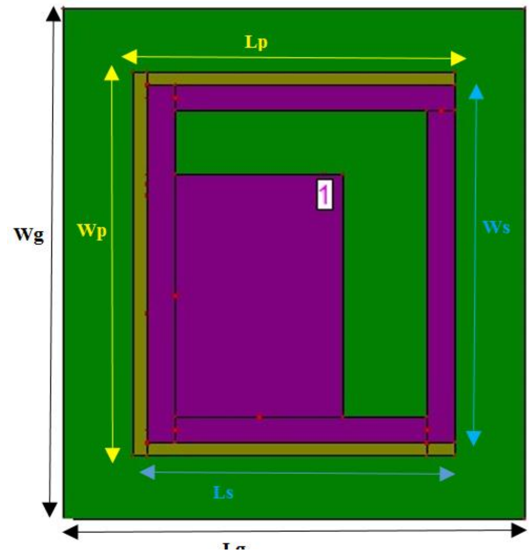

Fig.2 Geometry of proposed Microstrip antenna

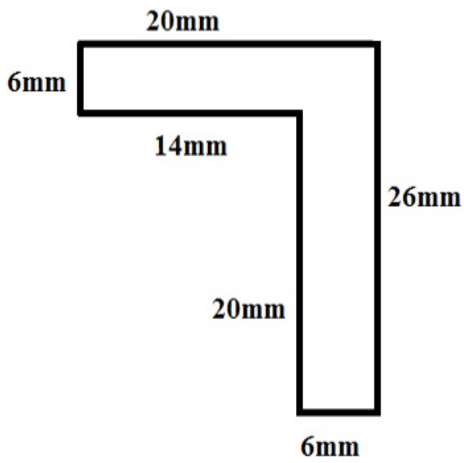

Fig.3 Dimension of Fed Patch L Slot

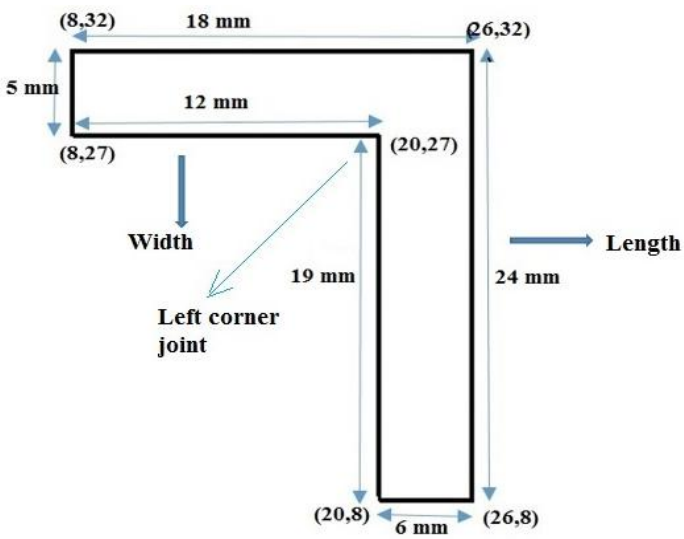

Fig.4 Dimension of Stack Patch L Slot with Variation Measurement

V. METHODOLOGY

In this work at the height of 76.6 mm only upper patch slot dimension are changed keeping fed patch slot dimension shown in fig.3 are fixed. here I changes the length and width of stack patch's slot L by 0.5 mm respectively firstly length is varied keeping width constant then width is varied keeping length constant and recorded the changes in bandwidth and higher resonant frequency but selection of slot dimension is by hit and trail according to maximum bandwidth. I choses this height because of high bandwidth and at lower value of height change in bandwidth is almost continuous and regular.

A. Generation of Data for Analysis

Firstly length of L Slot whose coordinate (20,8) and (20,27) from left side to the inner corner of L slot as shown in fig.2(c) are varied vertically in increasing order from 8 to 27 mm by 0.5mm starting from 8.5mm to 26.5 mm total 37 data set for length.

Then width of the slot is varied horizontally from left end to the inner corner of L slot whose coordinate are (8,32) and (26,32) as shown in fig.2(c) by 0.5mm from 8 to 20 mm starting from 8.5mm to 19.5 mm total 11 dataset for width.

VI. RESULT

In this study it was observed that when length is decreased by 0.5mm the changes at the patch end is not continuous as radiation doesn't shows no changes but when L slot length is changed by 3-4 mm then higher frequency point changes again constant for some length it also shows that when changes in length occurs near feed point continuous changes occurs in bandwidth as higher frequency changes as area around feed point shows considerable changes in the radiation pattern for variation in the slot length shown in table II.

When the width is varied changes in the bandwidth occurs more frequently than that of length variation but near the feed point region bandwidth is constant as shown in table III.

Table II. Length Variation Vs. Bandwidth

Length	Higher Frequency Point	Bandwidth
8.5	3.05	65.217
9	3.05	65.217
9.5	3.05	65.217
10	3.05	65.217
10.5	3.05	65.217
11	3.05	65.217
11.5	3.05	65.217
12	3.05	65.217
12.5	2.2	34.666
13	3.1	66.666
13.5	3.1	66.666
14	3.1	66.666
14.5	3.1	66.666
15	3.1	66.666
15.5	2.1	30.136
16	2.2	34.666
16.5	2.15	34.432
17	2.85	59.09
17.5	2.1	30.136
18	2.85	59.09
18.5	2.1	30.136
19	2.85	59.09
19.5	2.1	30.136
20	2.3	38.961
20.5	2.25	36.842
21	2.25	36.842
21.5	2.25	36.842
22	2.3	38.961
22.5	2.25	36.842
23	2.2	34.666
23.5	2.25	36.842
24	2.3	38.961
24.5	2.25	36.842
25	2.25	36.842
25.5	2.25	36.842
26	2.25	36.842
26.5	2.3	38.961

Table III. Width Variation Vs. Bandwidth

Width	Higher Frequency Point	Bandwidth
8.5	2.45	45
9	3.05	65.217
9.5	3	63.736

10	3.05	65.217
10.5	3	63.736
11	3.05	65.217
11.5	2.15	32.432
12	3.05	65.217
12.5	2.15	32.432
13	2.15	32.432
13.5	2.15	32.432
14	2.15	32.432
14.5	2.15	32.432
15	2.15	32.432
15.5	2.15	32.432
16	2.2	34.666
16.5	2.15	32.432
17	2.2	34.666
17.5	2.15	32.432
18	2.2	34.666
18.5	2.2	34.666
19	2.2	34.666
19.5	2.2	34.666

A. Radiation Parameters of the Antenna

This analyzed antenna at the 76.6 mm height gives 65.217% bandwidth having two resonant frequency at 1.6 GHz and 2 GHz with -21.65 dB and -17.3 dB return loss respectively for 1<VSWR<2 in the frequency range 1.55- 3.05 GHz and its 3D radiation pattern at 1.6 GHz is shown in fig.3. And other parameters like gain, directivity and efficiency also shown stack antenna at increased height shows less efficiency because of more losses.

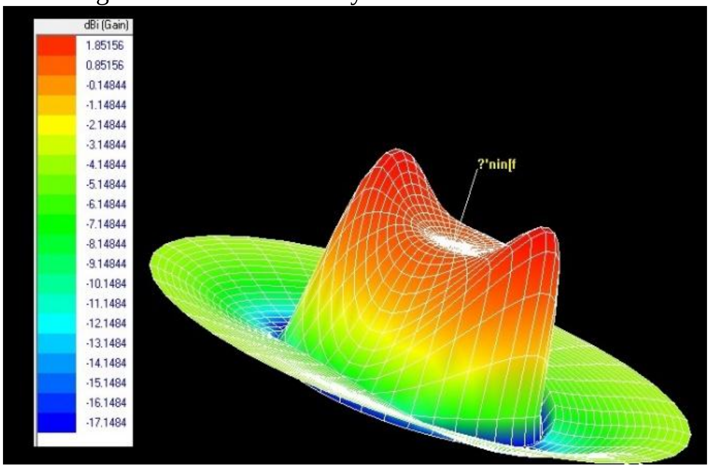

Fig.5 3D Radiation Pattern (1.55 GHz)

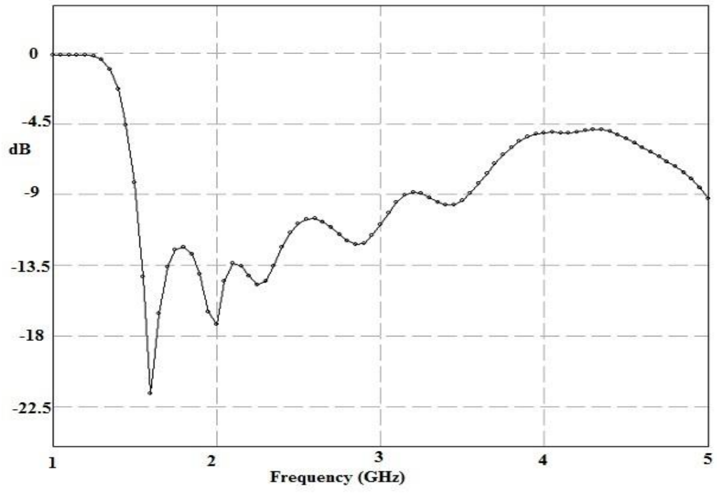

Fig.6 Return Loss vs. Frequency Graph

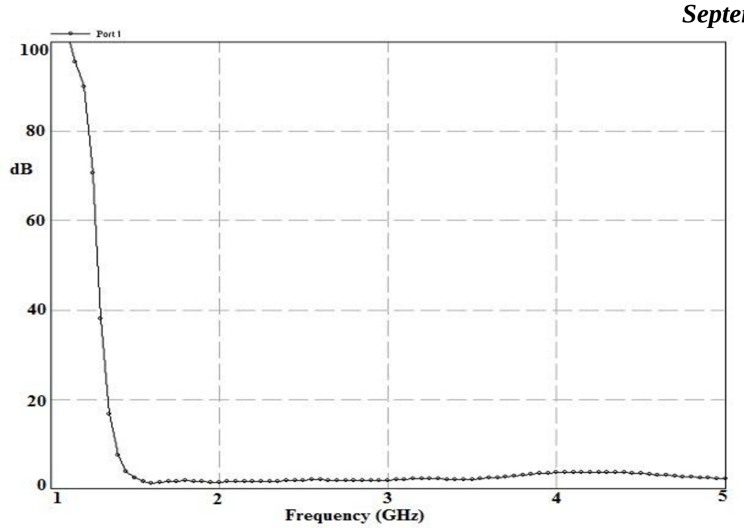

Fig.7 VSWR vs. Frequency Graph

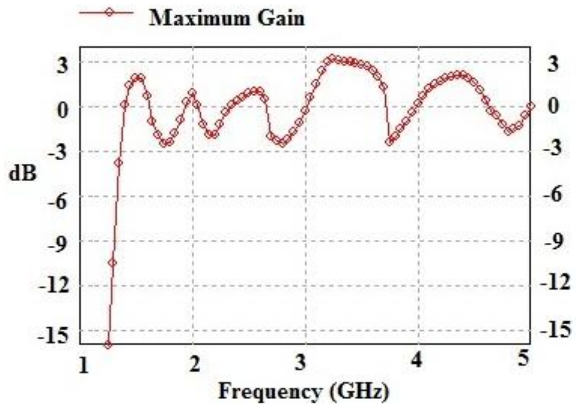

Fig.8 Gain Vs Frequency Graph

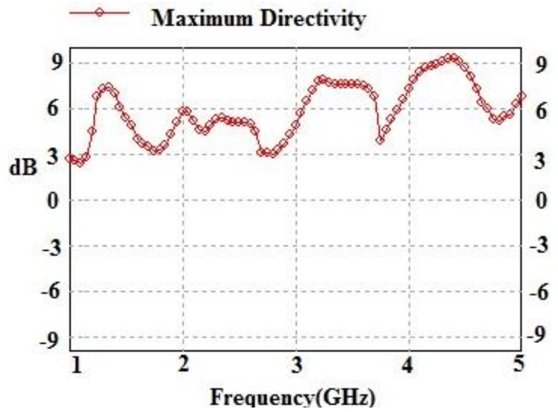

Fig.9 Directivity vs. Frequency Graph

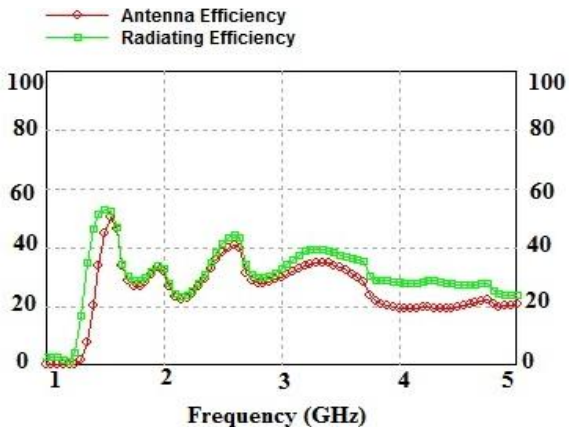

Fig.10 Efficiency vs. Frequency Graph

VII. CONCLUSION

In the concerned analysis of bandwidth of antenna for slot variation it can be concluded that same bandwidth is achieved for different dimension of slot and effect of slot variation is more near feed point region rather than patch edge or end region and antenna can be made application based antenna accordingly to the desired lower and higher frequency point.

Here in this antenna bandwidth and shift in the higher frequency point is studied where lower frequency point is fixed at 1.55 GHz, with the variation of L slot of stack patch it is observed from return loss vs. frequency graph that when we decrease the length by 0.5mm towards the feed bandwidth decreases as higher resonant frequency shift towards lower frequency up to 2.3 GHz and narrow bandwidth achieved. When the width of slot is varied then higher resonant frequency is varies alternately higher to low and low to higher up to 2.2 GHz.

So long arms of slot gives broad band while short arms gives narrow band lower frequency point is constant and higher frequency point shifts and at higher value of stack height slot dimension variation is irregular.

VIII. FUTURE SCOPE

In this work I implies vertical stacking but here we can also implement horizontal stacking for analysis of parameters here firstly length is varied keeping width constant then width is varied keeping length constant further changes simultaneously in both length and width can be studied. Other radiation parameters of antenna can be analyzed by varying slot dimensions in this area and combination of different dielectric constant materials for multiband performance. We can use Rotation of angle of slot of the stack patch for performance of antenna at optimized or constant height.

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REFERENCES

[1] Chebrolu Sandeep, Sudesh Mayur Darak, Anand S., Sriram D. Kumar, "performance analysis and comparison of Multifunctional patch array with stacked patch Antennas for radar applications*", Proceedings of SARC-ITR International Conference*, 04th May-2014, Chennai, India *ISBN: 978-93-84209-14-8.*

[2] Gupta V. and Gupta N., "Gain and Bandwidth Enhancement in Compact Microstrip Antenna", *International Union of Radio Science, Proceedings*, 2005.

[3] Kin-Lu Wong, *Compact and Broadband Microstrip Antennas*, John Wiley & Sons, pp. 12-14, ISBNs: 0-471-41717-3, 2002.

[4] Sabban, A,"A new broadband stacked two layer microstrip antenna".*IEEE AP-S International Symposium Digest* 1983 pp. 63–66.

[5] R. Q. Lee and K. F. Lee, "Experimental study of the two-layer electromagnetically coupled Rectangular patch antenna*", IEEE Trans. Antennas and Propagation*, vol. 38, pp. 1298-1302 August 1990, ISSN: 0018-926X.

[6] Balanis, C. A., *Antenna Theory: Analysis and Design*, John Wiley & Sons, Inc., USA, 2005.

[7] S. Egashira and E. Nishiyama, "Stacked microstrip antenna with wide bandwidth and high gain", *IEEE Transactions on Antennas and Propagation (USA)*, vol. 44, no. 11, (1996), pp. 1533-1534.ISSN: 0018-926X.

[8] D. M. Pozar," A micro strip antenna aperture coupled to a micro strip", *Electronics Letter*, vol. 21-1, pp. 49–50, 1985.

[9] Waterhouse, R. B.,"Broadband Stacked Shorted Patch, *"Electronics Letters*, vol. *35*, pp. 98–100, Jan 21, 2009.

[10] Atser A. Roy, Joseph M. Môm, Gabriel A. Igwue*,"*Enhancing the Bandwidth of a Microstrip Patch Antenna using Slots Shaped Patch," *American Journal of Engineering Research (AJER).*, Volume-02, Issue-09, pp-23-30, e-ISSN: 2320-0847, p-ISSN: 2320-0936.

[11] A. Ansari J., Singh Prabhakar, and P. Yadav Nagendra,"Analysis of Wideband Multilayer Patch Antenna with Two Parasitic Elements*". Microwave and optical technology letters*., vol. 51, no. 6, June 2009.

[12] K.F.Lee, K.M.Luk, K.M.Mak and S.L.S.Yang"On the use of U- slots in the design of dual and triple band patch antennas", *IEEE Transactions on antenna and propagation.* ISSN: 1045-9243.

[13] Koray Sürmeli, Bahattin Türetken,'' U-Slot Stacked Patch Antenna Using High and Low Dielectric Constant Material Combinations in S-band", *General Assembly and Scientific Symposium.*, 2011 xxxth URSI, ISBN: 978-1-4244-5117-3.

[14] Ansari, J.A., Mishra, A., Yadav, N., Singh, P. and Vishvakarma, B.R." Analysis of W-Slot Loaded Patch Antenna for Dual-Band Operation." *International Journal of Electronics*., vol. 66, pp. 32-38, 2012.

[15] Rao Neeraj and V. Kumar Dinesh," Gain and Bandwidth Enhancement of a Microstrip Antenna Using Partial Substrate Removal in Multiple-layer Dielectric Substrate*," Progress in Electromagnetics Research Symposium Proceedings,* Suzhou, China, Sept. 12-16, 2011.

[16] Motin, M.A., Hasan, M.I., Habib, M.S. and Sheikh, M.R.I.,"Design of a Modified Rectangular Patch Antenna for Quad Band Application," *International Conference on Informatics, Electronics & Vision* (*ICIEV*), Dhaka, 17-18 May2013, Page 1-4.
[17] Rop, K. V., Konditi, D. B. O., Ouma, H. A. & Musyoki, S. M.,"Parameter optimization in design of a rectangular microstrip patch antenna using adaptive neuro-fuzzy inference system technique," *IJTPE Journal*, 2012,ISSN 2077–3528,.
[18] Jackson, D. R. and N. Alexopoulos,"Simple approximate formulas for input resistance, band-width and efficiency of a resonant rectangular patch," *IEEE Transactions on Antennas and Propagation*, Vol. 39, pp. 409, March 1991.ISSN: 0018-926X.
[19] P Soh.J, M Rahim.K.A, Asrokin A., Aziz M.Z.A. Abdul," Comparative Radiation Performance of Different Feeding Technique for a Microstrip Patch Antenna", *Conference Paper* IEEE explore, Jan 2006.