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DESIGN AND SIMULATION OF DIFFERENT SHAPES MICROSTRIP ANTENNAS FOR S- BAND APPLICATIONS

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Keywords: Microstrip antenna, Return loss, VSWR,CST , bandwidth % , S – Band .

ABSTRACT
This paper has the design of different geometry shapes the U slot , H slot, T slot , E, I ,L and F slot developed from a rectangular patch of microstrip antenna . Rectangular patch of width (W)=39 mm, length (L)= 29mm is used . All different shapes proposed antenna has been analysed , designed and simulated using CST (Computer Simulation Technology) Microwave studio 2016 and the result are compared with the conventional Rectangular patch antenna . All designed antennas operate in the S band frequency range , which incorporates satellite and military applications . The properties of the antenna such as Return Loss , bandwidth , VSWR , Gain , Directivity , Radiation pattern , Bandwidth % , have been investigated. The substrate material used for the proposed antennas is FR-4 lossy, with the dielectric constant of 4.1..

INTRODUCTION
In wireless communication, there are several types of microstrip antennas, the most common of which is the patch antennas. Microstrip antenna consists of very small conducting patch built on a ground plane separated by dielectric substrate. The microstrip patch antenna offers the advantages of low profile, ease of fabrication, and compatibility with integrated circuit technology. They can be designed to operate over a large range of frequencies (1- 40GHz) and easily combine to form linear or planar arrays. It can generate linear, dual, and circular polarizations. The microstrip antenna has different feeding techniques like probe fed, aperture coupled, proximity and insert feed. As conventional antennas are often bulky and costly part of an electronic system, the microstrip antenna considered as an engineering breakthrough for compact communication devices and systems especially for remote uses where compactness is much desirable features. However, conventional microstrip patch antenna suffers from very narrow bandwidth. This poses a design challenge for the microstrip antenna designer to meet the broadband requirements. The proposed antennas are designed for S- Band frequency with rectangle patch having the U slot , H slot, T slot , E, I ,L and F slot developed.

DESIGN OF PROPOSED ANTENNA
To design different slot microstrip antenna first of all we need to design a conventional microstrip antenna as shown below using CST ,

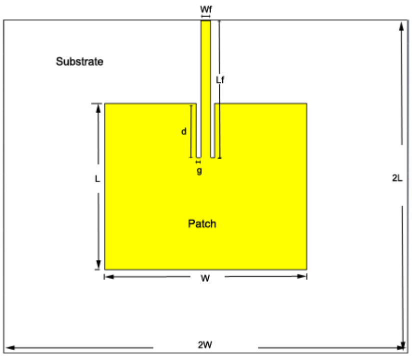

Fig. 1 Microstrip Antenna

To do so , we first resize CST working plane with size = 100 , width = 10 and snap width = .01.

Various steps to design Conventional microstrip antenna are given below

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Define Parameter and Dimensions

The proposed antenna has the following Parameter with dimensions

1. ***Create the Substrate***

To create the substrate, select the brick shape tool and press ESC. This will bring up a window that allows users to specify the dimension of the substrate. Give a name to the brick shape "Substrate", and enter the Width(-W,W), Length(-L,L) and Height(h) as shown in the figure below. We are taking FR-4 (LOSSY) substrate having twice the width and length of the patch that is 2L and 2W.

Freq. Range.	S- band 2-4 GHz
Dielectric Constant	4.1 FR-4
Patch Material	PEC
Length of Patch(L)	29
Width of patch (W)	39
Substrate thickness (h)	1.5
Patch thickness(t)	0.1
Inset fed gap ,Gpf	1mm

2. ***Create the Ground Plane***

We create a ground plane below of the substrate having Height Mt , to create the ground plane, we have to select the back face of the substrate and define that back face as our ground plane . Material that we are using for Ground plane is Copper (Annealed) .

3. ***Create The Patch***

To create the patch , rotate back to the front face of the substrate. Align the WCS coordinate with the front face by selecting the "Aligh WCS with Selected Face" from the WCS menu and double clicking on the front face. Now select the brick icon on the toolbar and press ESC key for patch antenna. This again brings up the window to enter the dimension and material for the brick. Enter the values Xmin= -L/2, Xmax=L/2, Ymin= -W/2, Ymax= W/2, Zmax= t (Zmin is not required, leave it empty.

4. ***Create Microstrip Feed Line***

To create a microstrip feed line, first an empty space will be created and then the microstrip line will be added. This makes a gap between the microstrip line and the antenna.

To do this, create another brick for the empty space by clicking on the rectangular brick tool and pressing ESC as in earlier steps. Then enter the dimension value for the empty space as Umin= -(Wf/2+g), Umax= Wf/2+g, Vmin= L/2-d, Vmax=L/2, Wmax= t. Select nickel from the material library as shown, load it and press ok
Once this is done a shape intersection window will appear as shown below because the newly created empty space and the patch antenna shape has intersected. Check the "Cut away highlighted shape" radio button to cut away the patch shape and create an empty space. Now to add the microstrip, create the brick tool again, press ESC key which will bring up the dialog box as before. Enter "Microstrip" as a name for the new brick shape, Umin= -Wf/2, Umax=Wf/2, Vmin= L/2-d, Vmax= Lf-L/2-d and Zmax= t. Select copper(annealed) in the material section.

After applying all the above steps we got following different shapes with different slot antenna.

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In designing the proposed rectangular micro strip patch antenna the equations that we are using given below

Patch Width

For the dominant mode TM_{010} there is no fringing fields along the width therefore there is no need to consider the effective dielectric constant. Width of the patch can be calculated by this formula

$$w = \frac{c_0}{2f_r}\left(\frac{\varepsilon_r + 1}{2}\right)^{-1/2}$$

Resonance Frequency

For the dominant mode TM_{010} the antenna resonates (without taking fringing into account) at the frequency given by $f_r = \frac{c_0}{2L\sqrt{\varepsilon_{reff}}}$

And when considering the effective dielectric constant the antenna will radiate at the frequency

$$f_r = \frac{c_0}{2(L + 2\Delta L)\sqrt{\varepsilon_{reff}}}$$

VOLTAGE STANDING WAVE RATIO(VSWR)

The standing wave ratio (SWR), also Γ known as the voltage standing wave ratio (VSWR), is not strictly an antenna characteristic, but is used to describe the performance of an antenna when attached to a transmission line.

a) Design of Rectangular patch antenna

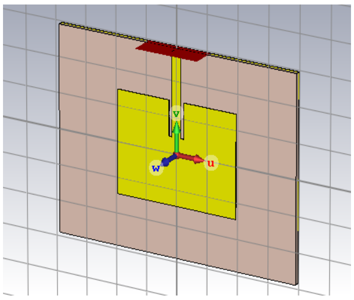

Fig 2: Rectangular patch on CST

b) Design of U-slot patch antenna

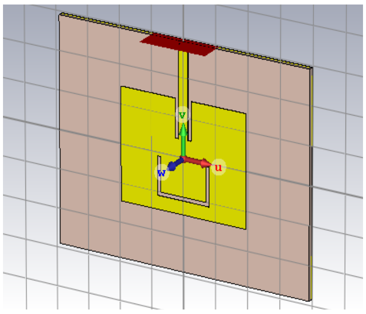

Fig 3: U-slot patch on CST

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c) Design of L-slot patch antenna

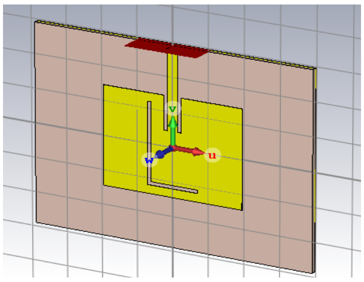

Fig. 4 L-slot patch on CST

d) Design of E-slot patch antenna

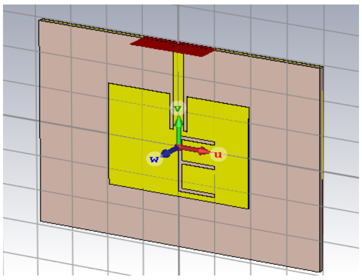

Fig 5: E-slot patch on CST

e) Design of F-slot patch antenna

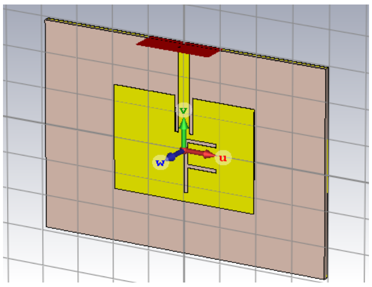

Fig 6: F-slot patch on CST

f) Design of H-slot patch antenna

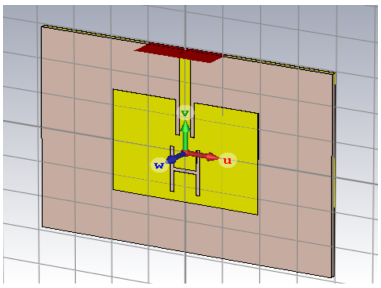

Fig 7: H-slot patch on CST

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g) Design of T-slot patch antenna

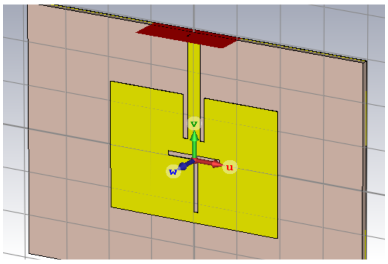


Fig 8: T-slot patch on CST

h) Design of I- slot patch antenna

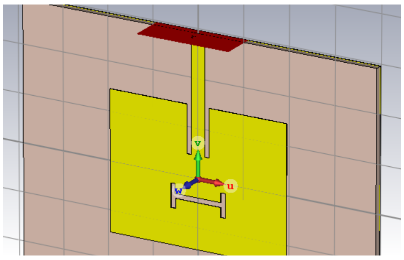


Fig 9: I-slot patch on CST

SIMULATION & RESULTS

The Simulation results of Microstrip Patch antenna with Different slot have been carried out using the Computer Simulator Technology (CST) . The following are the result of Simple Microstrip patch Antenna and patch antenna with different type of slots .

Return Loss

For Simple Microstrip Patch antenna

As shown in fig.10: the simulation indicates a response at 2.937GHz with return loss = -8.314dB. A negative value of return loss shows that this antenna had not many losses while transmitting the signals.

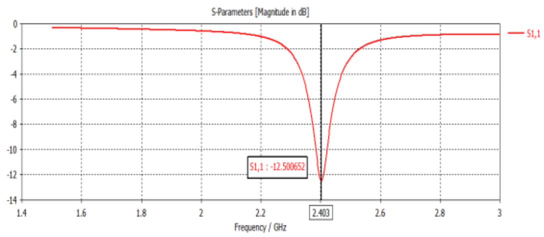
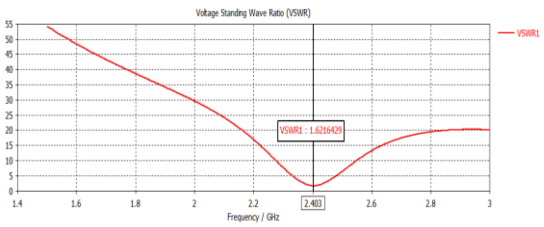


Fig.10: Simulated Return Loss For microstrip patch antenna

VSWR

VSWR of Simple microstrip patch antenna is 1.6216



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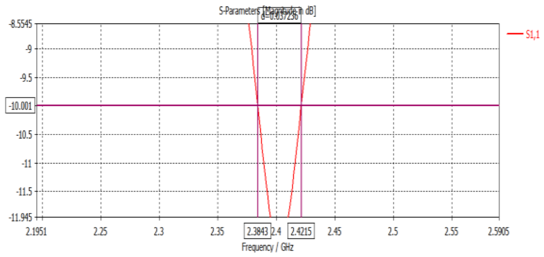
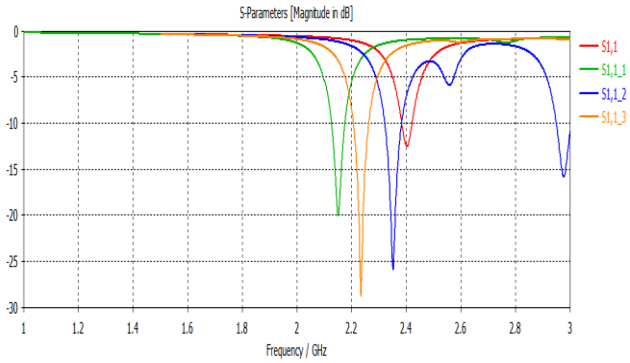
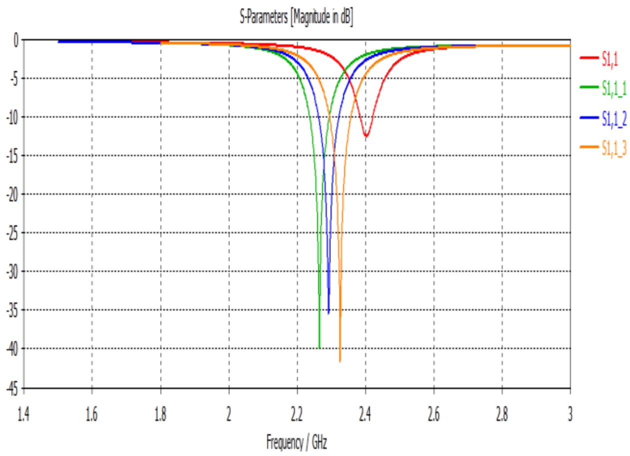
Band width



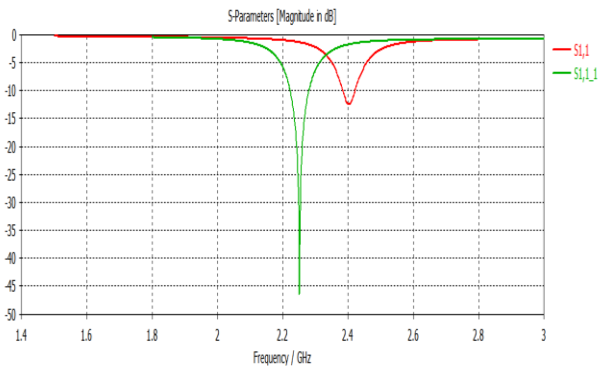
Comparison of Return loss of basic microstrip patch antenna and Patch antenna with U , L and E Slot .



Comparison of Return loss of basic microstrip patch antenna and Patch antenna with F , H and T Slot .



Comparison of Return loss of basic microstrip patch antenna and Patch antenna with I Slot .



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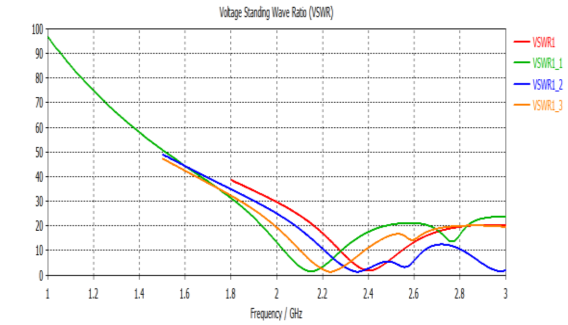
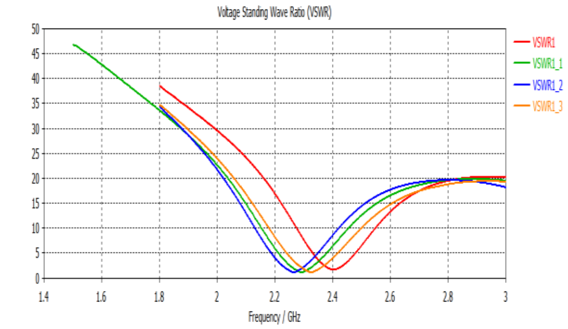
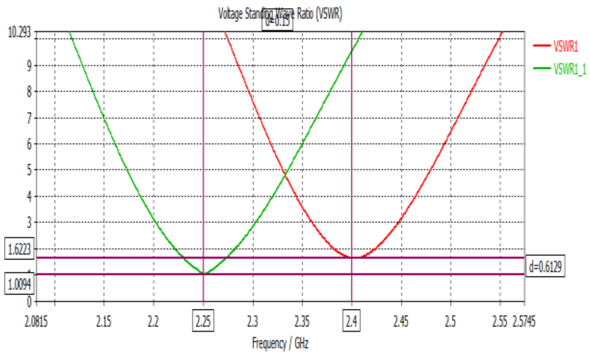
VSWR Comparison of basic microstrip patch antenna and Patch antenna with U , L and E slot .



VSWR Comparison of basic microstrip patch antenna and Patch antenna with F ,H and T slot .



BW Comparison of basic microstrip patch antenna and Patch antenna with I Slot .



Bandwidth OF basic Microstrip antenna

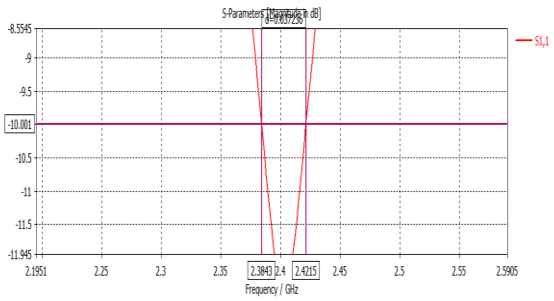


Fig. Bandwidth OF basic Microstrip antenna

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Bandwidth Of Microstrip Patch antenna With I slot

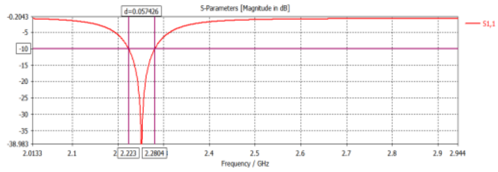

Fig. Bandwidth OF Microstrip Patch antenna With I slot

- In Microstrip patch antenna With Slots Return loss is -46.51 dB, which shows that the antenna has minimum losses.
- The Relative Percentage Bandwidth is about 57.426 which is sufficient for the satellite and military band applications.
- VSWR causes return loss or loss of forward energy through a system. A typical value of VSWR would be1.015, where the two first numbers relate the ratio of impedance Mismatch against a perfect impedance match and the second number is always 1, representing the perfect match. So from the result of VSWR impedance is perfectly matched which increases its efficiency.
- For proper working of an important antenna parameter must lie in specified range like return loss should be less than -10dB means losses less than -10 dB is acceptable another parameter VSWR lies between 1-2 for proper matching. In this design all the parameters also lie in this range.

Table1. : shows the Return loss , VSWR (voltage standing wave ratio), Bandwidth , and Gain at different frequency for different slot micro strip patch antenna. This result obtained by cutting the slot of different geometrical shapes the U slot , H slot, T slot , E, I ,L and F slots.

Table 1 Comparision of different shape

S.NO.	Type of antenna	Resonant Freq. (G Hz)	Return Loss (db)	VSWR	Bandwidth (M H z)
1.	Basic microstrip Patch antenna	2.40	-12.50	1.6223	37.23
2.	Microstrip antenna with U slot	2.15	-20.12	1.2186	49.34
3.	Microstrip antenna with L Slot	2.35	-25.87	1.1071	61.70
4.	Microstrip antenna with E slot	2.23	-28.73	1.0792	56.24
5.	Microstrip antenna with F slot	2.29	-35.48	1.0341	59.33
6.	Microstrip antenna with H Slot	2.26	-39.86	1.020	57.53
7.	Microstrip antenna with T slot	2.32	-41.66	1.0166	62.91
8.	Microstrip antenna with I slot	2.25	-46.51	1.0094	57.42

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CONCLUSION

In this paper , we have designed and simulated different shapes microstrip patch antenna with 2 to 4GHz (S-band).Here we found Return loss ranging from -20dB to - -46dB, , VSWR (Close to 1) and Gain 3dB to 12dB for different shape Rectangular Microstrip patch Antenna with 2GHz to 4GHz frequency band . This antenna can be used for satellite and wireless communication.

REFERENCES

1. C. A. Balanis, "Antenna Theory, Analysis and Design," John Wiley & Sons, NewYork, 1997.
2. "Analysis of Electrical Parameters of Inset Fed Rectangular Micro strip Patch antenna (RMPA)", International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 7, July 2013).
3. "Design and Characterization of E-Shape Microstrip Patch Antenna for Wireless Communication", International Journal of Advanced Trends in Computer Science and Engineering, Vol.2, No.2, Pages : 177-180 (2013) .
4. "Performance Comparison of Micro-strip Antennas with DifferentShape of the Patch", International Journal of u- and e- Service, Science and Technology Vol. 6, No. 3, June, 2013.
5. "Enhancing the Bandwidth of a Microstrip Patch Antenna using Slots Shaped Patch", American Journal of Engineering Research (AJER) e-ISSN :
6. Ashok Kumar and Shailesh Kumar,"Design & Simulation of 8–Shaped Coaxial Feed Patch Antenna"International Journal of Current Engineering and Technology Vol.6, No.3 (June 2016).
7. Srikanta Patnaik, Mihir Narayan Mohanty "Optimization of Z-Shape Microstrip Antenna with I- slot Using Discrete Particle Swarm Optimization (DPSO) Algorithm"2nd International Conference on IntelligentComputing, Communication & Convergence (ICCC-2016)
8. Pawankumarpunia, Riakalra and B. Mohapatra "Inset Fed Rectangular Microstrip Patch Antenna for UHF Radio Frequency Identification"International Journal of Engineering Research & Technology (IJERT)ISSN: 2278-0181Vol. 4 Issue 08, (August-2015)
9. Bimal Garg, HimanshuShrivastava,Prem Kumar, "Microstrip Patch Antenna with Parameters Improvement Using "Symmetric Cylinder Shapes of Zero & Four Segments" Metamaterial Structure" IRACST – International Journal of Computer Networks and Wireless Communications (IJCNWC), ISSN: 2250-3501 Vol.2, No.3,(June 2012)
10. Liton Chandra Paul, Nahid Sultan, "design, simulation and performance analysis of a line feed rectangular micro-strip patch antenna"International Journal of Engineering Sciences & Emerging Technologies, Volume 4, Issue 2, pp: 117-126 (Feb. 2013).
11. Ali HanafiahRambe, Eddy Marlianto, Nasruddin M.N., FitriArnia "Optimizing Rectangular Patch Antenna with Microstrip Line Feed Using Single Stub"International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181Vol. 2 Issue 12, December – 2013.
12. Hemant Kumar Gupta, BhupeshGautem, Poonam Sinha,AbhaSoni "Design of Very Low Return Loss, Rectangular Microstrip Patch Antenna for Cellular and Mobile Communication" nternational Journal of Electronics and Electrical Engineering Vol. 1, No. 3, September, 2013.
13. Kamariah Ismail and SitiHasyimahIshak "Sierpinski Gasket Fractal Antenna with Defected Ground Structure (DGS)" 978-1-4673-4828-7/12/$31.00 ©2012IEEE.
14. Chandan Kumar Ghosh,Arabinda Roy,and Susanta Kumar Parui "Elevated CPW-Fed Slotted Microstrip Antenna forUltra-Wideband Application"Hindawi Publishing CorporationInternational Journal of Antennas and PropagationVolume 2012, Article ID 425919,8pagesdoi:10.1155/2012/425919.
15. Sheikh Dobir Hossain, K. M. AbdusSobahan, Md. Khalid Hossain, Md. Khalid Hossain Jewel, Rebeka Sultana, Md. Al Amin "A Linearly Polarized Coaxial Feeding Dual Band Circular Microstrip Patch Antenna for WLAN Applications" I.J. Wireless and Microwave Technologies, 2016, 3, 50-60 Published OMay 2016 in MECS DOI: 10.5815/ijwmt.2016.03.06.
16. R. L. Yadava, M. Ram and S. Das, " Multiband Triangular Fractal Antenna For MobileCommunications," International Journal ofEngineering Science and Technology, Vol. 2(11), (2010).
17. Amit A. Deshmukh, M. Parulekar, S. Kadam and Ameya Kadam, "Broadband Proximity Fed Modified E -Shaped Microstrip Antenna," National Conference on Communications (NCC), Bangalore, pp.1-5, (2011).
18. Garg, R., Bhartia, P. and Ittipiboon, A., "Microstrip Antenna Design Handbook, Boston Artech, House", (2001).

ISSN 2349-6193
Impact Factor: 2.805

IJESMR

International Journal OF Engineering Sciences & Management Research

19. Padros, N., J. Ortigosa, J. Baker, M. Iskander, and B. Thomberg, "Comparative study of high-performance GPS receiving antenna design,"IEEE Trans. Antennas Propagat., Vol. 45, No. 4, 698–706, (1997).
20. T. P. Wong and K. M. Luk, "A wideband L-probe patch antenna array with wide beamwidth,"IEEE Trans. Antennas Propag., vol. 51, no. 10, pp. 3012–3014, Oct.(2003).
21. W. Yun and Y.-J. Yoon, "A wide-band aperture coupled microstrip array antenna using inverted feeding structures,"IEEE Trans. Antennas Propag., vol. 53, no. 2, pp. 861–862,(Feb. 2005). [22] H. Wang, X. B. Huang, and D. G. Fang, "A microstrip antenna array formed by microstrip line fed tooth-like-slot patches,"IEEE Trans. Antennas Propag., vol. 55, no. 4, pp. 1210–1214,(Apr. 2007).
22. K. L. Lau, K. M. Luk, and K. F. Lee, "Wideband U-slot microstrip patch antenna array," Inst. Elect. Eng. Proc.-Microw. Antennas Propag., vol. 148, no. 1, pp. 41–44, (2001).
23. C.A.Balanis,"Antenna Theory Analysis and Design", third edition, Wiley, New Jersey, (2005).