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# Gain Enhancement of Microstrip Antenna using Metamaterials

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***Abstract: The purpose of this paper is to design a Microstrip triangular patch antenna is designed with dimension 35x45 mm2 for gain improvement. The antenna is designed over the two operating frequencies such as 5.7 GHz and 6.6 GHz using the Metamaterials substrate. The designed antenna can be used for radio broadcasting, broadcast TV, two-way radio, communication receivers, RADAR, cell phones and satellite communications. The Metamaterials micro strip patch antenna has low profile, low cost, easy fabrication and good isolation. The antenna is designed by using High Frequency Structure Simulator (HFSS) simulation software and designed antenna provides the peak gain of 6.096 dB at 5.7 GHz and 5.020 dB at 6.6 GHz.***
***Keywords: Microstrip antenna, Gain, Feeding technique and HFSS***

## I. INTRODUCTION

For communication, a human greatest natural resource is the electromagnetic spectrum and the antenna has been instrumental in harnessing this resource. An antenna is a device designed to efficiently emit and receive radiated electromagnetic waves. Microstrip patch antennas are becoming increasingly popular for use in wireless applications due to their low profile structure. Therefore, they are highly compatible with antennas built into portable wireless devices, such as mobile phones, pagers, and so on. Another area in which they have been used successfully is satellite communications. Some of their main benefits discussed by Kumar and Ray are listed below:

*A.* Light weight and volume.
*B.* Low profile flat configuration that can be easily adapted to the host surface.
*C.* Therefore, low manufacturing costs can be manufactured in large quantities.
*D.* Supports linear and circular polarization.
*E.* Can be integrated with MIC chips.
*F.* Able to operate on two and three frequencies.
*G.* Robust mechanical when mounted on hard surfaces

Microstrip patch antennas suffer the major drawbacks as compared to conventional antennas are Low Gain.
To overcome the drawback, Geometric shape of a Microstrip antenna plays a vital role. There are several category of the Microstrip patch antenna, can be cited some example the circular, a square radiating element, triangular, semicircular etc..,. The study and the design of triangular Microstrip patch antenna are presented in this research paper.

## II. LITERATURE SURVEY

Design and Analysis of a New Dual-Band Microstrip Fractal Antenna by I. Zahraoui et.al., presents a novel design of a Microstrip fractal antenna based on the use of Sierpinski triangle shape, designed and simulated using the FR4 substrate in the operating frequency band (GPS, WiMAX), the design has a fractal antenna with a modified ground structure. The proposed antenna has been simulated and validated using CST microwave studio software, the simulation results showing good performance in terms of radiation modeling and proper input loading
Miniaturization of Antenna for Wireless Application with Difference Metamaterial Structures by Maryam Rahimi, Ferdows et.al., In this paper, periodic structures are explored in antenna design for wireless applications. These antennas were compared using the CRLH miniaturization method. Three different coaxial feed patches on EBG soil, Metamaterials substrate or EBG / AMC structure were introduced in the antenna models. Also, two compact dual band antennas based on CRLH technology have been designed and built for wireless and GSM applications. The first antenna is a directional model and has double polarization. The size of the prototype patch antenna is 20 * 20 $mm^2$, which is about 47% less than a traditional patch antenna of 2.5 GHz.

The second antenna is designed using digital capacitors and spiral inductors. The dimensions of the antennas are 15: 5 * 12mm$^2$, so the size is reduced by about 69% compared to the 1.8 GHz compared to the traditional Microstrip patch antenna. The second antenna operates at two frequencies (1.8 and 2.5 GHz) are suitable for GMS and WLAN applications. Both designs were designed and fabricated on low cost FR4 substrates with "r = 4: 4 and 1.6 mm thickness. All simulations are made with CST and HFSS.

A Butterfly-Shaped Wideband Microstrip Patch Antenna for Wireless Communication by Liling Sun,Maowei He et.al., This paper introduces a new butterfly patch antenna for wireless communication. Antenna is designed for wireless broadband communication and radio frequency identification (RFID) systems. Two symmetrical semicircular arms and two symmetrical round holes are combined in a Microstrip antenna patch to extend its bandwidth. The diameter and position of the circular slot are optimized for wide bandwidth. The validity of the design concept is indicated by the prototype with a bandwidth of about 40.1%. The return loss of a butterfly-sized tenant is greater than 10 dB between 4.15 and 6.36GHz. The antenna can meet many modern wireless communication standards at the same time

Beam Scanning Properties of a Ferrite Loaded Microstrip Patch Antenna by Sheikh Sharif IqbalMitu and Farooq Sultan Insert an axially magnetized ferrite load microstrip antenna with adjustable beam scanning properties. The ferrite cylinders are well placed in the field area, next to the patch, to introduce the phase disconnections required for beam scanning. The interaction between the gyrotropic properties of the radiated and ferrite EM wave is controlled by changes in magnetic fields. Beam scan simulated ten antenna properties obtained for 0–0.19 t for the DC polarization interval are verified using experimental results.

Metamaterial Inspired Microstrip Antenna Investigations Using Metascreens by Muhammad Tauseef AsimandMushtaq Ahmed The double layer on a low cost FR4 substrate is designed, simulated, fabricated and tested on a tenant induced with regularly induced metamaterial. Eigen mode dispersion simulations have left metamaterial characteristics and are adjustable with substrate permeability. The cellular structure of the metamaterial unit is used to create the meta-screen. The experimental results of this tenant are very good and fit closely with the simulation. The - 10 dB bandwidths measured for metamaterials with meta and double monopolar screens are 14.56% and 22.86%, respectively. Meta answers on dual-band response near simple correction shows. The first and second bands calculated 10 dB of bandwidth of 9.6% and 16.66%. The simulated peak gain and radiation efficiency are 1.83 dB and 74%, respectively. Radiation samples are also very good and can be useful in UWB wireless applications

## III. ANTENNA DESIGN

A triangular Microstrip antenna is conceived for wireless communication application, which is operating at a frequency of 5.7 GHz. To improve performance of antenna depends on the dimensions, shape, material used, feed position etc. The proposed triangular patch antenna has been conceived utilizing the Metamaterials substrate and its dimensions are shown in the figure 1.

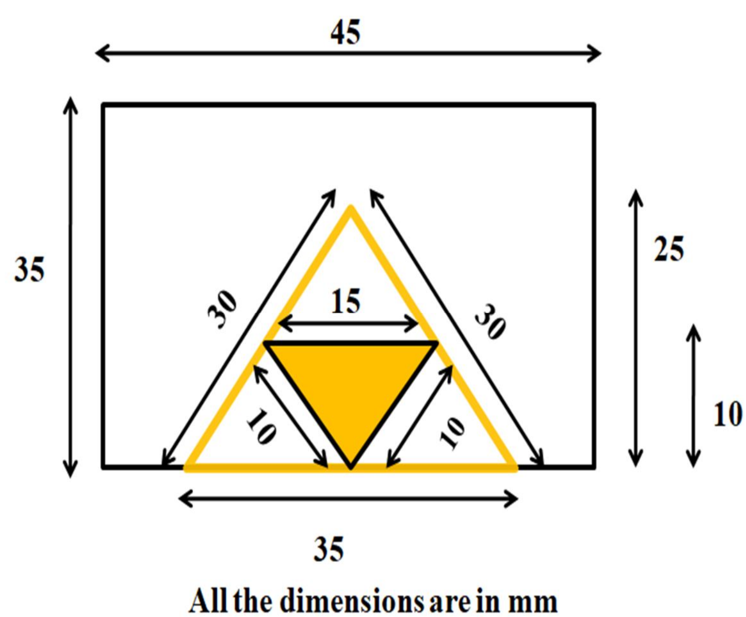


Figure 1: Design of proposed triangular patch antenna

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## IV. HFSS SIMULATION

The results of simulation of triangular patch antenna made by software Ansoft High Frequency Structure Simulator (HFSS) and the hardware implementation is shown on figure 2 and elevation pattern of triangular Microstrip patch antenna as shown in the figure 3 and 4.

Figure 2: Hardware of Metamaterials Patch Antenna

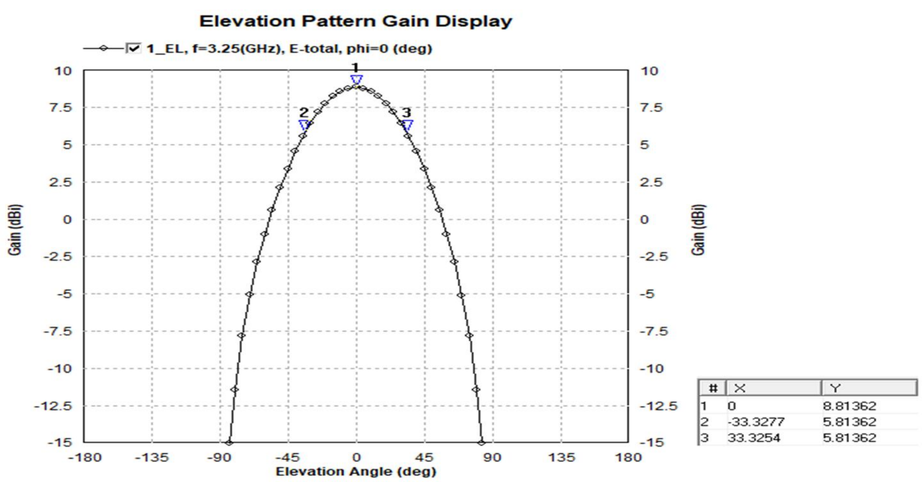


Figure 3: single element: radiation pattern for PHI=$0^0$

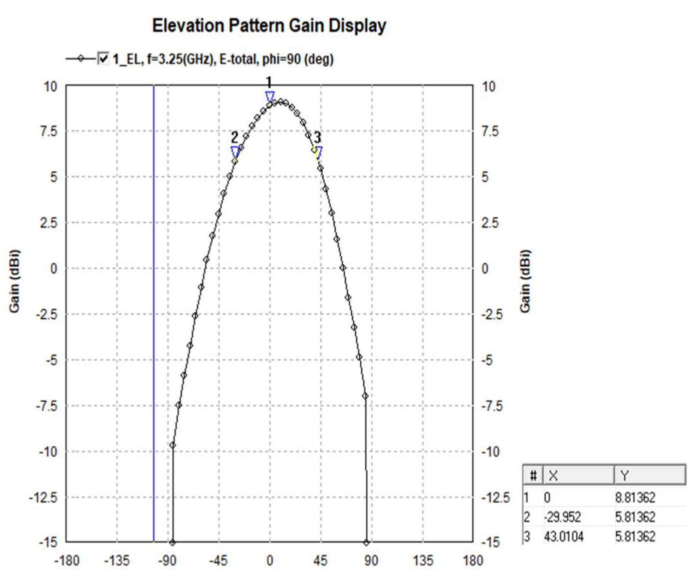


Figure 4: single element: radiation pattern for PHI=90

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Return loss simulation result of the schematic model of triangular patch antenna is shown in Fig.5 from this plot, it is determined that the return loss is low at resonant frequency 7.5 GHz. At which an antenna radiates more.

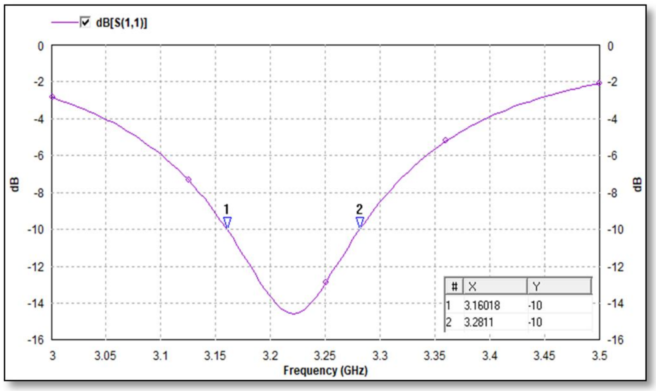


Figure 5: Return Loss of Metamaterials Patch Antenna

Table1 performance evaluation in Microstrip Antenna

| Parameters | Existing Method (Normal copper Metal Patch Antenna) | Proposed Method (Metamaterial Patch Antenna) |
|---|---|---|
| Gain | 1.563 dB at 5.7 GHz | 6.096 dB at 5.7 GHz |
| | 1.285 dB at 6.6 GHz. | 5.020 dB at 6.6 GHz. |

## V. CONCLUSION

The conception and simulation of triangular Microstrip patch antenna that operates in wireless communication frequencies was successfully designed using advanced design system. From observing the return loss, VSWR, it is very clear that this antenna works on the designed wireless communication frequency range. This research, detailed the designing of our wireless communication triangular antenna in the Advanced Design System and Ansoft High frequency structure simulator.

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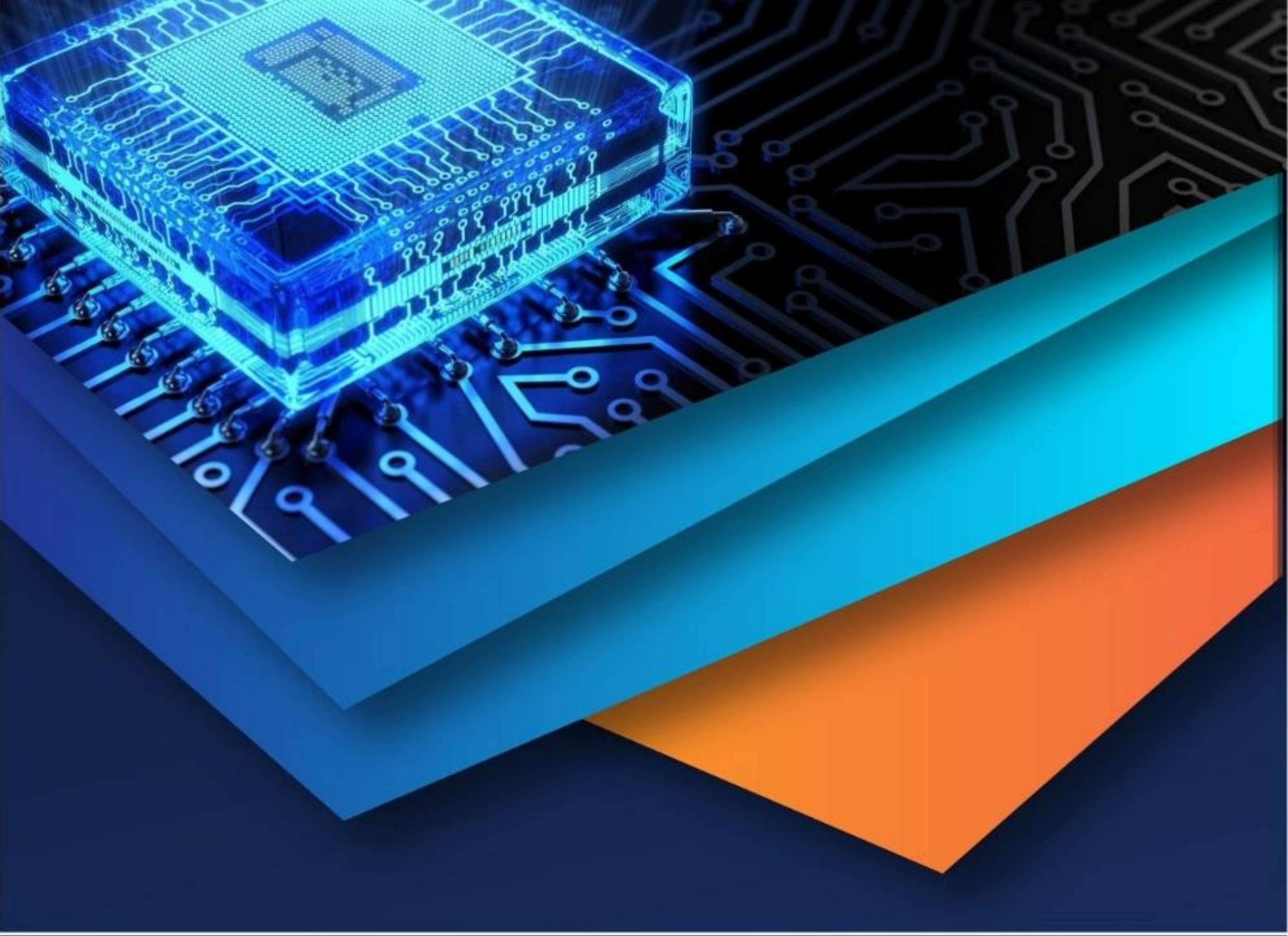


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