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RESEARCH ARTICLE

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CUSTOMIZATION AND CHARACTERIZATION OF BOW-TIE SMART ANTENNA FOR WIRELESS APPLICATIONS

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ABSTRACT

The aim of this project is to increase the gain and the coverage area and the efficiency parameters such as reverse isolation matching of the antenna and to increase the radiation pattern of the antenna. This is achieved by altering the geometrical dimensions of the patch antenna. So that the installation cost of the antenna will be reduced by reducing the number of periodical reflectors at each geographical intervals.The gain of these antennas is between the ranges between 8dBi to 20dBi. This project involves the designing, building, and testing of a highly directional antenna that can be manufactured cheaply and be sold at a price that would be appeal to customers.

Keywords — Microstrip patch antenna, Band width, Gain, Bow-Tie, Reflector, Dipole Antenna.

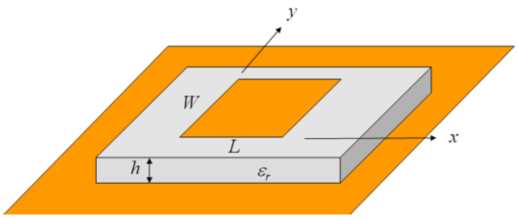
1. INTRODUCTION

The goal of this project is to design and build high gain, low cost, low profile antenna that can be used for Wi-Fi applications that can compete with current high gain antennas already in the market. In order to accomplish this goal, we first review current high gain antennas available on the market to access and determine both the competitive production cost and gain performance of an antenna that would be able to compete with other high gain antennas. We investigate the Wi-Fi 802.11 standard to determine the operation frequency of our antenna and determine the antenna configuration will used to meet our gain, low cost, and low profile standards. Once an antenna design is chosen, we design our antenna using a simulation program. Following, we build the design and test our antenna to compare simulated results with experimental results to evaluate whether or not the designs goals were met.

The patch acts approximately as a resonant cavity. In a cavity, only certain modes are allowed to exist, at different resonance frequencies. If the antenna is excited at a resonance frequency, a strong field is set up inside the cavity, and a strong current on the surface of the patch which produces significant radiation. A microstrip antenna can radiate well, even with a thin substrate. As the substrate gets thinner the patch current radiates less, due to image cancellation. However, the *Q* of the resonant cavity mode also increases, making the patch currents stronger at resonance. These two effects cancel, allowing the patch to radiate well even for thin substrates.

The patch antenna is having three main parts: Metal conductor, substrate, Connector. The metal connector is made up of copper and the copper is more suitable for antenna in mobile and broadband applications. The substrate is made up of glass or Teflon or plastic or glass fiber which is used as an insulating material and to provide support to the antenna. Some antennas are having the substrate which will have effect in the radiation parameter of the antenna. The connector is used to provide the input to the antenna setup. The connector plays the important role in the antenna part it should be properly insulated to avoid the leakage and losses due to radiation.

The resonance frequency calculation can be improved by adding a "Fringing length" ΔL to each edge of the patch to get an "Effective length" *Le*.



$$L_e = L + 2\Delta L$$

$$f_{10} = \frac{c}{2\sqrt{\varepsilon_r}}\left(\frac{1}{L_e}\right)$$

Radiation efficiency is the ratio of power radiated into space, to the total input power. The frequency of operation of the patch antenna is determined by the length *L*. The centre frequency will be approximately given by:

$$f_c \approx \frac{c}{2L\sqrt{\varepsilon_r}} = \frac{1}{2L\sqrt{\varepsilon_0 \varepsilon_r \mu_0}}$$

The width *W* of the microstrip antenna controls the input impedance. Larger widths also can increase the bandwidth. For a square patch antenna fed in the manner above, the input impedance will be on the order of 300 Ohms. By increasing the width, the impedance can be reduced. However, to decrease the input impedance to 50 Ohms often requires a very wide patch antenna, which takes up a lot of valuable space.

I. EXISTING SYSTEM: THE DIPOLE ANTENNA

This is the simplest ultra high frequency antenna. Variations on the dipole are the bowtie antenna which has wider bandwidth than the dipole. The folded-dipole antenna which can solve an efficiency problem and the loop antenna a variation on the folded dipole. All the above said antennas have the same gain and the same radiation field: a torroid or doughnut shape or apple shape. The gain is generally 2.15 dBi. An isotropic antenna is one which is a transmitting antenna, and it could also be an antenna which will have the same gain when receiving as when transmitting, and also the same radiation pattern in both the cases.

DRAWBACKS IN THE EXISTING SYSTEM:

There are so many problems in the existing system like heavy metal structure, lengthy dipole parasitic elements which are not portable. A large mechanical support for grid is needed with large space. The power consumption is very high and it is not reconfigurable which is restricted to only one frequency

PROPOSED SYSTEM: BOW-TIE ANTENNA

A Bowtie antenna is another name for a UHF fan dipole antenna. By using triangular elements instead of rods, the bandwidth is greatly increased, to cover the entire UHF band. Additionally, the mesh reflector of the bowtie is more efficient than the rod reflector and it is lower in weight and has less wind resistance. Bowtie Antenna is another broadband antenna. It also has a similar Omni directional radiation pattern compared to the traditional dipole. Bowtie antenna can constructed using a wire to form the same shape. This is beneficial because it is lower in weight because less use of metal and decreases wind resistances. The bow tie antenna is centre fed like a dipole. This method will lower production cost and decrease the weight of antenna.

II. ANTENNA GEOMETRY AND DESIGN PROCEDURE

WORKING OF THE SYSTEM

The problem with the existing system is size and power of operation. The antenna is of larger size and we need repeaters at regular intervals to increase the coverage area of the particular antenna but in this paper we are using the reflector technique to increase the coverage areas and the system parameters are measured by the radiation monitoring tool.

Why Bow-Tie antenna?

The most obvious difference between VHF and UHF antennas is the size. A half wave dipole for channel 2 will be 10 times longer than for channel 28. This means that much more elaborate UHF antenna can be constructed without the antenna becoming physically unmanageable. With more elements added to the UHF antenna, higher gain and directivity can be obtained.

MODIFIED BOWTIE ANTENNA

The bowtie antenna dimension is altered to increase the gain as well as all antenna parameter. Simulated output of modified bowtie antenna and its frequency ranging from 2GHz to3GHz.this include antenna parameter.

Fig2: Designed model of the Bowtie Antenna

WIRELESS HARDWARE MODULE

Reflection technique:

The reflector is used to provide the effect of Fresnel and Fraunhofer effects which will change the radiation parameter of the antenna .There are two types of reflector available: Solid beam reflector and the mesh type of reflector. In the case of near field communication the mesh type of reflectors are used and the in case of far field communications the solid beam type of reflectors are used.

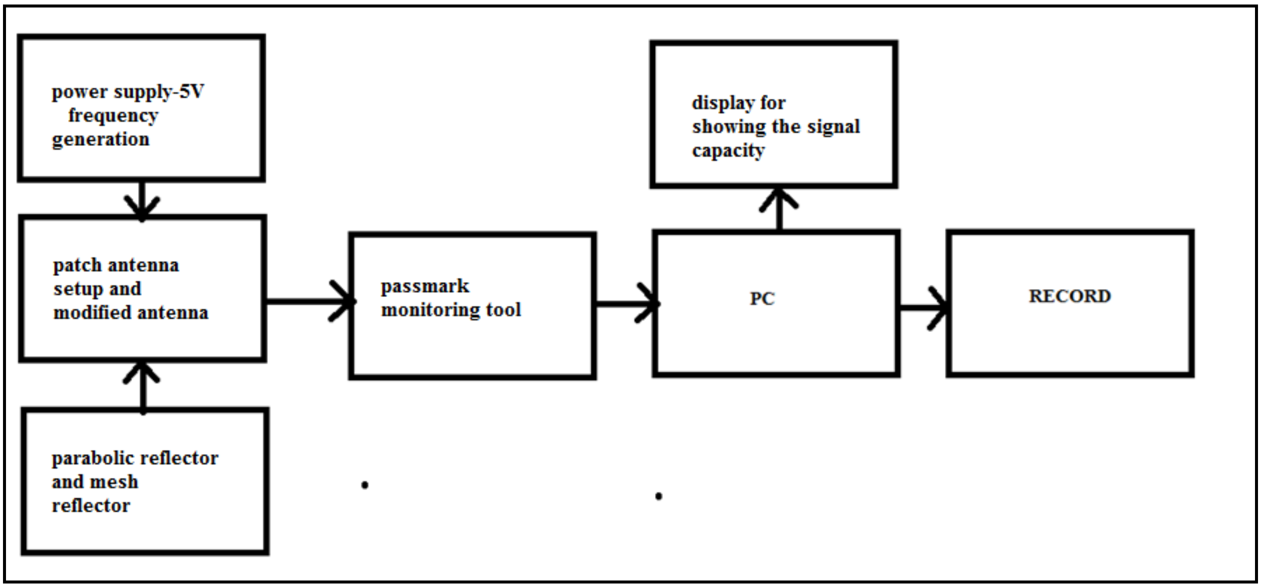
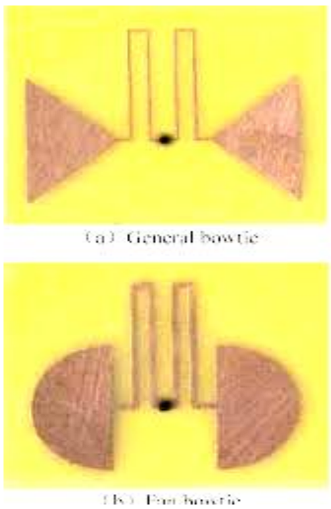


Fig.1 Schematic Block diagram of the Design model of the system



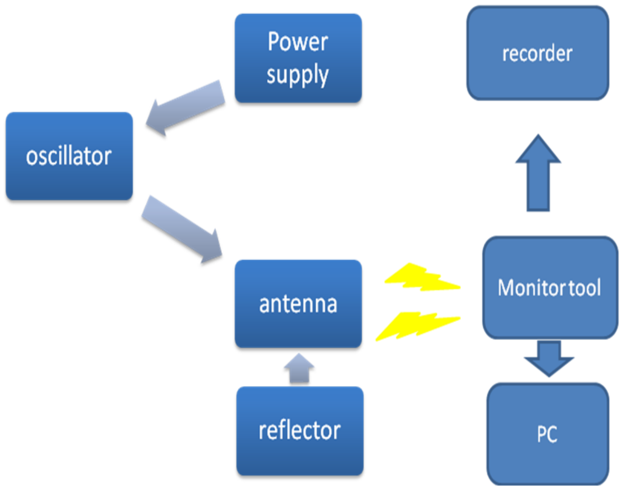


Fig2: Designed model of the Bowtie Antenna

Fig.3: Design Flow model

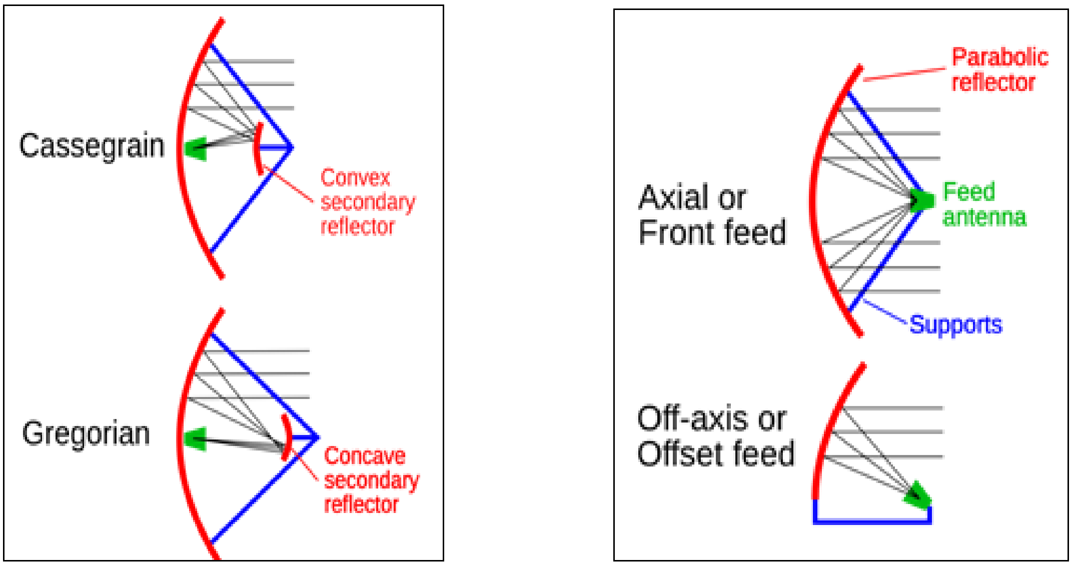


Fig.4: Various types of feed systems with the reflectors

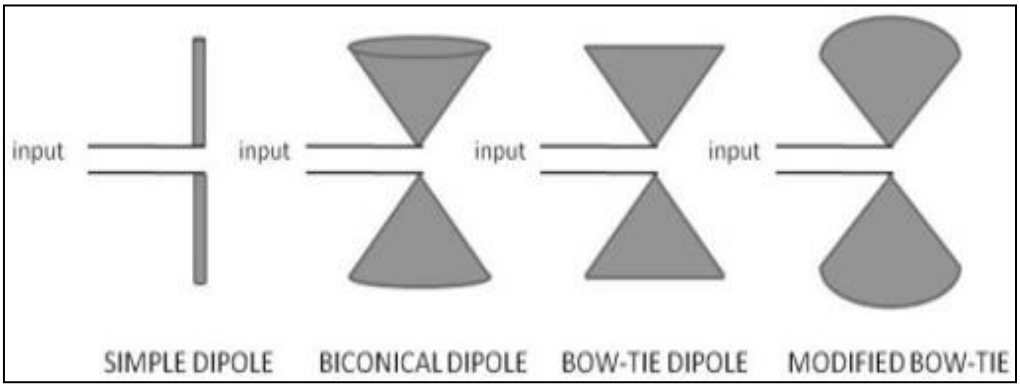


Fig 5: Proposed Geometrical changes in the antenna

DIMENSIONS OF BOWTIE DESIGN

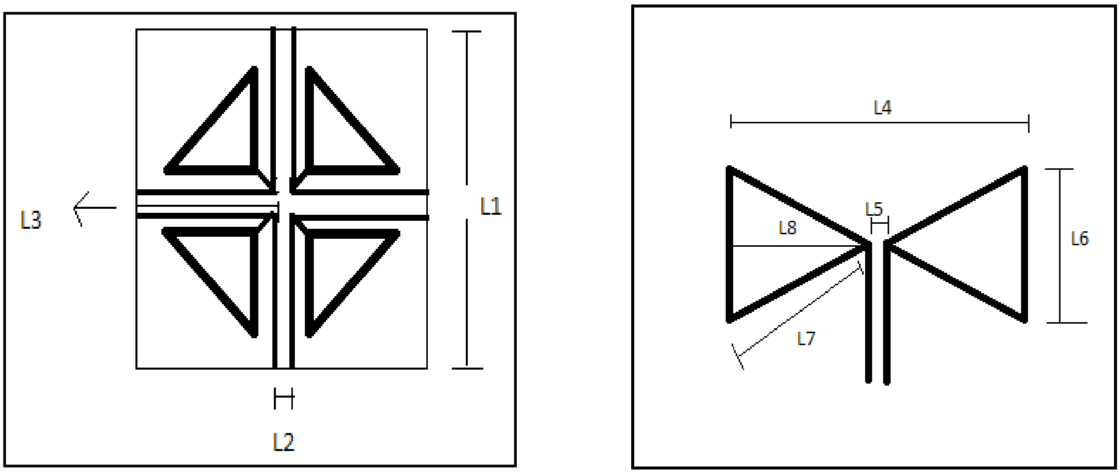


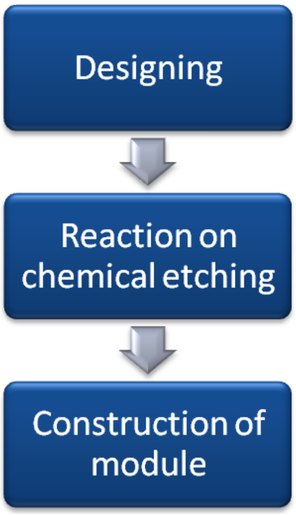
Fig.6: Various dimensions of the Bow-tie Antenna structure.

DESIGN FLOW OF THE SYSTEM:

DESIGNING: Designing of a bowtie antenna is done on a "PCB" board since it is (i) Affordable (ii) Reliable (iii) Compact. PCB is the board base for physically supporting and wiring the surface mounted and socketed components. The substrate of PCB is made of glass or Teflon or plastic or glass fiber which is used as an insulating material and to provide support to the antenna. Some antennas are having the substrate which will have effects in the radiation parameter of the antenna.

REACTION ON CHEMICAL ETCHING

- **FERRIC CHLORIDE** – $FeCl_3$ dissolves copper quickly. Therefore it is used as PCB etchant in electronics board designing. $FeCl_3$ can act as etchant since; Fe (3+) is strong oxidizer; Cl (-) is a strong complexing agent for copper (II) ions.



VIEW OF ETCHING PROCESS

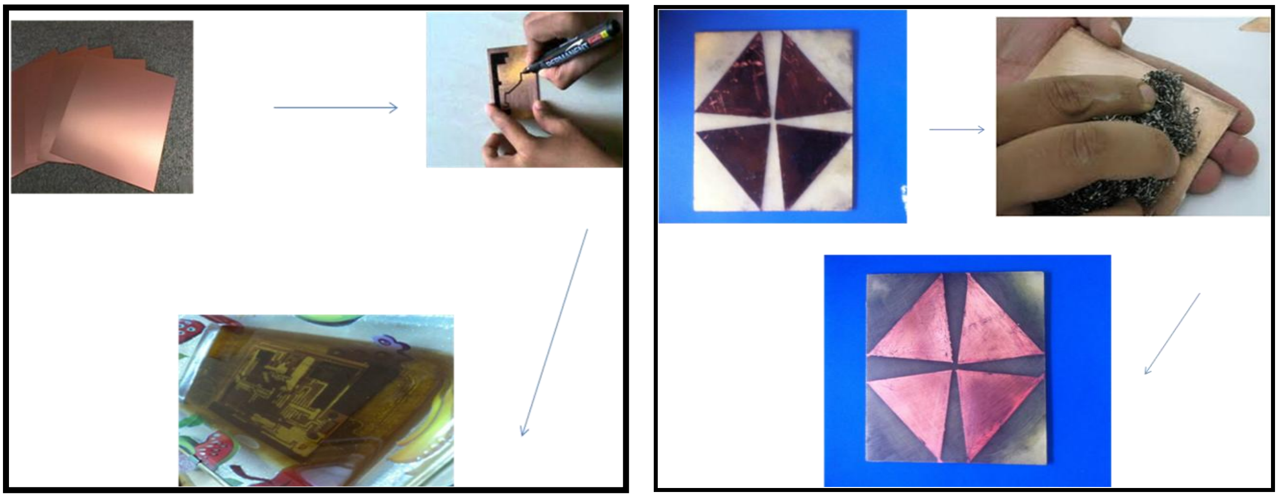


Fig.7: The Practical process of designing and chemical processing.

III. **RESULTS AND DISCUSSION: WIRELESS MONITORING TOOL & SIMULATED OUTPUT FROM CST DESIGN SUITE**

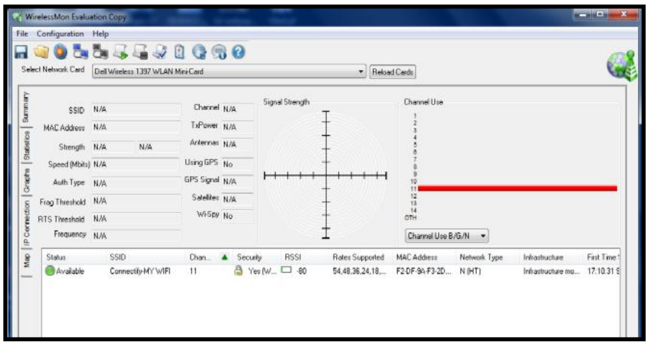


Fig.8: Simulated output of Monitoring Tool

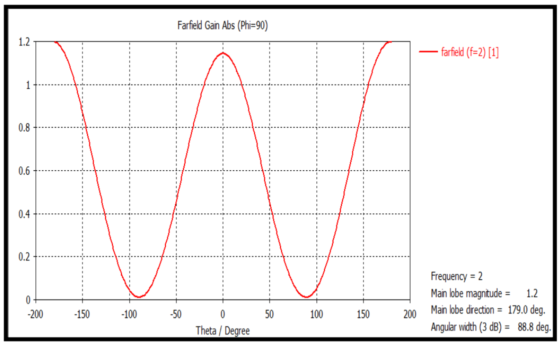


Fig.9: Simulated output of cartesian image of 2 GHz Bowtie Antenna

Simulated output of bowtie antenna and its frequency ranging from 2GHz to3GHz.this include antenna parameter.

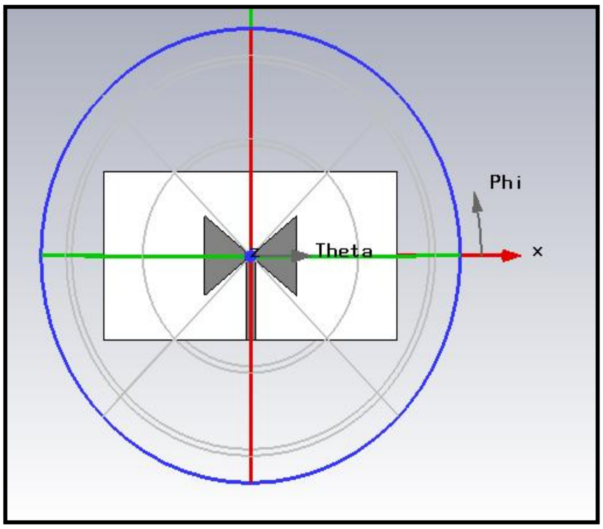


Fig.10: Simulated output of Bowtie design

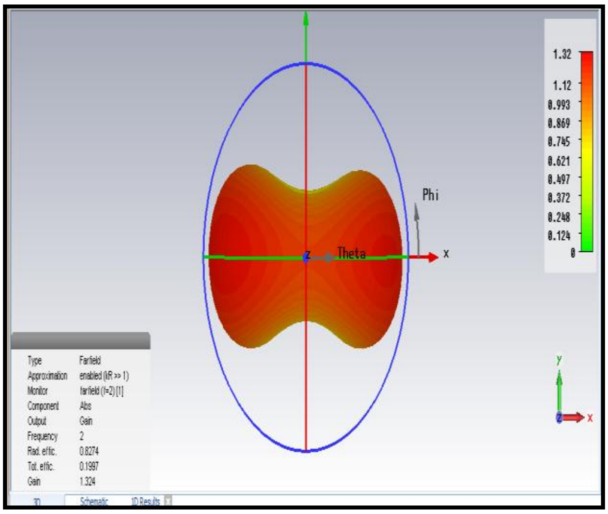


Fig.11: Simulated output of 3-D sample of 2GHz frequency

APPLICATIONS:

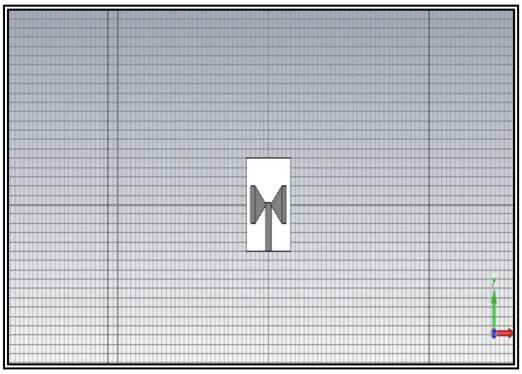
1. Used in Mobile Satellite Communication System (2.3 GHz)
2. Wireless LAN'S (2.3 GHz)
3. GPS system (2.3 GHz)
4. Can also be used for Radio Applications (5.8 GHz)

COMPARISON BETWEEN BOW-TIE AND MODIFIED BOW-TIE ANTENNA

PARAMETER	BOW-TIE ANTENNA	MODIFIED BOW-TIE ANTENNA
FREQUENCY	(2GHz)	(2GHz)
GAIN	1.289 db	-11.78 db
RADIATION EFFICIENCY	0.8205 db	-13.45 db
TOTAL EFFICIENCY	0.2517 db	-31.13 db
MAIN LOBE MAGNITUDE	1.18 db	-11.8 db
MAIN LOBE DIRECTION	178.0 deg.	8.0 deg.
ANGULAR WIDTH (3db)	88.0 deg.	89.8 deg.

I. RESULTS AND DISCUSSION:

In order to achieve our goal of building a high gain, low profile, low cost, and easy to manufacture antenna, we conducted research of high gain antennas configurations, the construction cost of these antennas, the material cost, and the man hours to build them. Reflector antennas can provide sufficient gain with the use of a plain, parabolic, or corner reflector. Aperture antennas use a waveguide and branch into an aperture which can be designed to achieve a desired high gain. Phased arrays radiation pattern can be changed by varying the phase of each/or certain radiating element. It can provide high gain but also be configured to directional high gain signals to multiple users in various directions. Micro strip antennas can provide directivity in the range of 7- 9dBi. An array of micro strip antennas can achieve considerable higher gain. Helix antenna in axial mode can produce directive radiation patterns.



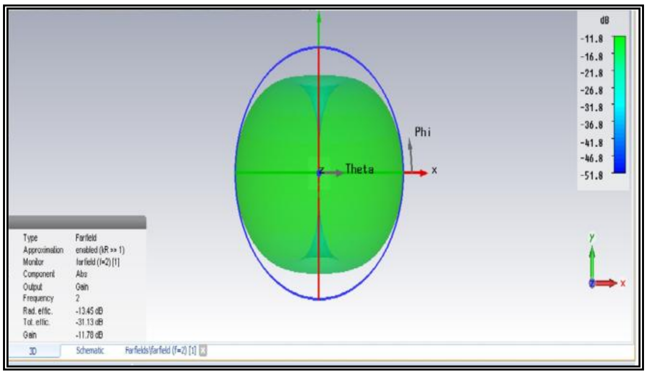


Fig.12: Far Field Image Modified of Bowtie Fig. 13: 3-D Image for 2GHz Design

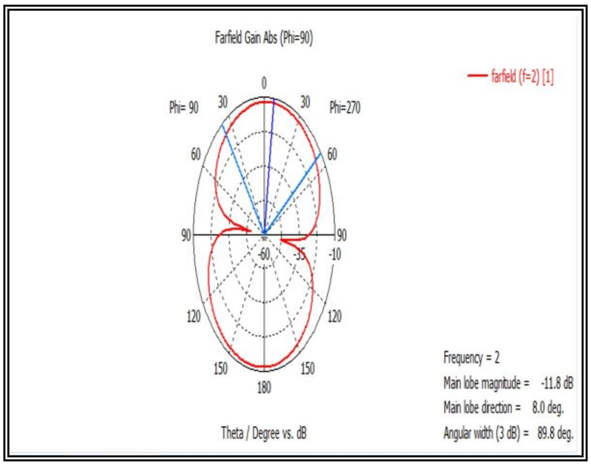


Fig.14: Polar Graph Image for 2GHz design

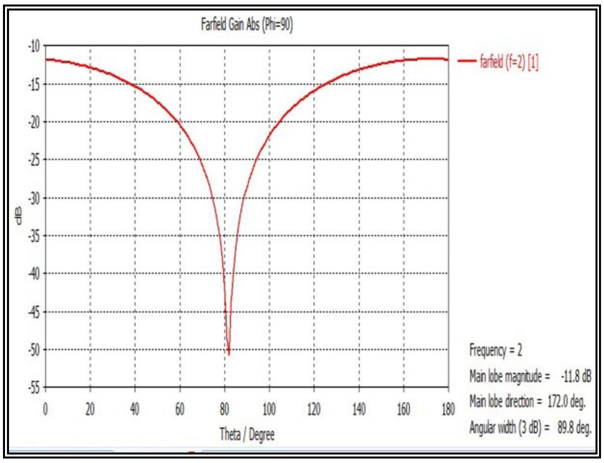


Fig.15: Cartesian Graph Image For 2GHz Design

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