DESIGN OF DUAL BAND MIMO ANTENNA FOR 5G SMARTPHONE APPLICATION

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ABSTRACT: This paper suggests a dual band MIMO antenna for the 5G connectivity. The antenna built in this letter is different from conventional 5G antenna. This paper antenna is perpendicular to the edge of the circuit board of the device it can be applied to the famous full screen cell phone. According to the simulation tests, the module's reflection coefficient is less than 6 db, and the insulation is higher than 12 db over the 3300-3600 MHz and 4800-5000 MHz frequencies which satisfy the needs of future 5G applications. This paper describes the design of printed slot antenna and prototyping on available low cost FR-4 material, fed by a microstrip line with a bandwidth enhancement pentagon slot. There are two wifi frequency bands: lower frequency wifi band at 2.4GHZ and the higher frequency wifi band at 5.8GHZ.Similarly in gps and wimax we can use this antenna. A pentagon microstrip antenna with pentagon slot is modeled and evaluated in this paper. The dielectric material FR-4 with relative permittivity of 4.4 and loss tangent (d) 0.02 was used as a substrate material for the design of the antenna proposed.The thickness of the substrate material used in the antenna proposed is 1.6mm. The technique of microstrip line feeling with patch insertion was used to feed the power to the antenna with a suitable impedance match of 50.This means full power can be transferred. The pentagon microstrip antenna with parameters for the pentagon slot has been tested for return loss (db), gain(db) and VSWR etc. The simulation tool Ansoft high frequency structure simulator (HFSS) was used for the study and simulation.

1. INTRODUCTION

The advancement of telecommunication technology has brought many challenges in the design of mobile devices in recent years, particularly in the area of antennas. For several different bands in the telecommunication network. Nowadays dual band and multi channel are among the most frequently used. Many studies have implemented dual-band and multi-band antennas for GSM, UMTS and Wifi on cell phones, but as now the LTE standard is announced and it is now important to cover frequency bands. Because of the low frequency used by this standard, it becomes a challenge to build an antenna that can work over a wider frequency band and be incorporated in a cell phone. The purposes for integrated wireless electronics have a very high demand at compact volume and wide bandwidth. Pentagon microstrip patch antennas are chosen for meeting these specifications. Pentagon patch antennas are designed for multiband applications in this project. There is an immense market for commercial applications for antennas with multiband performance attributes. The microstrip patch antenna is a single-layer system typically consisting of four parts (surface, ground plane, substratum, and feeding portion). Patch antenna can be defined as a resonant antenna with a single part. If the frequency is given, all is set (such as input impedance of the radiation pattern, etc.). The patch is a very thin radiating metal strip positioned on one side of a thin non-conductive substratum, while the ground plane is the same metal positioned on the other side of the substratum. The advantages of the microstrip antennas are small size, low profile, and lightweight, planar and non-planar surfaces compatible. When mounting it requires a very small volume of the structure. These are easy and inexpensive to manufacture using advanced circuit printing technology. The key disadvantages of the microstrip antennas are: low performance, narrow bandwidth of less than 5%, low RF strength due to the limited gap between the radiation patch and the ground plane. The purpose of a pentagon-shaped microstrip antenna was implemented to obtain multiband behavior and miniaturization. It is imperative that most networks adopting multiple wireless standards employ antennas that can cover these bands. Multiband antennas only radiate at different, distinct frequencies to match these needs. The primary design constraints of these antennas however include preserving purity of gain and radiation pattern over different frequencies. A large number of research papers focused on the design of multiband antennas, the most common techniques of which were etching slots on the radiating patch or ground plane. Steps must be taken when etching patch slots as it reduces the effective aperture of the radiation resulting in lower gain values. Patch stacking is another common strategy for adding multiple bands but at the cost of

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increasing real estate. Alternatively, the antennas can operate on the 10.5 and 12Mhz frequency bands in all mobile phone application frequency bands with a return loss of less than -10db.

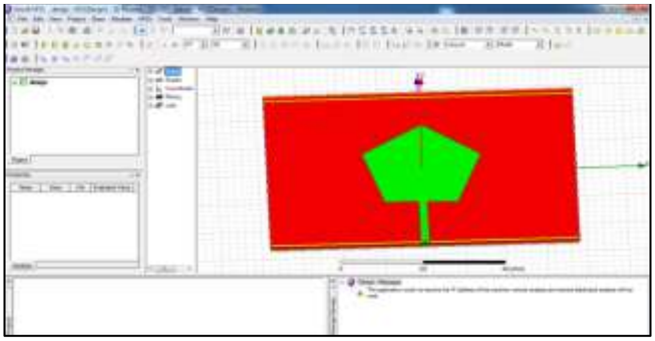


FIG 1.Pentagon shape patch antenna

2. EXISTING SYSTEM

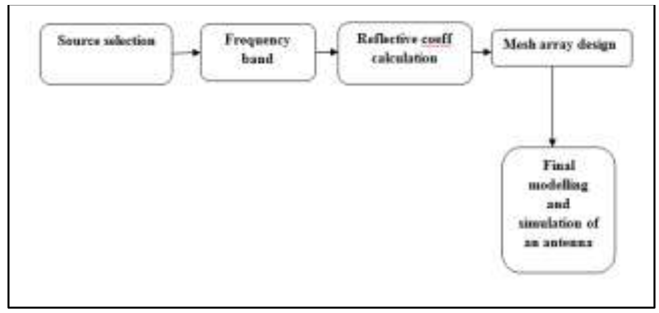
Antennas used before are capable of working in the unique application of frequency. Where quarter wavelength radiators are subjected to miniaturization that affects the creation of a small bandwidth and low efficiency in radiation. The drawbacks are less reception due to high return loss due to single patch antennas being used for each individual device.

3. PROPOSED SYSTEM

The world is moving through the age of connectivity, new technologies and apps evolving each day, linking people and artifacts. The amount of data collected is growing along with the demands of an rising innovative society, smarter and better services. The exponential increase of the number of connected devices, as well as the amount of data traffic generated, is anticipated in the coming years. The fifth generation of mobile communications, 5 G, is aimed at adapting to this technological change, offering an improvement in capability, coverage, accessibility, energy efficiency, and cost savings as opposed to the 4G. The 5 G networks would allow connectivity from the most densely populated to the most remote locations everywhere, stationary or moving, and its implementations can be grouped into three key topics with their own needs and priorities: Massive Internet of Things (IoT), Mission-Critical Services, and Improved Mobile Broadband[1-2]. Massive IoT is low-power and low-cost communications, usually includes connecting hundreds of small sensors, and has common applications in agriculture, robotics, smart homes or smart cities. Mission-critical services include high performance, low latency, high reliability and safety features and have application in autonomous vehicles, drones, and other critical applications. Enhanced Wireless Broadband applies to systems with high latency, broad coverage and quicker internet access. This is capable of operating in 4 frequency bands and as built in by one antenna, for 3 applications. Miniaturization is performed in pentagon shaped, optimistically constructed to achieve the minimum return loss over the frequency. Such as

- 1.575-1.665GHz GPS
- 2.4-2.545GHz IEEE 802.11b&g WLAN
- WiMAX 3.27-3.97GHz
- IEEE 802.11a WLAN 5.17-5.93GHz

DESIGN PROCESS



4. DESIGN THE PARAMETER OF PENTAGON PATCH ANTENNA

Micro- antenna architecture includes the resonant frequency, dielectric material and substrate height (h). The antenna proposed is for the 5.2GHz frequency band. The substratum used is FR-4 with 4.34 dielectric constant, and 1.6 mm height (h). High dielectric constant is used to minimize scale.

Step 1: Calculation of the Effective dielectric constant:

Equation (1) gives the effective dielectric constant as

$$\in \quad = \in r + 1 \div 2 (1+0.3*h) \qquad (1)$$

Step2: Calculation of the Length of Strip (Ls):

The length of the Microstrip Antenna given by the equation (2)

$$Ls = 0.42*C \div (fr * \sqrt{\in}) \qquad (2)$$

Step 3: Calculation of Width of Ground plane(Wg):

$$Wg = 1.38*C \div (fr * \sqrt{\in}) \qquad (3)$$

Step 4: Calculation of Length of Ground plane (Lg):

Here the length of the ground plane is obtained by equation (4)

$$Lg = 0.36*C \div (fr * \sqrt{\in}) \quad (4)$$

Step 5: Calculation of the Resonant Frequency (fr):

Resonant frequency (fr) is given by an equation (5),

$$fr = 3 + (2 \div \sqrt{\in})\{ (21 \div Ls) + (65 \div Wg) + (18 \div Lg) - 3\} \quad (5)$$

4.1 PARAMETERS CALCULATED BY THE ABOVE FORMULAE:

Length of the pentagon	12mm
Width of the pentagon	9.06mm
Length of the ground	24mm
Width of the ground	32mm
Length of the substrate	24mm
Width of the substrate	32mm
Length of the strip	9mm
Width of the strip	1.6mm

Table 1. Parameters

5. SOFTWARE DESCRIPTION

5.1 ANSOFT HFSS SOFTWARE:

The antenna is conceived and simulated in the design program of ANSOFT HFSS. HFSS is a commercially available finite element solver system for electromagnetic structures. The acronym originally stood for structural simulator with high frequency. It is one of many commercial devices used to design antennas, and design complex RF electronic circuit elements including filters, transmission lines, and packaging. HFSS provides reliable and effective computational methods for the design and study of electromagnetics. Our 3D EM simulation program is user friendly and helps you to pick the most method for designing and optimizing systems that work at a wide range of frequencies. It is based on the Finite Element Method (FEM). FEM originates from the field of structural analytics. This is a numerical technique which is more efficient and adaptable for managing programs involving complex 24 geometry. FEM is a computational method in mathematics for finding approximate solutions to problems with limit value. This uses variational methods (variation calculus) to reduce an error function and generate a steady solution. As we know that joining several tiny straight lines can approximate a larger circle, FEM includes all methods to connect several simple equations of elements over many small subdomains, called finite elements, to approximate a more complex equation over a larger domain. FEM analysis of any issue essentially includes four steps: Passive microwave and RF system design is a major application of ANSOFT HFSS and supporting it is one of the core competencies of ANSOFT HFSS. ANSOFT HFSS MWS provides a wide variety of solver technologies, working in both the time and frequency domain and able to use surface mesh as well as Cartesian and tetrahedral volume mesh. An antenna array helps one to achieve high gain with several radiating components and additionally a phased array provides the possibility of shaping and guiding the beam without altering the configuration of the array.

6. DESIGN PROCEDURE FOR THE SIMULATION:

There are six main steps to create and solve a proper ANSOFT HFSS simulation. They are

1. Create model/geometry

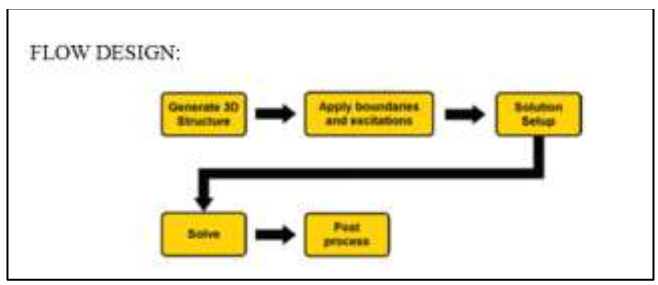
2. Assign boundaries

3. Assign excitations

4. Setup the solution

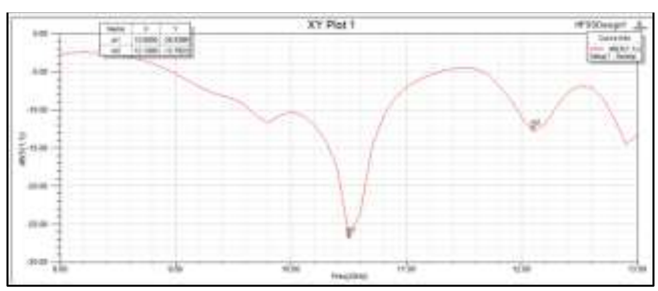
5. Solve

6. Post process the results



7. SIMULATION RESULT

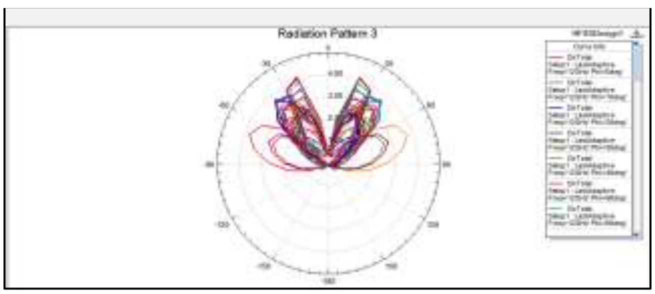
7.1 RETURN LOSS



The loss of return is another way of communicating imbalances. It is a logarithmic ratio expressed in dB, relating the power the antenna reflects to the input fed from the transmission line into the antenna. The simulated return loss results for the 8 to 13GHz frequency range are shown in figure above. From the return loss curve, the operating frequencies are obtained between a bandwidth of 10GHz to 11GHz and 11.5GHz to 13 GHz. Resonant frequencies obtained are 10.5GHz and 12.1GHz.

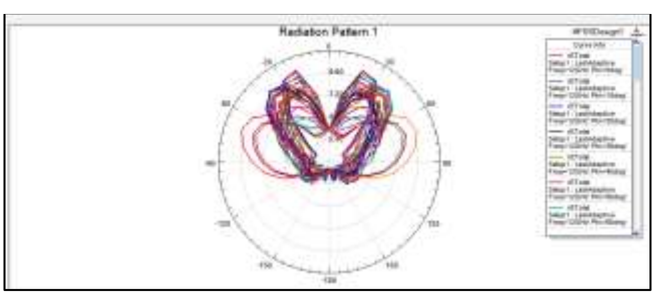
7.2 DIRECTIVITY

Directivity is the ratio between intensity of radiation of an antenna in a particular direction to the intensity of an antenna along all directions. The directivity of the proposed antenna is found to be 4db.

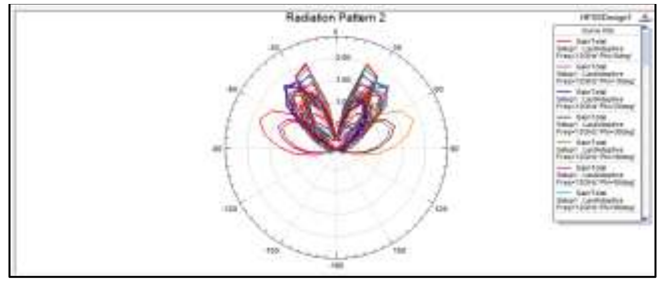


7.3 RADIATION PATTERN

An antenna's radiation pattern is a plot of an antenna's far-field radiation properties as a function of the spatial co-ordinates defined by the angle of elevation (A) and the angle of azimuth (A). More simply it is a power plot radiated from an antenna per solid unit angle which is nothing but the force of the radiation. This 3D graph can be plotted as a 3D line, or as a 2D polar or cartesian slice. This is an extremely parameter, because it indicates the directivity of the antenna as well as gain in space at different scales. The proposed antenna is found to have radiation pattern at 9.06 db.

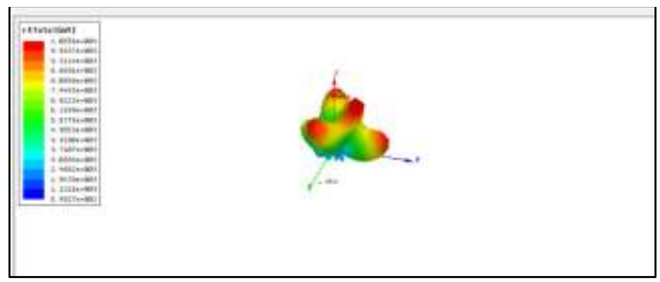


7.4 GAIN



This the gain obtained for proposed antenna which has to be found nearly 2dB.

7.5 3D VIEW OF RADIATION PATTERN



8. CONCLUSION

Through the simulation outcome of the pentagon patch antenna microstrip, we get the frequency band at 10GHz to 11GHz and 11.5GHz to 13GHz in dual band frequencies. And the resonant frequencies are at GHz 10.5 and GHz 12.01. Return losses are equally measured at -26.8 dB at 10.5GHz and -12.7 dB at 12.1 GHz. In smartphone applications and X-band applications, this type of antenna can be used efficiently

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NOVEL MINIATURIZED KOCH PENTAGONAL FRAC-TAL ANTENNA FOR MULTIBAND WIRELESS APPLI-CATIONS

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