Design and Development of 4X4 Fractal MIMO Antenna for Wi-Fi Application

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Abstract— With the advent of practical implementation of multiple input multiple output technology, several constraints have come into picture, one of them is to define strategies to place multiple antennas on transmitter and receiver side in such a way, that they provide least interference with each other. The locations, at which the antennas are to be placed, are not always suitable to place multiple antennas at desired positions. To overcome this problem, MIMO antennas with low vertical beamwidth are designed and placed strategically inside a single radome. This solves the problem of placement of antennas to a great extent. (A. Ismahayati, P.J. Soh, R. Hadibah, G.A.E Vandenbosch). In this thesis to design such antenna, firstly a dual band microstrip antenna is designed which radiates efficiently in both the WLAN bands. This antenna is designed using a copper sheet of 0.5mm thickness. The dual band characteristics are achieved by cutting two slots in the sheet to create two dipoles, one for each frequency band. (Ahn, J., Kim, S., Lee, M., and Kim, Y.). This type of antenna solves the problem of location constraint, which is faced when multiple antennas are to be placed at transmitter and receiver side in such a way, that they provide least interference with each other. The locations, at which the antennas are to be placed, are not always suitable to place multiple antennas at desired positions. To overcome this problem, high gain MIMO antennas can be used which are capable of accepting input from multiple sources without causing interference with each other. This solves the problem of placement of antennas to a great extent. (Alhaddad, A.G., Abd-Alhameed, R.A., Zhou, D., See, C.H., Elfergani, I.T.E., Excell, P.S.). The aim of the research undertaken in this thesis is to develop a high gain fractal antenna which is able to cater with the needs of future communication standards for high data rates and reliable performance at the same time. The developed antennas solve the problem of location constraints of placing multiple antennas in a MIMO system. (Amer Basim Shaalan).

Keywords: 4X4 Fractal MIMO Antenna, Wi-Fi Application

I. ANTENNA DESIGN

The metal plate dual band antenna is designed using a thin copper sheet. To design a dipole antenna, the design should be symmetric at both sides from center. In addition, the sum of length and breadth of each radiating arm should be equal to quarter or half wavelength of the operating frequency. In accordance with this fact, there should be two uneven arms acting as radiating arms. The dual band dipole antenna is thus designed using a copper strip having dimensions 39.5 mm (length) x 9.75 mm (width) x 0.5 mm (thickness) as shown in Fig. The center portion of the strip is shorted with a strip. Two L- slots are cut into both the arms to create two radiating dipole arms. Dimensions of the two dipole arms are adjusted to 15.25 mm (length) x 1.85mm (width) and 13.25 mm (length) x 4.25 mm (width) for optimal performance. The antenna is fed using a SMA connector, connected to a 50Ω coaxial cable. (B.B. Mandelbrot)

The antenna design is solved by CADFEKO using Method of Moments (MoM) numerical method. The module which solves the antenna design is called FEKO solver. After the FEKO solver has completed its processing. POSTFEKO is used to view the results. (B.L. Ooi)

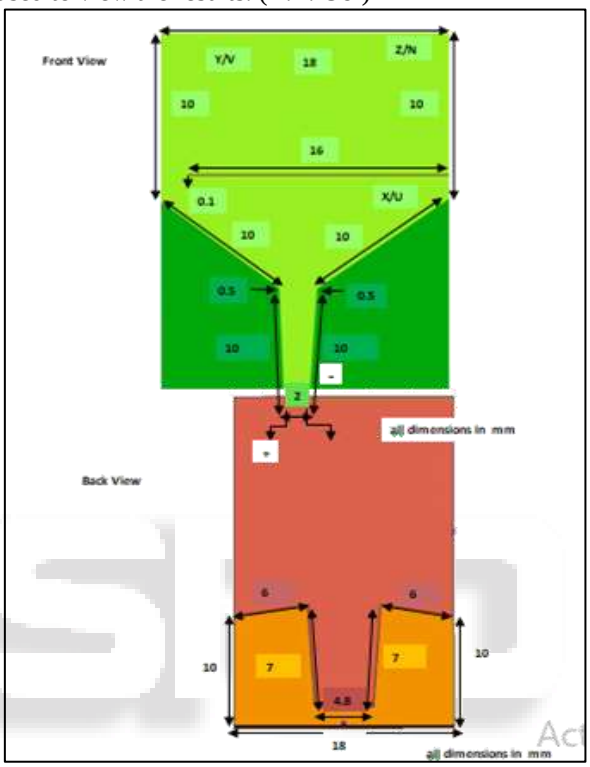

Fig. 1: Proposed Antenna Design

II. ANTENNA FABRICATION

Fig. 2: Proposed Antenna

It acts as a transitional structure between the transceivers and the free space. Officially according to the Institute of Electrical and Electronics Engineers definition of antenna follows that it is that part of a transmitting or receiving system that is designed to radiate or receive electromagnetic waves which is given by Stutzman and Thiele. In other words, antenna is an interface for electromagnetic energy, which

propogates between free space and guided medium (Balanis, 2009). A rectangular micro-strip patch antenna is a type of radio antenna with a low profile which can be mounted on a flat surface. Mobile phone handsets are generally required to be small in size. LTE (Long Term Evolution) is the trademarked project name of a high performance air interface for cellular mobile telephony. It is a project of the 3rd Generation Partnership Project. LTE is the latest in the mobile network technology that ensures competitive edge over its existing standards such as Global system for mobile communication, Universal Mobile Telecommunication Switching etc. It improves user experience with full mobility. LTE minimizes the system and user equipment complexities. (C. puente, j. Romeu, R. Bartoleme, and R. pous)

A. Antenna Theory

In order to know how an antenna radiates, let us first consider how radiation occurs. A conducting wire radiates mainly because of time varying current or an acceleration (or deceleration)of charge. If there is no motion of charges in a wire, there is no flow of current and hence no radiation will occur. Radiation will not occur even if charges are moving with uniform velocity along a straight wire. However, charges which flow with uniform velocity along a curved or a bent wire will all produce radiation. If the charge is oscillating with time then radiation will occur along a straight wire (Balanis, 2009). Antenna (radio), also known as an aerial, a transducer designed to transmit or receive electromagnetic (radio) waves. Television antenna, is an antenna specifically designed for the reception of broadcast television signals. Antennae Galaxies, the name of two colliding galaxies 4038 and 4039. Antenna (biology), one of one or more pairs of appendages used for sensing in arthropods, also applied to cilium structures present in most eukaryote cell types. (C. Puente, j. Romeu, R. pous and A. Cardama)

III. RESULTS

Figures show the measured radiation pattern of the antenna on Virtual Network Analyzer. The VNA used for measurement is Anritsu make VNA Master MS2025B. The frequency range of VNA is 500 KHz – 6 GHz. The fig. reveals that the measured radiation pattern is in accordance with the simulated radiation pattern. Return loss of -10dB is obtained for both frequency bands. For lower band, the minimum value of return loss is -9.2936 dB at 2.400 GHz and for upper band, it is -25.914 dB at 2.488 GHz. (C. Puente, J. Romeu, R. Pous, J. Ramis, and A. Hijazo)

To manufacture the required MIMO sector antenna, first of all an elementary metal plate dual band antenna is fabricated which radiates efficiently at required frequency bands of WLAN standard. Using this antenna, two designs of fractal antennas are created. Four sections of these fractal antenna designs are then placed inside a single radome to create the required 4 port MIMO fractal antenna. (D.D. Krishna, M. Gopikrishna, C.K. Aanandan, P. Mohanan, and K. Vasudevan)

Fig. 3: VNA Testing of Proposed Antenna

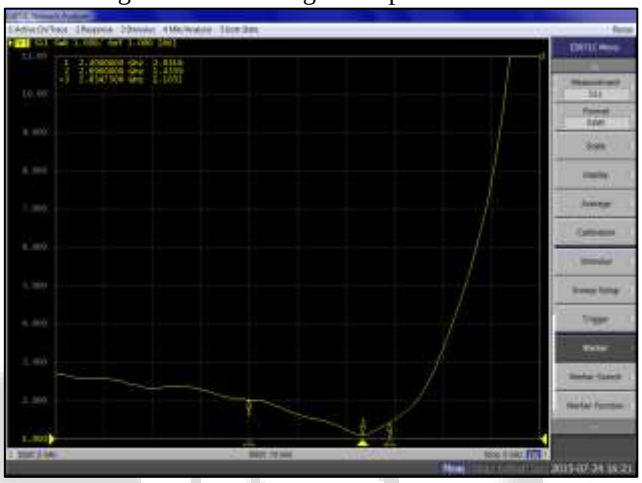

Fig. 4: Measured VSWR vs. frequency curve on VNA

Fig. 6: Measured return loss vs. frequency curve on VNA

IV. CONCLUSION

In this thesis, a dual band MIMO antenna with 4 ports is designed, that works on IEEE 802.11a/b/g/n frequency bands. These bands are specified for WLAN applications and the frequency of operation in these bands is 2400MHz-2488MHz. To design such antenna, firstly a dual band microstrip antenna is designed which radiates efficiently in both the WLAN bands. This antenna is designed using a copper sheet of 0.5mm thickness. The dual band characteristics are achieved by cutting two slots in the sheet to create two dipoles, one for each frequency band.To create

the microstrip antenna, the microstrip antennas are then strategically placed in front of a reflector to generate the desired radiation pattern.

However, there is some disagreement in theoretical and practical VSWR values for both the microstrip antenna, which can be attributed to calibration mismatch between VNA and the antenna. The desired 4 port MIMO microtsrtip antenna can be designed by arranging four units of the individual antenna sections inside one radome. Since the size of both types of sector antennas is reasonably small, it permits to place 4 such sections inside a single radome with sufficient gap. Also, the low vertical beamwidth prevents interference of radiations from individual antennas.

This type of antenna solves the problem of location constraint, which is faced when multiple antennas are to be placed at transmitter and receiver side in such a way, that they provide least interference with each other. The locations, at which the antennas are to be placed, are not always suitable to place multiple antennas at desired positions. To overcome this problem, high gain MIMO antennas can be used which are capable of accepting input from multiple sources without causing interference with each other. This solves the problem of placement of antennas to a great extent.

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