International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
ISSN: 2457-0362

DESIGN OF A BROADBAND SLOTTED MIMO ANTENNA FOR VARIOUS APPLICATION

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Abstract
Multiple-input-multiple-output (MIMO) is an efficient technique for improving the reliability and channel capacity of wireless communication systems However, when the space for antenna installation is limited, the strong mutual coupling between each antenna element decreases the channel capacity and radiation power. In the case when patches are used as the elements of MIMO antennas, if the element separation is much less than 0.5λ0, where λ0 is thefree-space wavelength at its resonant frequency, Mutual coupling effect occurs. This coupling effect results in substantial degradation in performance. Various methods have been studied to suppress the mutual coupling in the E-plane and H-plane between patch elements. In this project, the patch and ground plane of antenna contain slots such that it can be used for wide range of frequencies This broadband slotted MIMO antenna will be used for various applications like WIFI, BLUETOOTH, LTE BANDS, WIMAX and ISM BAND.

Keywords: Computer Vision for Other Robotic Applications, Localization, Semantic Scene Understanding.

Introduction

1 HISTORY OF ANTENNAS

• In the 1890s, there were only a few antennas in the world. These rudimentary devices were primarily a part of experiments that demonstrated the transmission of electromagnetic waves. By World War II, antennas had become so ubiquitous that their use had transformed the lives of the average person via radio and television reception. The number of antennas in the United States was on the order of one per household, representing growth rivaling the auto industry during the same period.

• By the early 21st century, thanks in large part to mobile phones, the average person now carries one or more antennas on them wherever they go (cell phones can have multiple antennas, if GPS is used, for instance). This significant rate of growth is not likely to slow, as wireless communication systems become a larger part of everyday life. In addition, the strong growth in RFID devices suggests that the number of antennas in use may increase to one antenna per object in the world (product, container, pet, banana, toy, cd etc.). This number would dwarf the number of antenna sin use today. Hence, learning a little (or a large amount) about of antennas could not hurt, and will contribute to one's overall understanding of the modern world.

1.2 Antennas

Antennas are the basic components of any electric system and are connecting the

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A peer reviewed international journal www.ijarst.in
ISSN: 2457-0362

transmitter and receiver through space as the communicating medium. They play a vital role in wireless communications. An antenna (or aerial) is an electrical device which converts electric currents into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter applies an oscillating radio frequency electric current to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified. An antenna can be used for both transmitting and receiving

1.2.1 Definition of Antenna

An antenna is a metallic structure that sends or receives electromagnetic waves such as radio waves. In other words, antennas convert radio frequency fields into electrical current. An antenna (or aerial) is an electrical device which converts electric currents into radio waves, and vice versa. Antennas are essential components of all equipment that uses radio. They are used in systems such as radio broadcasting, broadcast television, two-way radio, communications receivers, radar, cell phones, and satellite communications, as well as other devices such as garage door openers, wireless microphones, and Bluetooth enabled devices. Antennas were used for the first time, in1889, by Henrich Hertz (1857- 1894) to prove the existence of electromagnetic waves predicted by the theory of James Clerk Maxwell.

- There is a wide variety of antenna structures allowing operation on just one band, narrow band antennas, or several bands, known as multiband or broadband antennas. Narrow band antennas include not only single dipoles or verticals but also directive arrays. Such arrays have high gain and directivity to make the antennas more efficient to a certain direction. With these antenna signals coming from the back will be rejected due to its front to back ratio, this is the ratio of the maximum directivity of an antenna to its directivity in the opposite direction. Yagi-Uda antenna, developed by Dr. HidetsuYagi and Dr. Shintaro Uda is the commonest directive antenna in the world.
- The important properties of an antenna are the Radiation pattern, Radiation
- Intensity, Polarization, Gain, Directivity, Power gain, Efficiency, Effective Aperture or area, Self and Mutual inductance, Return loss, Mutual coupling, Bandwidth etc. Reduced ambiguity and improved reliability.

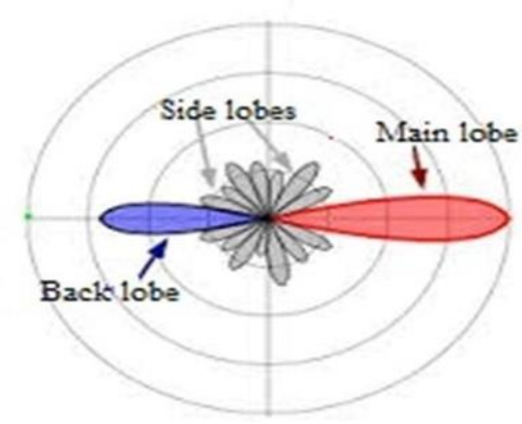

Fig.1.2 Basic Radiation Patterns with Major and Minor Lobes

1.2.2 Radiation Pattern

Radiation intensity is defined as “Power per unit solid angle.” This parameter is used to define directivity, power gain and antenna gain. In electromagnetism, radiation intensity describes the power density that an antenna creates in a solid angle. A solid angle is a section of the surface of the imaginary sphere around the antenna.

Given an antenna's power density P, radiation density is calculated by multiplying it with the square of the distance (r2) from the antenna to the designated solid angle:

U = Pr2 ……………………………(1.16)

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This is so because unlike power density, radiation intensity does not depend on distance: because radiation intensity is defined as the power through a solid angle, the decreasing power density over distance (i.e., over r2 of the imaginary sphere around the antenna) due same law. Therefore, power density can be converted to radiation intensity by multiplying it with r2.

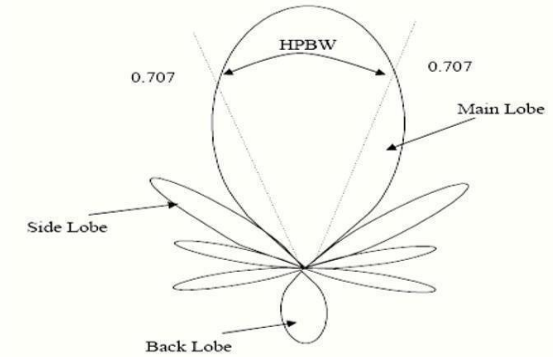

Fig.1.2 Radiation Pattern and 3dB Beam Width

With the great advances of communication systems, the emerging Internet of things (IOT) has been widely used in many fields including the medical health services, the environment monitoring and the manufacturing industry. An enormous information network can be established by IOT based on various sensing devices such as the radio frequency identification devices, wireless sensors, global positioning systems and other electronic equipment. The low-power sensing devices can be found almost everywhere with the popularity of the IOT, which requires a large amount of maintenance cost caused by the recharging or replacement of the battery [4]. Additionally, the devices are supposed to be portable and self-sustainable in most cases, thus wireless power charging is urgently required.

2. Proposed Method

High Frequency Structure Simulator (HFSS) is used for design and simulation of Microstrip Patch Antenna Array. In this chapter the simulated results of single Microstrip Antenna is explained first and followed by MIMO Antenna. The results obtained in present work conclude that the designed Antenna is efficient from the Antenna parameters like return loss, VSWR and Radiation pattern. The Antenna parameters measured below are

Return loss: The return loss is another way of expressing mismatch. It is a logarithmic ratio measured in dB that compares the power reflected by the antenna to the power that is fed into the antenna from the transmission line. The relationship between SWR and return loss is the following

VSWR: The VSWR is basically a measure of the impedance mismatch between the transmitter and the antenna. A practical antenna design should have an impedance of either 50 ohm or 75 ohms since most radio equipment's built for this impedance.

Radiation Pattern: The radiation pattern of an antenna is a plot of the far field radiation properties of an antenna as a function of spatial coordinates which are specified by elevation angle θ and azimuth angle ϕ. Most specifically it is a plot of the power radiated from an antenna per unit solid angle.

Bandwidth: The bandwidth of an antenna refers to the range of frequencies over which the antenna can operate correctly.

Gain: The term Antenna Gain describes how much power is transmitted in the direction of peak radiation to that of an isotropic source.

Radiation Efficiency: The efficiency of an antenna relates the power delivered to the antenna and the power radiated or dissipated within the antenna.

ECC: Envelope Correlation Coefficient tells us how independent two antennas radiation patterns are.

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TARC: The Total Active Reflection Coefficient relates the total incident power to the total outgoing power in an N-port microwave component.

Simulated results of single antenna:
The obtained final design of single antenna is shown in Fig.8.1

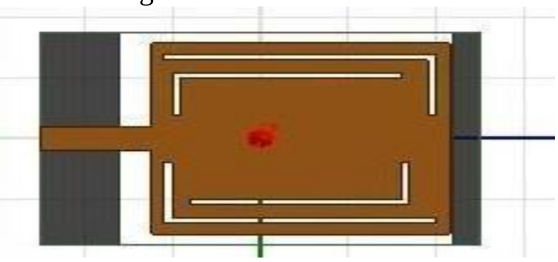

Fig.8.1 Final Design of Single Antenna

Return loss:
After simulation the obtained return loss is -34.56dB at 3.12GHz and obtained bandwidth range is 2.07GHz-3.54GHz as shown in Fig.8.2.

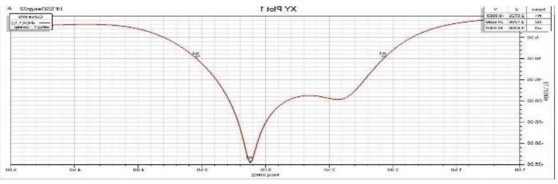

Fig.8.2 Return Loss of Single Antenna

Radiation efficiency:
After simulation the maximum radiation efficiency obtained is 98.29% in the required bandwidth as shown in Fig.8.3.

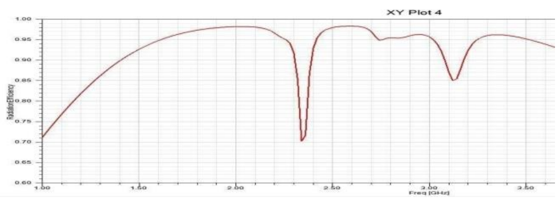

Fig.8.3 Radiation Efficiency of Single Antenna

VSWR:
The obtained VSWR ranges from 1.03 to 1.6 which is in the acceptable range of 1 to 2 as shown in Fig.8.4

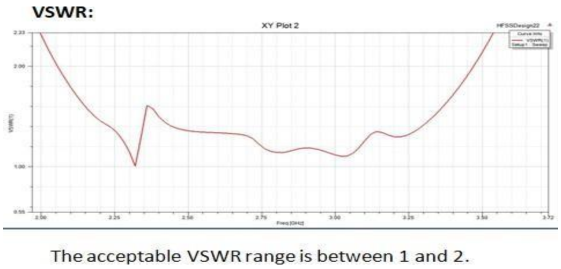

Fig.8.4 VSWR of Single Antenna

Radiation Pattern:

The obtained radiation pattern is omni-directional as shown in Fig.8.5.

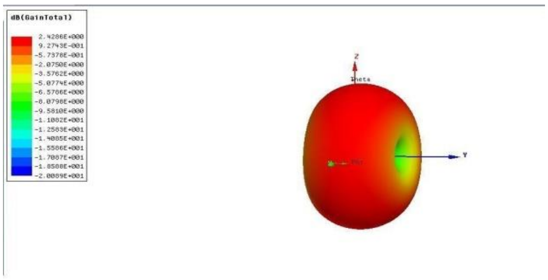

Fig.8.5 Radiation Pattern of Single Antenna

Simulated results of MIMO antenna:
The obtained final design of MIMO Antenna is shown in Fig.8.7

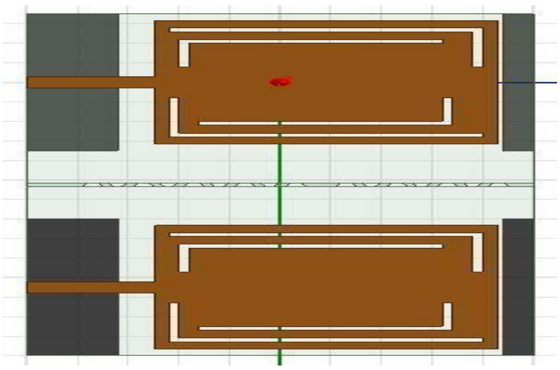

Fig.8.7 Final Design of MIMO Antenna

BANDWIDTH:
After simulation the obtained bandwidth for MIMO Antenna is 1.11GHz(2-3.11GHz) and return loss is -23dB as shown in Fig.8.8.

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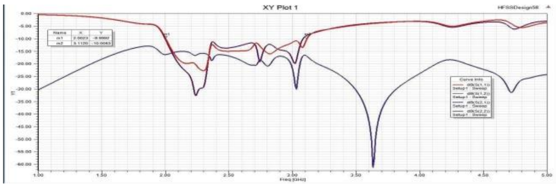

Fig.8.8 Bandwidth of MIMO Antenna

VSWR:
After simulation the obtained VSWR ranges from 1.05 to 1.8 as shown in Fig.8.9.

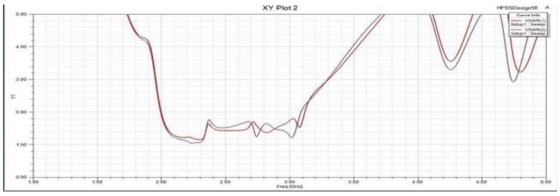

Fig.8.9 VSWR of MIMO Antenna

RADIATION EFFICIENCY:
After simulation the obtained maximum radiation efficiency is 97% as shown in Fig.8.10.

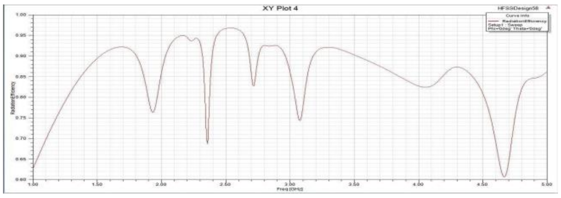

Fig.8.10 Radiation Efficiency of MIMO Antenna

3D RADIATION PATTERN:
After simulation the obtained 3D radiation pattern of MIMO antenna as shown in Fig.8.12.

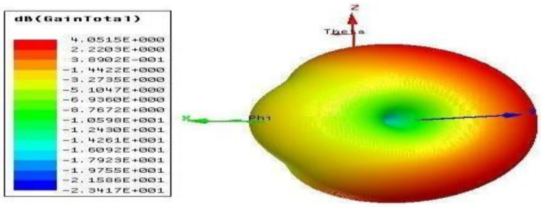

Fig.8.12 3D Radiation Pattern of MIMO Antenna

E AND H PLANE REPRESENTATION:

After simulation the obtained 2D radiation pattern of MIMO antenna is shown in Fig.8.13.

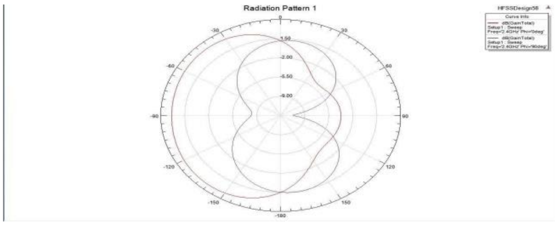

Fig.8.13 2D Radiation Pattern of MIMO Antenna

ECC:
After simulation the obtained ECC is 0.1639 as shown in Fig.8.14

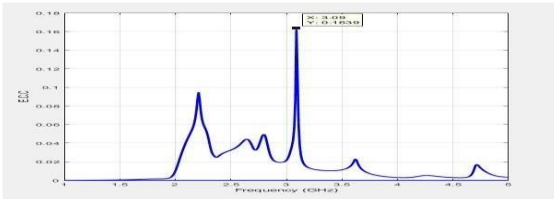

Fig.8.14 ECC of MIMO Antenna

TARC:
The obtained TARC is shown in Fig.8.15 which is less than -15dB in the required bandwidth.

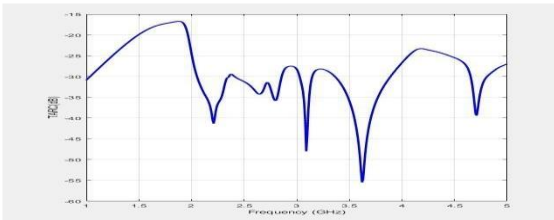

Fig. 8.15 TARC of MIMO Antenna

V. CONCLUSION
The broadband MIMO antenna with L shaped and inverted L shaped slots has been designed for various applications like Bluetooth, WIFI, WIMAX, ISM band and LTE bands. In this design initially, a single antenna has developed, in which we have obtained the better characteristics like gain, bandwidth, return loss, VSWR when compared with the considered base paper. Further it has improvised to MIMO by placing a parasitic element as mutual coupling reduction technique. The obtained results have been presented.

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