Design of Rounded Bowtie Antenna for Indoor Applications

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Abstract: ***In wireless communication a broadband signaling method is one that handles a wideband of frequencies. The wider the bandwidth of a channel, the greater the information carrying capacity given the same channel quality. At present there is increase in demand for several wireless applications which increases the number of antennas per system typical antennas are designed for specific narrowband of operation. Broadband antennas are designed to operate effectively over a wide range of frequencies. In this paper MIMO antenna which is compact is designed operating at a frequency is designed. The antenna is fed by a co-axial cable that makes matching easier. The designed antenna can be used for applications like GSM1900, DCS1800, UMTS2000, Bluetooth, microwave oven, WLAN, and some of the LTE bands.***

Keywords: MIMO, Broadband, Bandwidth, WLAN, GSM

1. Introduction

Multiple Input Multiple Output **(MIMO)** wireless systems characterized by multiple antenna elements at the transmitter and receiver have demonstrated the potential for increased capacity in rich multipath environments. For many years base stations antenna have been modified in one way or the other to optimize the transmission or reception of the signals. Multiple antenna elements may be used to shape beams and steer nulls in one direction or another. Such systems operate by exploiting the spatial properties of multipath channel there by offering a new channel dimension which can be used to enable enhanced communication performance. Traditionally, wireless communications were used for voice and small data transfers while most of the high-rate data transfer products used wired communications. However in the recent years wireless multimedia applications, such as cell phones having an integrated camera, emailing capability and GPS have been increased. As a result there are more requirements for wireless high speed data transfers which traditional antennas are not capable of multipath fading effect has to be dealt with. Hence multiple input multiple output antennas are used to reduce the error rate as well as to improve the quality and capacity of a wireless transmission.

2. Literature Survey

Various techniques have been studied to improve the bandwidth of the MIMO antenna. Conventional microstrip antennas have a conducting patch printed over a grounded dielectric substrate and operate as resonant cavity elements.

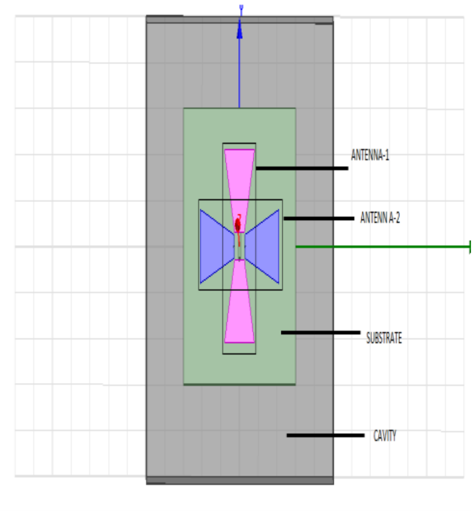
This operation leads inherently to narrow impedance bandwidth which is barrier for microstrip antenna application. Bowtie antenna is well known for its multiband performance. The application of curved ends allows as to improve the impedance matching. The bowtie antennas are attractive due to their compact nature when compared to rectangular patches. To achieve multiple frequency we can etch multiple slots in the printed patch[1], [6].Bowtie shaped slot has broader bandwidth response when compared to narrow rectangular slot [2].By modifying the edge of the aperture bowtie antenna the impedance bandwidth the of the antenna can be improved [3].By changing the instantaneous surface current distribution of resonance mode the multiple frequency performance can be achieved [4].In [5] it is seen that a patch loaded with u shaped slot can provide impedance bandwidth in excess of 30% for an air substrate and in excess of 20% for material substrate. By slit cutting at the boundaries, instead of slot cutting on the surface, of the patch, similar broadband operation can be obtained. [7].

3. Problem Identification

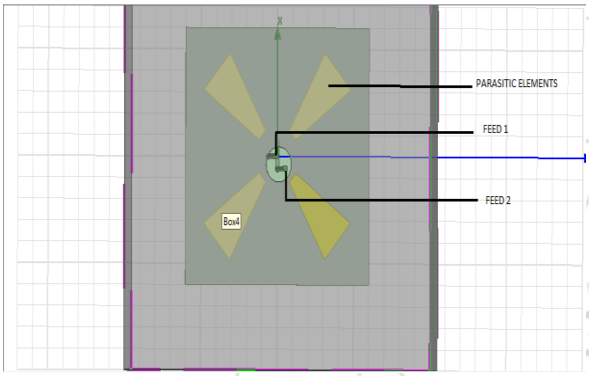
At present there is increase in demand for several wireless communications which increases the number of antennas per system. Typical antennas are designed for a specific narrow band of operation. Broadband antennas are designed to operate effectively over a wide range of frequencies.In wireless communication a broadband signalling method is one that handles a wide band of frequencies. The challenge is to create an antenna that can operate at wide range of frequencies. To provide steadier wireless communication services regardless of place and to provide improved performance the demand for high channel capacity and wider coverage has rapidly increased.For indoor base stations or repeaters covering various mobile wireless communication systems, such as DCS/PCS/UMTS/LTE bands, the most important recent issue is how to design compact multiband MIMO antennas with a low cost and how to obtain good isolation between closely spaced MIMO antenna elements where antennas must be designed within a small volume.

4. Antenna Design

Two different configuration of bowtie antenna is designed in this paper. First one is conventional bowtie antenna with wide rectangular part and second one is the rounded bowtie antenna. The antenna is designed with the FR-4 substrate whose dielectric constant is 4.3. The overall dimension of the substrate is 60x60x1.2. The height of the dielectric substrate is 1.2mm. Flare angle is 45˚ which is defined as the angle within the metal sheet. The antenna is design using ANSYS HFSS.



(a)



(b)

Structure of the conventional bowtie antenna with wide rectangular part.(a) Top view (b) Bottom view.

Here the bowtie antennas are placed orthogonal to each other. The bowtie antennas with wide rectangular part are excited by using two co-axial feeds. The inner conductor of the Co-axial feed extends through the dielectric and is soldered the one arm of the bowtie antenna. The outer conductor of the co-axial cable is connected to the other arm of the bowtie antenna. The parasitic elements are added at the backside of the substrate in order to reduce cross polarization and to produce high isolation. The antenna is backed by a metallic cavity. Cavities can suppress surface waves and mutual coupling in thick substrates and act as heat sinks in a high-powered large transmit array. Gain and radiation patterns can be changed significantly by placing the patch antenna into a cavity enclosure and changing the shape of the enclosure. The overall dimension of the cavity includes (100X100x40).

Table 1: Shows the design specifications of the l rectangular wide bowtie antenna.

Design Parameter	*Value*
Arm length of the bowtie	18
Length of the wide rectangular part of the bowtie	16
Width of the wide rectangular part of the bowtie	2
Bottom width of the bowtie	5.2
Length of the parasitic element	21
Top width parasitic element	12
Bottom width of the parasitic element	3

5. Simulated Results Using ANSYS HFSS

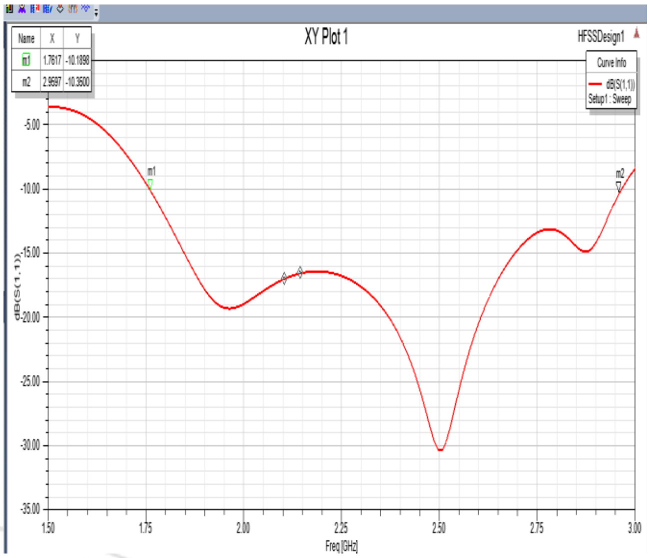


Figure 2: The return loss is below -10 db for the frequency range 1.7617-2.9597.Hence it is clear that the antenna operates at a wide range of frequency.

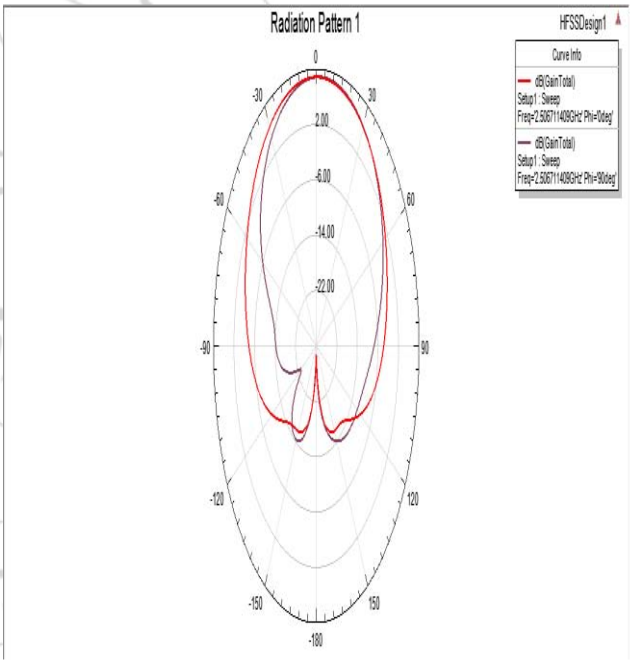


Figure 4: Shows the radiation pattern in terms of gain at 2.5 GHz.

From the results obtained above it is seen that the bandwidth of the antenna obtained is 118%.The bandwidth of the antenna can be slightly improved by using rounded bowtie antenna. The structure of the rounded bowtie antenna is shown below. The dimensions of the rounded bowtie antenna is same as the conventional antenna except that the edge of the bowtie are curved to form the rounded bowtie.

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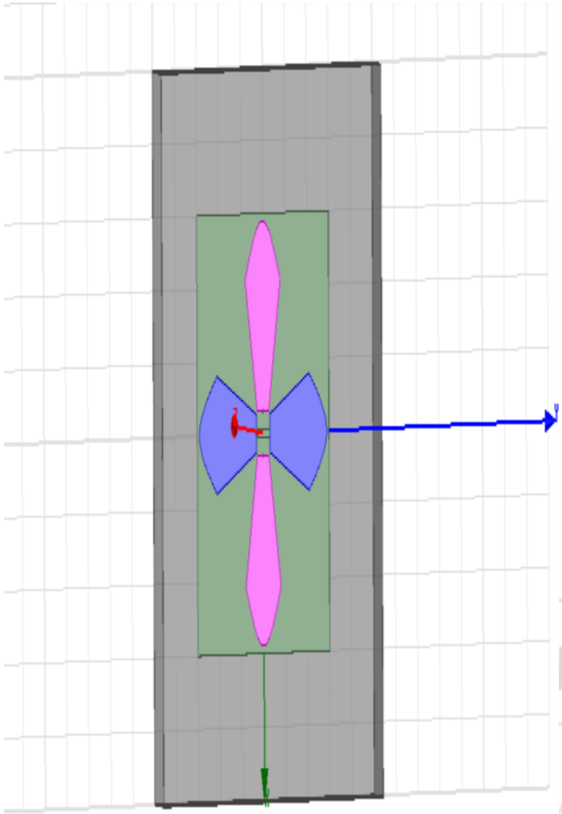

Figure 5: Structure of the rounded bowtie antenna

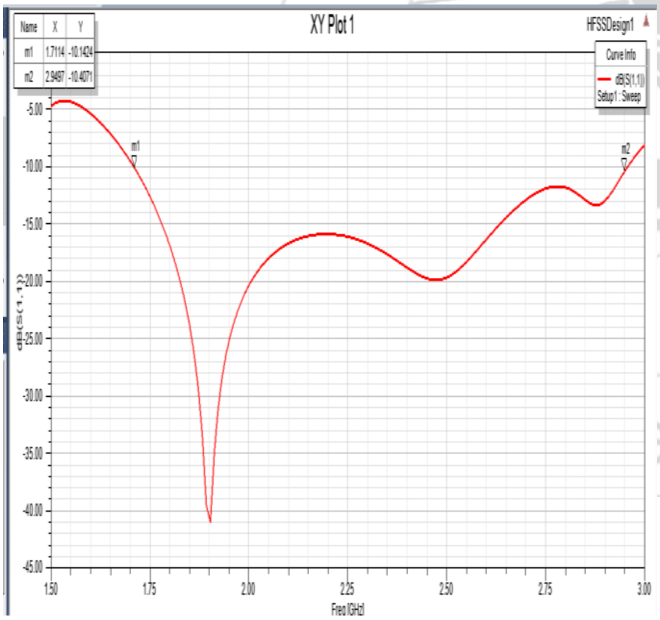

Figure 6: Shows the return loss of the rounded bowtie antenna. The return loss is below 10 db for the obtained frequency range 1.7114 -2.9497.

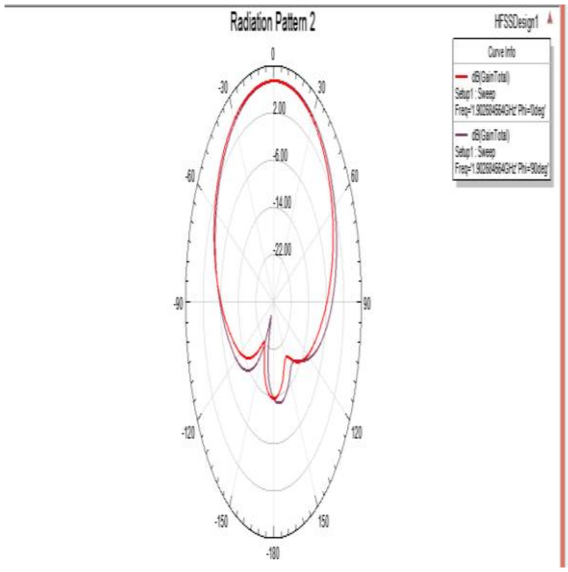

Figure 8: shows the radiation pattern in terms of gain at 1.9 GHz

6. Conclusion

The designed antenna can be used for wide range of frequencies. It is also clear that modifications added to the edge of the bowtie antenna can improve the bandwidth. A slight change in the edge of the bowtie antenna from wide rectangular path to rounded bowtie antenna has improved the bandwidth from 118% to 123%.It is also seen that with rounded bowtie antenna there is a frequency shift towards left. The return loss obtained at 1.9 GHz is around -40 dB which makes the antenna highly useful for GSM application. The broadband nature of the antenna makes it highly efficient for many indoor wireless applications. Etching slots along edges of the patch can improve the bandwidth. There are also other techniques that can be employed to improve the bandwidth of the antenna. Improving the bandwidth and there by designing an antenna for ultra wideband might be the future work of this paper.

7. Future Scope

A compact broadband dual-polarized cavity-backed rounded bowtie MIMO antenna is proposed to achieve wide bandwidth. The proposed antenna provides sufficient broad. bandwidth to cover the entire operating frequency band (1.8221-3.000) : (DCS/PCS/UMTS bands and LTE **1** (1920-1980), **2** (1850-1910), **3** (1710-1785), **4** (1710-1755), **7** (2500-2570), **9** (1749.9-1784.9), **10** (1710-1770), **15** (1900-1920), **16** (2010-2025), **23** (2000-2020), **25** (1850-1915) bands).The proposed antenna can be used for indoor applications like Bluetooth, WLAN, WiMAX, Microwave oven etc.,

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