Implementation of Microstrip Patch Antennas with UWB Consideration in CST Microwave Environment

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Abstract: **The goal of this research is to study how the performance of the antenna depends on various parameters of microstrip patch antenna. This is a simulation based study. CST Microwave studio software, one commercial 3-D full-wave electromagnetic simulation software tool is used for the design and simulation of the antenna. Then, the antenna parameters are varied to study the effect of variation of the antenna parameters on the antenna performance. The common shapes of the microstrip patch are rectangular, square, circular, triangular, etc. All these have been theoretically studied and there are well established design formulae for each of them. Antenna design is an innovative task where new types of antenna are studied. So, here a new shape of microstrip patch antenna is designed which will cover the entire Ultra Wide Band. One of the major problem for UWB systems are electromagnetic interference (EMI) from existing frequency bands, because there are many other wireless narrowband application that are allocated for different frequencies band in the UWB band. Therefore it is necessary for the designer to design the UWB antenna they can reflect the interference from the other existing bands. To overcome this interference problem UWB antennas should have banded notches therefore they can reject the existing frequency bands within the ultra-wide band. Here three designs with different band notches for UWB applications are proposed.**

INTRODUCTION

In now day's the wireless system has become a part of human life. Most of the electrical and electronics equipment around are using the wireless system. An antenna is an essential element of the wireless system. Antenna is an electrical device which transmits the electromagnetic waves into the space by converting the electric power given at the input into the radio waves and at the receiver side the antenna intercepts these radio waves and converts them back into the electrical power. There are so many systems that uses antenna such as remote controlled television, cellular phones, satellite communications, spacecraft, radars, wireless phones and wireless computer networks. Day by day new wireless devices are introducing which increasing1 demands of compact antennas. Increase in the satellite communication and use of antennas in the aircraft and spacecraft has also increased the demands a low profile antenna that can provide a reliable communication. A microstrip antenna is one who offers low profile and light weight. It is a wide beam narrowband antenna can be manufactured easily by the printed circuit technology such as a metallic layers in a particular shape is bonded on a dielectric substrate which forms a radiating element and another continuous metallic layer on the other side of substrate as ground plane. Not only the basic shapes any continuous shape can be used as the radiating patch. Instead of using dielectric substrate some of the microstrip antennas use dielectric spacers which results in wider bandwidth but in the cost of less ruggedness. Microstrip antennas are low profile antenna and mechanical rugged and can be easily mounted on any planar and nonplanar surfaces. The size of microstrip antenna is related to the wavelength of operation generally. The applications of microstrip antennas are above the microwave frequency because below this frequency the use of microstrip antenna doesn't make a sense because of the size of antenna. At frequencies lower than microwave, microstrip patches don't make sense because of the sizes required. Now a day's microstrip antenna is used in commercial sectors due to its inexpensiveness and easy to manufacture benefit by advanced printed circuit technology. Due to the development and ongoing research in the area of microstrip antenna it is expected that in future after some time most of the conventional antenna will be replaced by microstrip antenna.

Proposed Problem Statement

After declaring the ultra-wide band (UWB) from frequency band 3.1 to 10.6 GHz by Federal Communications Commission (FCC) in 2002 for the use of indoor and hand-held systems, Ultra wideband (UWB) antennas have gained so much of interest by the researchers [17]. For an antenna to be considered ultra wideband (UWB) or not there are two criteria available on the basis of fractional bandwidth. One definition (by Defence Advanced Research Projects Agency report) requires an antenna to have fractional bandwidth greater than 0.25. An alternate and more recent definition by Federal Communications Commission (FCC) places the limit at 0.2.

$$\mathrm{BW} = 2\frac{f_h - h_l}{f_h + h_l} \geq \begin{cases} 0.25 & DARPA \\ 0.2 & FCC \end{cases}$$

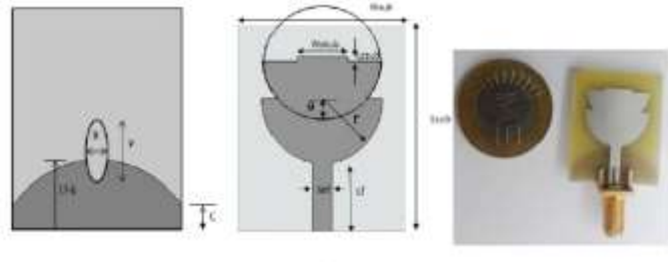
The major disadvantage of microstrip antenna is narrow bandwidth. For the enhancement of impedance bandwidth, several types of techniques such as uses of high value dielectric constant[8], parasitic coupled patches[19], defected patch structure, use of metamaterial[20], stacked structure [18]and using a matching network for proper impedance matching[21] have been reported. Here in the proposed designs for broadening the impedance bandwidth of the antennas defected ground plane strategy is used. In some designs circular shape partial ground plane with an elliptical notch is used. Some designs have partial ground plane with curvy edges and a narrow rectangular slit is also used.

Design 1

Modified Circular Patch Antenna for UWB application

The designed antenna has two half circular patches which are overlapped to each other. A narrow rectangular slit is added to the patch to improve the performance of antenna. The proposed antenna is fabricated on an inexpensive and easily available dielectric material FR-4 with permeability of 4.4.

Antenna design and parameters:



Front and Back View and Fabricated Antenna

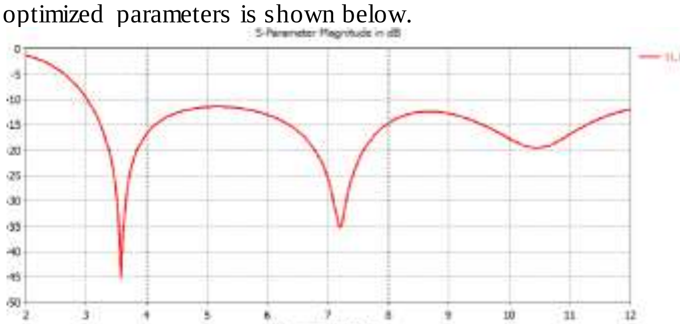
Dimensions of the Proposed 1st Design

Parameters	Description	Value
r	Radius of half circular patch	9.5
a	Overlapping length	4
Lf	Length of feedline	10
Wf	Width of feedline	3.058
Lstub	Length of stub	0.7
Wstub	Width of stub	6
Lsub	Length of substrate	29.8
Wsub	Width of substrate	12.6

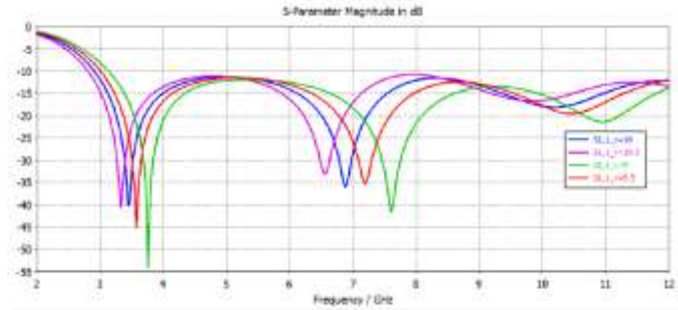
Proposed microstrip antenna is fed by standard 50ohm microstrip feed line. Different parameters with their Optimized value of the proposed antenna are listed below in table:

Simulation Results:

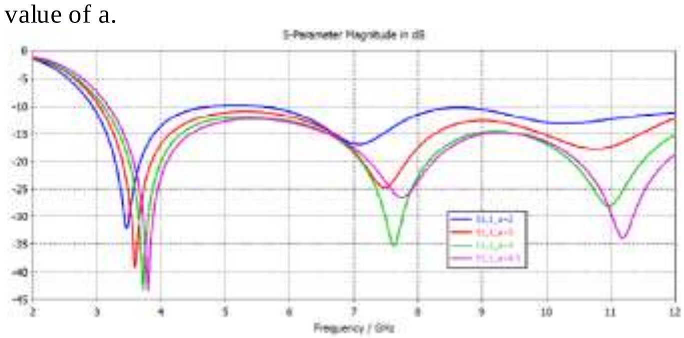
A circular shape partial ground plane is used in the design. To increase the bandwidth of antenna defected ground plane strategy is used. An elliptical notch is created in the ground plane, major axis and minor axis radius of which is x=1.6 and y=3.1 respectively. The s11 vs frequency curve for the optimized parameters is shown below.



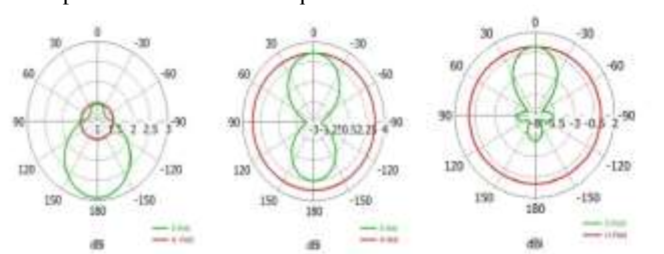
The effect of modifying the radius of patch effect on s11 parameter is observed. Figure below shows different s11 vs frequency curve for different values of radius r. It is observed that when we increase the radius the s11 vs frequency curve shifts towards lower frequency while on decreasing it shifts toward right. Therefore we can conclude that the two resonance frequencies we are getting are inversely proportional to the radius of the circular patch. It is also observed that for optimum value of radius r=9 the s11 is more deep.



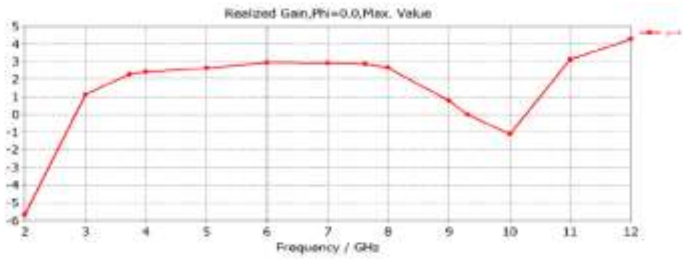
The overlapping of circular patches also affects the antenna characteristics and the value of overlapping length a is manually optimized. Figure shows s11 results for different value of a.



From the results it is clear that when the overlapping of the patches increases or decreases from its optimum value a=4 the s11 vs frequency curve shift upward. The figures below showing the antenna radiation pattern with principal E-plane and H-plane for different frequencies.



We can observe that the H-Plane patterns are omnidirectional and the E-Plane patterns have dumble shape pattern. Figure below showing the Gain vs frequency curve. Antenna have maximum gain at 12 GHz 4.2 dB and minimum -5.6 dB and -1.1 dB at 2 GHz and 10 GHz respectively.



6 Realized Gain vs Frequency plot

Conclusion and Future Work:

This work describes seven different microstrip patch antenna designs with different shapes. Four of them are designed for use in UWB application without any band notches and three of them are designed to work in UWB with different band notches for different applications like (WiMAX) operating in 3.3-3.7 GHz, (WLAN) for IEEE 802.11a 5.15-5.825 GHz, Downlink X-band satellite communication systems in 7.25 - 7.75 GHz.4.5- 4.8 GHz INSAT / Super-Extended C-Band (Indian National Satellite systems). The easiest and most common method to achieve a band notch is making a narrow slot of different shapes into the radiating patch of the antenna, will affect the current flow in the patch, different type of shapes is used to make the slots are used to get the band-notched in the desired frequency band. These proposed antenna structure's simulation is carried out using the CAD software Microwave Studio in Computer Simulation Technology Simulator (CST), one commercial 3-D full-wave electromagnetic simulation software. The Simulated results are presented, shows the usefulness of the proposed antenna structure for UWB applications. The simulation results of band notch antenna indicate that the proposed antenna fulfills the excellent triple band notch characteristics for various frequency bands and showing the good return loss and radiation patters in the interested UWB. New techniques should be explored to reduce the size of the UWB antennas to suit more practical applications. Metamaterial is a promising candidate since it can reduce the size greatly. Some optimization techniques should be used to optimize the optimum results like PSO, Genetic algorithm.

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