Effect of Directly Coupled Parasitic Patch on Floral Shaped Patch Antenna

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ABSTRACT

With the rapid development in wireless communication systems, the multiple separated frequency band antennas have become one of the most important circuit elements and attracted much interest. In this paper firstly a floral shaped patch antenna is designed to resonate at multiple bands by introducing four slits on all the four sides of a rectangular shaped patch. Later on by adding four different radiating elements connected together and directly coupled to the floral shaped patch provides three adjacent resonant modes very close to each other. By controlling the resonant frequencies of the parasitic elements, a wide impedance bandwidth can be observed. The bandwidth is found to be increased from 4.04 % to 8.582 %. The composite effect of integrating slits with the parasitic elements in the design provides a simple and efficient method for obtaining low profile, broadband, high gain antenna. The design is suitable for wireless applications in the range of 3.68GHz to 4.01GHz.

Keywords- **bandwidth, directly coupled, multiple bands, parasitic elements**

I. INTRODUCTION

Modern wireless systems are placing greater emphasis on antenna designs for future development is communication technology because of antenna being the key element in the whole communication system. Microstrip patch antenna is promising to be a good candidate for future wireless technologies. Microstrip patch antenna consists of a dielectric substrate, with a ground plane on the other side. Due to its advantages such as low weight , low profile planar configuration, low fabrication costs and capability to integrate with microwave integrated circuits technology, the microstrip patch antenna is very well suited for applications such as wireless communications system, cellular phones, pagers, Radar systems and satellite communications systems [1, 2, 3]. On the other side, the greatest disadvantage of Microstrip Patch Antennas is its low bandwidth. Many designs and techniques such as meandered slots in the ground plane [4], slot-loaded [5, 6], stacked shorted patch [7], E-shaped with compatible feeding [8] and chip resistor loading [9, 10] have been reported to achieve a wideband and reduced size antennas. Moreover the multi-band antennas [11, 12] are important in areas such as mobile communication handsets and base stations systems [13, 14].

The main goal of this paper is to present a new antenna configuration with combined effect of slotting and use of parasitic elements to design a simple low profile, broadband and high gain antenna. Firstly a floral shaped patch antenna is designed to resonate at multiple bands by introducing four slits on all the four sides of a rectangular shaped patch as shown in fig. 1. The dimensions of the slits are controlled to get the maximum bandwidth. Later on by adding four different radiating elements connected together and directly coupled to the floral shaped patch as shown in fig. 2 provides three adjacent resonant modes very close to each other by overlapping the parasitic elements frequency response.

II. FLORAL SHAPED ANTENNA DESIGN

In this section a multiband floral shaped patch antenna is designed. Fig. 1 depicts the geometry of the proposed patch antenna with its dimensions 36 mm×28 mm. The four slits as shown in fig 1 are created in its shape. The FR4 material is used as the substrate. The thickness of the substrate is 1.6mm (h1). The dielectric constant of the material is ε_r=4.4 and loss tangent=0.02. The optimized dimensions of the slits along the length are L1=4mm and W1=10mm and along the width are W2=4mm and L2=12mm. The four squares as shown in fig. 1 are of size A1=12mm.The patch antenna feed is through a coaxial cable , which is positioned along the x axis from the center of the rectangular patch by 0.5mm . The ground plane size is 100 mm ×100 mm.

The proposed antenna is simulated using HFSS which is based on FEM. Fig. 3 shows the simulated result with variation in slits dimension. The length and width of the slits are varied to get the optimum results.

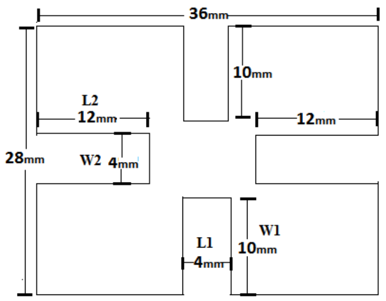

Fig. 1 A floral shaped rectangular microstrip patch antenna

III. OPTIMIZING ANTENNA DESIGN WITH PARASITIC PATCHES FOR WIDE BANDWIDTH

The above antenna suffers from the drawback of narrow bandwidth. To increase its bandwidth the use of directly coupled parasitic patches are made. Fig. 2 shows the geometry of the proposed new above modified floral shaped patch antenna with parasitic patches. As shown in fig. 4 additional parasitic elements of T shape are directly coupled and inserted in the slits of the above designed floral shaped patch. All the dimensions of the parasitic elements are shown in the fig. Again the length and width of each element of the T shaped parasitic element are optimized to get the broad bandwidth. These additional resonators generate the modes very close to the fundamental resonant frequency of the main patch resulting in broad bandwidth. The antenna operates in the frequency range of 3.68GHz to 4.01GHz. Also the position of coaxial probe feed is also very important in antenna designing. Trial and error method is used to locate the approximate feed point to optimize the bandwidth. The optimized feed location is found to be at 0.35mm away from the center point along x axis. The results are shown in fig. 4.

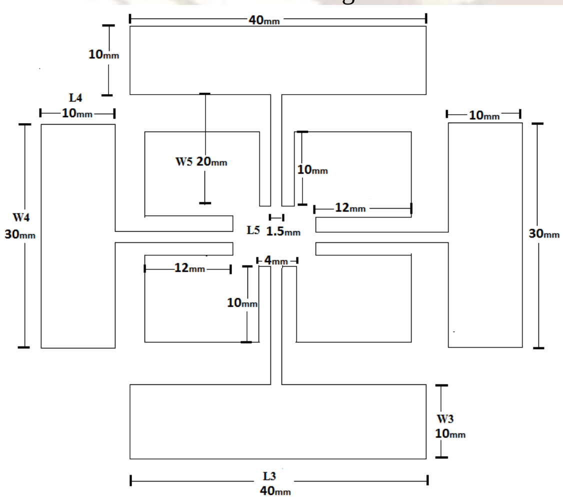

Fig. 2 Geometry of proposed new floral shaped patch with parasitic elements

IV. RESULT AND DISCUSSION

A. Return Loss

The simulated results of the input return loss for the floral shaped patch antenna is shown in fig 3. It is observed that the optimum results are obtained at L1=4mm, W1=10mm, L2=12mm, W2=4mm as mentioned in fig. 1. The bandwidth at the optimum dimension is found to be 4.04% at the center frequency of 3.6GHz.

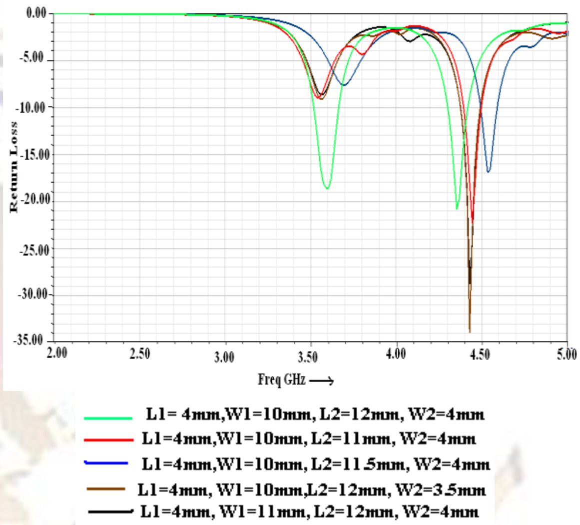

Fig. 3 Effect on Return Loss of variation in dimensions of slits in floral shaped patch antenna

Fig. 4 shows the input Return Loss vs Frequency curve for the new modified floral shaped patch antenna with parasitic elements. It can be observed from the curve that after directly coupling the four T shaped parasitic patches to the floral shaped patch, there are three nearby resonant modes at frequencies 3.725GHz, 3.86GHz, 3.98GHz with their return loss at -29.288dB, -25.0126dB, -14.5034dB respectively. The 10dB impedance bandwidth is found to be 330MHz, which is about 8.582% of the center frequency.

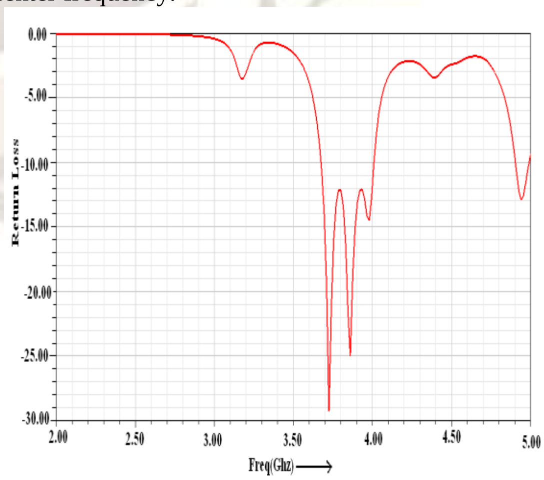

Fig. 4 Simulated Return loss vs. frequency of modified floral shaped patch antenna with parasitic patches

B. Radiation Pattern

Fig 5 shows the radiation pattern at the three resonant modes at 3.98GHz, 3.86GHz and 3.725GHz respectively.

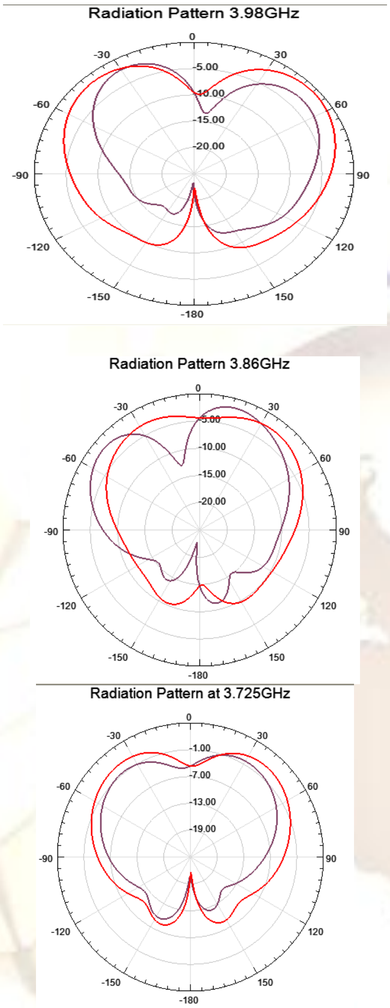

Fig. 5 Simulated radiation pattern of the proposed new modified floral shaped patch antenna with parasitic elements

From the figure above it can be observed that there is reduction in power loss in side lobes. Front to back ratio is also improved.

V. CONCLUSION

In this work, a new technique for enhancing the gain and bandwidth of rectangular microstrip patch antenna is presented successfully by using combined feature of slotting and additional resonators. The simulated results demonstrate that multi band characteristics can be observed by the use of slotting at the four sides of patch antenna with impedance bandwidth of 4.04% with respect to the normal rectangular patch antenna having only 1% bandwidth. The new modified floral shaped patch antenna with directly coupled additional resonators show impedance bandwidth of 8.582% which is nearly twice of floral shaped patch antenna without resonators. The improvements demonstrated with the additional resonators provide a strong foundation for designing future broadband path antennas.

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