A Report on

Bandwidth Enhancement of Microstrip Patch Antenna using Parasitic Patch

For the Subject

Electromagnetics and Antenna of Third Year (Semester-VI)

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ABSTRACT

Microstrip patch antenna finds a better choice in wireless communications because of their less cost, light weight and ease of fabrication. We propose the design for the bandwidth enhancement of microstrip patch antenna with parasitic patch placed adjacent to the radiating patch along with the slots. The proposed structure is designed at 8.5 GHz using FR4-epoxy as substrate material that has relative permittivity 4.4 and loss tangent 0.02. HFSS (High Frequency Structure Simulator) software is used for simulating the proposed design. Comparative analysis with various slots on both main patch and parasitic patch has been done for various antenna parameters like; return loss, gain, directivity and VSWR.

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List of Abbreviations

mm	Milimeter
cm	Centimeter
GHz	Giga Hertz
dB	Decibel
tm	Trademark
RF	Radio Frequency

Chapter 1

Introduction

Microstrip patch antennas are being widely used in various fields of communication, like ground to air communication in case of spacecrafts and aircrafts for the past few decades. Because of their ease of installation, low cost and light weight they are preferred mainly over other antennas. Very small size wide band antennas are of great demand in future technologies with the rapid growth of wireless communication technology. In spite of inherent limitation like narrow bandwidth and low gain, microstrip patch antennas have numerous advantages. But various techniques have been investigated for the enhancement of both bandwidth and gain.

In our design both parasitic patch and slots are used for bandwidth enhancement. This parasitic patch provides an additional resonance with a good performance of bandwidth enhancement. It can also suppress the surface waves for the improved radiation efficiency in a specific frequency band. Resonant frequency is determined by the length of the parasitic patch and bandwidth is determined by its width.

Chapter 2

Literature Survey

2.1 Literature Review:

The first one is the bandwidth enhancement of microstrip patch antenna using parasitic patch. It was observed that with single rectangular patch alone the bandwidth was 0.2995 GHz i.e. 3.49 percent and with the parasitic patch the bandwidth was 0.5572 GHz i.e. 6.52 percent. So parasitic patch finds an appropriate technique for the enhancement of the bandwidth rather than other methods. Such robots will not reach the desired place as it moves randomly while avoiding the obstacles. In addition such robots are not controllable. The maximum gain of proposed design is observed to be 5.3542 dB and directivity is 5.4617 dB. So from gain and directivity plot it is found the efficiency of the antenna to be 98 percent. [1] The second research paper is bandwidth enhancement of microstrip patch antenna using parasitic patch configuration. In this paper, 4x3cm rectangular microstrip patch antenna fed with contacting method using probe feed contemporary technique. The dimensions and location of the parasitic patch play important role in obtaining the wide bandwidth for the proposed antenna as distance between radiators patch and the parasitic patch along radiating side on the impedance bandwidth of antenna. Actually the separation distance d is very small but variation in it affects the input impedance of an antenna. The rectangular MSA presented with RT/duriod 5880 (tm) substrate and thickness h=0.32 cm and got return loss bandwidth 2.1 percent. In two layer of substrate in parasitic patch antenna presented and got 10.62 percent bandwidth. Main reason of bandwidth improvement is the effective aperture area is increased and the surface wave is decrease. [2]

Table 2.1: Summary of existing works on object detection

Author	Work Done	Remarks
Mekala Harinath Reddy, R.M. Joany, M. Jayasaichandra Reddy, M. Sugadev and E. Logashanmugam [1]	Bandwidth Enhancement of Microstrip Patch Antenna using Parasitic Patch	Comparative analysis was made with various slots on the main patch for better performance characteristics and it was found that hexagonal slot gave better performance characteristics.
Paritaba B Parmar, Balvant J Makwana and Mehul A Jajal [2]	Bandwidth Enhancement of Microstrip Patch Antenna Using Parasitic Patch Configuration	To increase the bandwidth, the number of substrates were increased.

Chapter 3

Software Used

3.1 Ansys HFSS

Ansys HFSS is a 3D electromagnetic simulation software solution for designing and simulating high-frequency electronic products such as antennas, RF and microwave components, high-speed interconnects, filters, connectors, IC components and packages and printed circuit boards.

3.1.1 Antenna Geometry

The dimensions of the proposed design are mentioned in the table 1. The type of feed used in the design is line feed with an input impedance of 50 ohms. The substrate material that is used here is FR4 epoxy which has relative permittivity 4.4 and loss tangent 0.02. The thickness given to the substrate is 1.6mm. The centre and starting position of hexagonal slot that is used on the main patch is given as (8.1, 7.9, 1.6) and (8.1, 9.95, 1.6). To the rectangular slot on the parasitic patch the length and width is given as 5mm and 1mm and the distance between main patch and the parasitic patch is 0.5mm.

Parameter	*Dimensions*
Substrate length ( )	16 mm
Substrate width ( )	18 mm
Substrate thickness (h)	1.6 mm
Main Patch length ( )	9 mm
Main Patch width ( )	5.75 mm
Parasitic patch length( )	9 mm
Parasitic patch width( )	5.75 mm

Figure 3.1: Table 1: Parameters of proposed Antenna Design

3.1.2 Design Methodology

This antenna works at 8.5 GHz with parasitic patch placed next to the main patch with an intention to increase the bandwidth. The parasitic patch is sometimes known as electromagnetically coupled patch. Here, both parasitic patch and slots are used for bandwidth enhancement. Excitation to the parasitic patch is provided through coupling with the fringing fields of the main patch. This parasitic patch provides an additional resonance with a good performance of bandwidth enhancement. It can also suppress the surface waves for the improved radiation efficiency in a specific frequency band. Resonant frequency is determined by the length of the parasitic patch and bandwidth is determined by its width. The microstrip patch antenna proposed for satellite applications is designed at 15 GHz with multiple slots on the rectangular patch. These slots on the patch shift the resonant frequency to the lower side and also affect various antenna parameters.

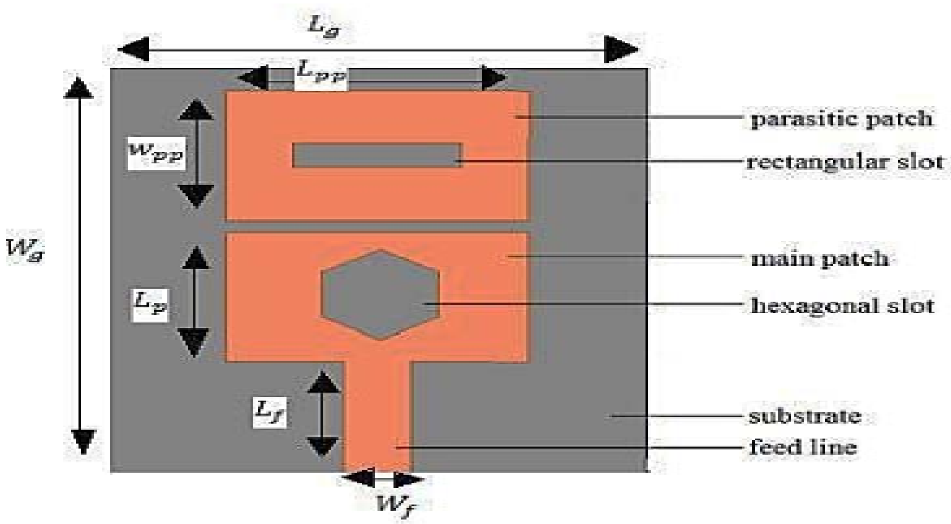

Figure 3.2: Proposed Antenna Design

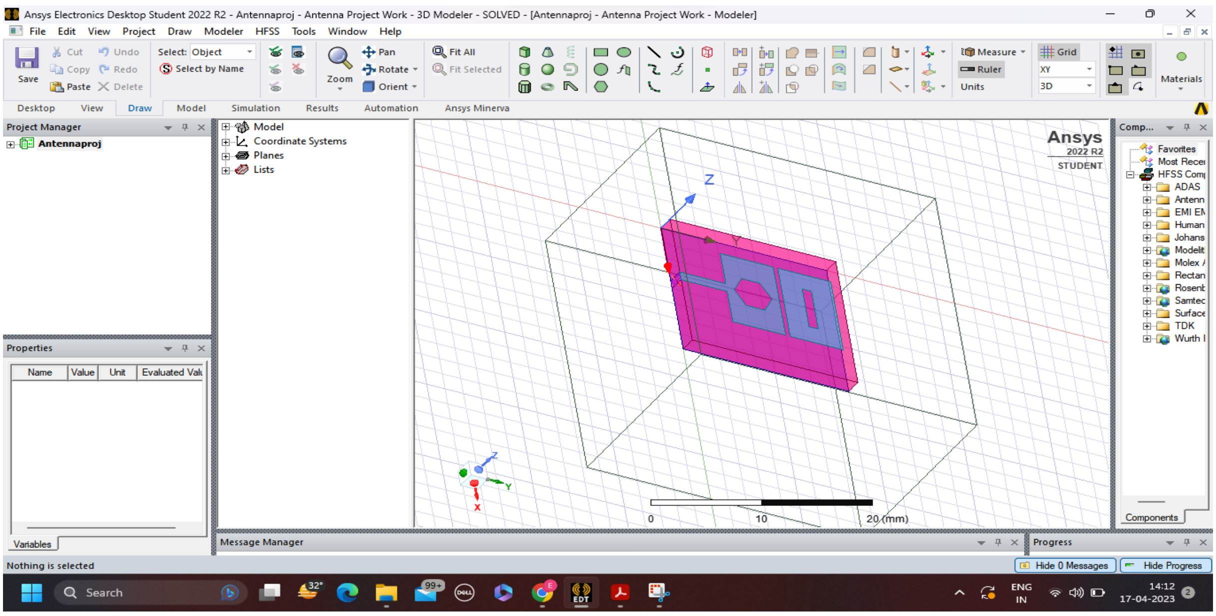

Figure 3.3: 3D geometry of proposed design

Chapter 4

Simulation and Experimental Results

4.1 Return Loss plot of proposed antenna design

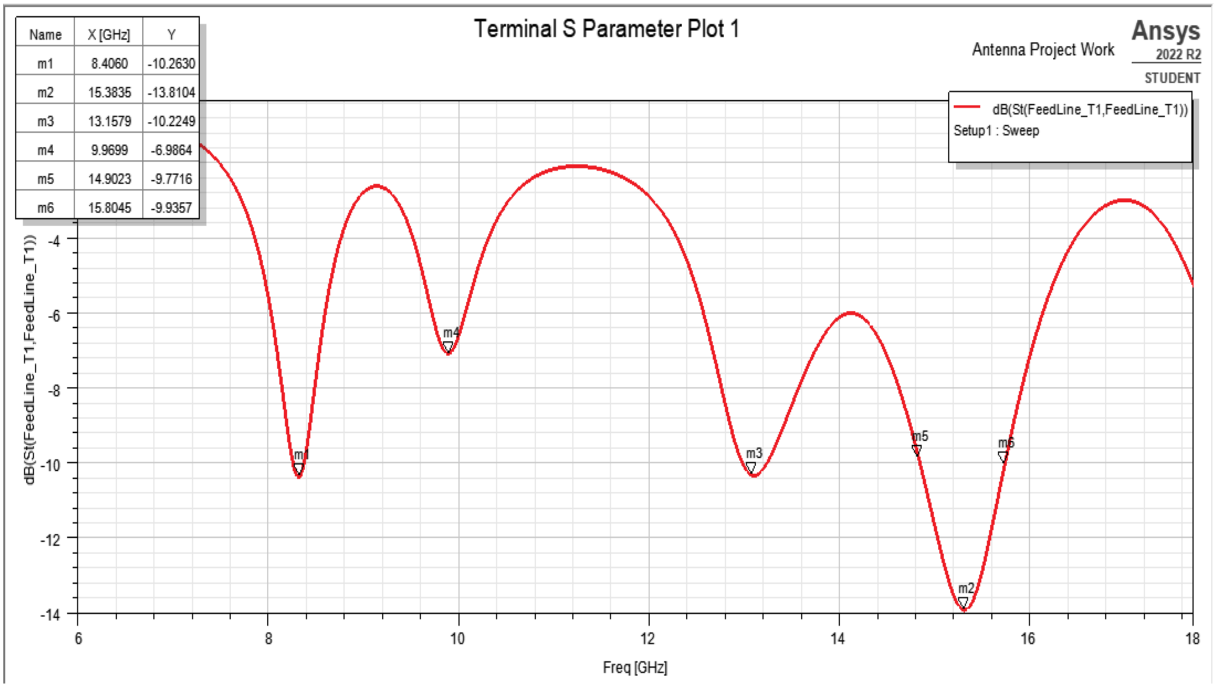

Figure 4.1: S- Parameter

Table 4.1: Figure 4.1 represents

Result	Return Loss	Resonant Frequency
Simulated Result	-10.2630 dB	8.4060 GHz
Simulated Result	-13.8104 dB	15.3836 GHz
Simulated Result	-10.2249 dB	13.1579 GHz

4.2 Gain

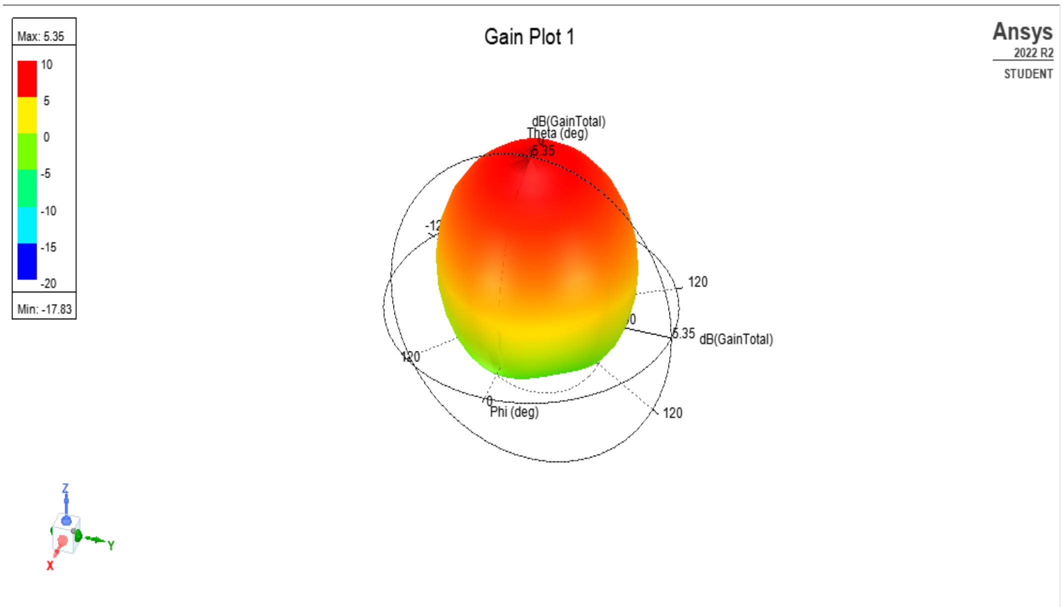

Figure 4.2: Gain

As seen in fig 4.2 the gain of the proposed antenna is 5.35dB.

4.3 Directivity

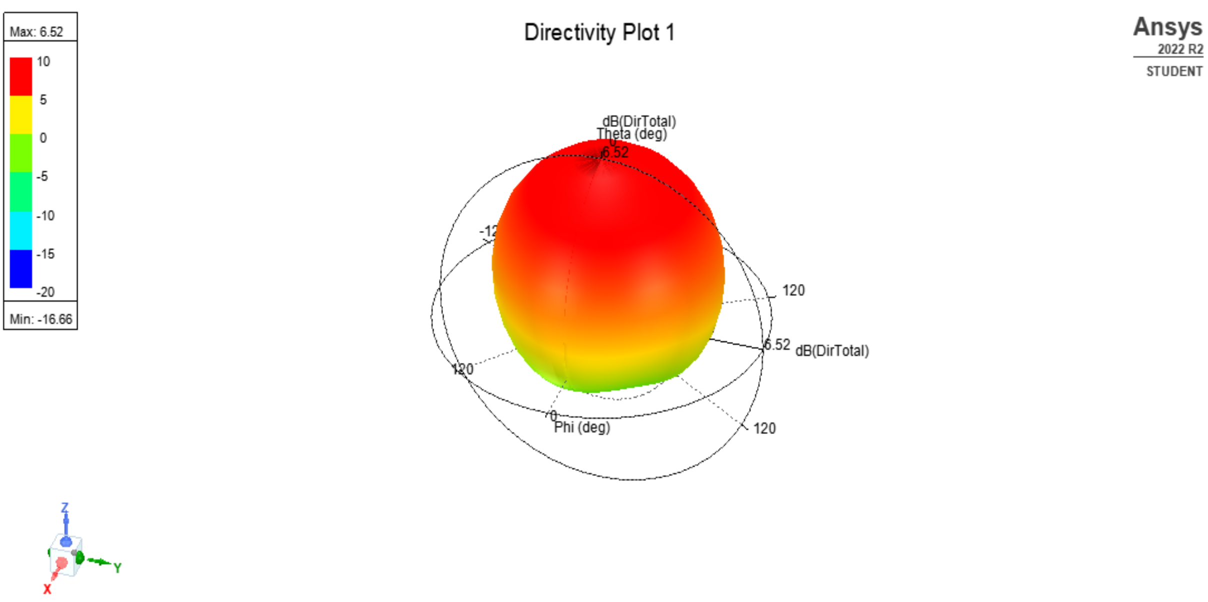

Figure 4.3: Directivity

As seen in fig 4.3 the gain of the proposed antenna is 6.52dB. The efficiency of the simulated antenna can be calculated by Gain/Directivity.

The efficiency is 82.05 percent.

4.4 Radiation Pattern

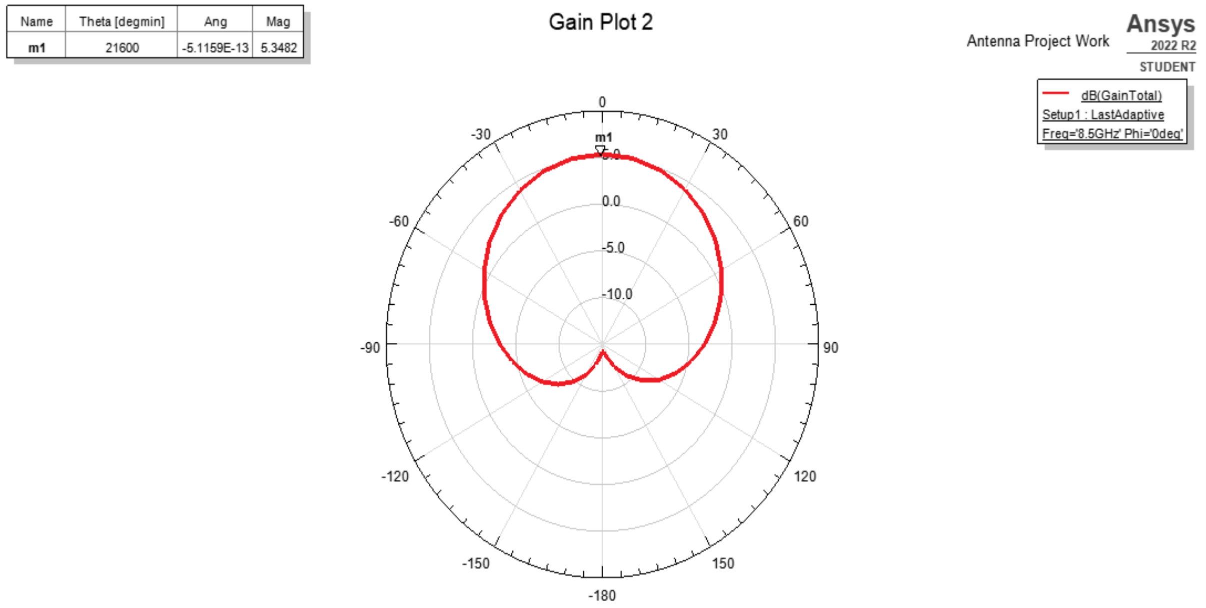

Figure 4.4: Radiation Pattern
The gain obtained from the radiation pattern is 5.3482dB.

We can see that the gain obtained in Fig.4.2 that is the gain plot and the gain in obtained from Fig. 4.4 that is the Radiation Pattern are same.

as seen in fig 4.2 the gain of the proposed antenna is

Chapter 5

Conclusion

In conclusion, the project on bandwidth enhancement of a microstrip patch antenna using a parasitic patch on HFSS has shown promising results. By adding a parasitic patch to the original microstrip patch antenna, the bandwidth of the antenna has been significantly increased. This has been achieved by tuning the dimensions of the parasitic patch to achieve a resonant frequency that complements the original microstrip patch antenna. The results obtained from this project could be further optimized through practical experimentation and by incorporating additional design parameters such as substrate material, feed position, and antenna size. In summary, the project has contributed to the advancement of antenna technology and has demonstrated the potential for improving the performance of microstrip patch antennas through the use of parasitic patches.

Bibliography

[1] Mekala Harinath Reddy, R.M. Joany, M. Jayasaichandra Reddy, M. Sugadev and E. Logashanmugam. "Bandwidth Enhancement of Microstrip Patch Antenna using Parasitic Patch." IEEE International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials (2017): 295-298.

[2] Paritaba B Parmar, Balvant J Makwana, and Mehul A Jajal. "Bandwidth Enhancement of Microstrip Patch Antenna Using Parasitic Patch Configuration." International Conference on Communication Systems and Network Technologies (2012).