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Design of Patch Antenna for High Gain WIFI Applications

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ABSTRACT

Due to the existence of growth in development of low cost, less weight, highly reliable, minimal profile antennas for wireless devices, it poses a new challenge for the design of antenna in wireless communications. This paper presents design and simulation of a rectangular micro strip patch array antenna at 2.4 GHz for wireless communications that provides a radiation pattern along a wide angle of beam and achieves a gain of 4.4 dB The rectangular micro strip patch antenna was analysed using Ansof/Ansys HFSS and also made a comparison among the different substrates which shows different results based on same parameters.

I. INTRODUCTION

At present, we are living in the era of communication system, where communication is a process of exchanging information between the two points. There are many ways of communication but most preferred way is wireless communication technology. The use of wireless technology changes the way of human thinking. In wireless communication systems, antenna plays a vital role, it is a metallic device used for radiating and receiving the information in the form of radio waves. The wireless communication system without proper antenna setup encounters problems. Any perversion in the transmission and reception of information causes complete system failure. A proper design selection of an antenna is the most important factor for the designing of wireless communication system. Due to rapid growth of devices in wireless communication, there is requirement of antenna which has compact size, low cost, easy handling and better performance. Microstrip antenna is the best suited option which fulfils all the necessary requirements of wireless communication system. In telecommunication, a microstrip antenna also known as printed antenna usually means an antenna fabricated using photolithographic techniques on a printed circuit board. Microstrip antenna approach was first introduced in 1950, but the genuine consideration on the microstrip antenna was received in 1970. It is a kind of internal antenna. Microstrip antennas have become very popular in recent times due to their thin planar profile. Microstrip antenna has few preferences over conventional antenna because of light weight, economical and easy to integrate narrow bandwidth. Microstrip antenna structure are divided into four main parts i. e; ground plane, dielectric substrate, patch and feeding line. Ground plane is etched on bottom side of a dielectric substrate and conducting in nature. There are several types of dielectric substrates which are used for designing this antenna and the value of dielectric constant used is ranges between 2.2 and 12. Low dielectric constant

values are preferred for high frequency or power applications to minimize power loss. The radiating patch is a conductor which is etched on dielectric substrate along with feed lines. Shape of radiating patch may be square, rectangular, circular etc. But Rectangular and square shaped are mostly used because of their easy analysis and fabrication.

Feeding techniques used in designing of antenna are: coaxial probe feed, Microstrip line feed, Aperture coupled feed method and proximity couples feed method. In this paper, the coaxial probe feed is used. In this feeding method, inner conductor of coaxial cable is connected to microstrip patch of an antenna and outer one is connected with ground plane. The most serious limitation of microstrip antenna is low gain. This is because of the surface wave propagation. Generally we want all our energy to be radiated, but due to these surface waves the energy is lost in the conductor due to its finite conductivity. This results in reduced gain.

II. LITERATURE REVIEW

A.B. MUTIARA, R.REFIANTI, RACHMANSYAH et al There is a various number of dielectric substrate available for the Microstrip patch antenna (MPA). Material selection for the dielectric substrate in microstrip patch antenna can be considered in three classes of wireless communication given as the millimeter-wave applications and the mobile base station applications and mobile phone miniaturization applications [1].Praveen Kumar Patidar ,Nidhi Tiwarib et al the radiation pattern is mostly directional and The proposed antenna is designed and the optimized using two commercial 3D full-wave software, viz. CST microwave studio and Ansoft HFSS. A prototype of the designed antenna that was fabricated and showed good agreement between the actual measurements of S11 & VSWR and the simulation results using both software [2].Ahmed Mahfuz Tamim,Md. Abdur Rahman Chowdhury et al An antenna is a device that transmits and receives radio frequency signals for the standard of an antennas that means for radiating or receiving radio waves and the Inmodern era, for microwave and wireless engineering, the demand of miniature antenna is so high that it is one of themost demandable topics in antenna theory and design. Fromdifferent types of antenna, MPA have attracted moreconcentration because of their light weight, low profile nature,low cost, easy fabrication process, and conformity etc[3].Kukunuri Suraj and M. Neelaveni Ammal et al Due to the existence growth in the development of low cost, less weight, highly reliable, minimal profile antennas for the wireless devices and it poses a new challenge for the design of antenna in wireless communications and As communication devices become smaller due to the greater integration of electronics, the antenna becomes a significantly larger part of the overall package volume. and this results in a demand for the similar reductions in an antenna size. In addition to this, low profile antenna designs are also important for fixed wireless application[4].Niamat Hussain , Uktam Azimov , Minjoo Jeong , Seungyeop Rhee et al a microstrip patch antenna with the multiple superstrates for performance enhancement operating at the central frequency of 5.5 GHz for high-gain WLAN application and the The performance of the antenna in terms of reflection loss and the gain are investigated using multiple high dielectric constant and the different ways of the antenna in micro strip and the frequency bands are assigned based on the technology, purpose, network size, and requirements of the communication [5].

III. METHODOLOGY

The approaches of the project design are represented in the flowchart in Fig.1. The methodology of the project starts by understanding the Microstrip antenna technology. This includes the properties study of antenna such as operating frequency, radiation pattern , antenna gain and polarization. The antenna design started by calculating the dimensions of Microstrip patch antenna operate at frequency 2.4Ghz The simulation has been done by using High frequency structure simulator(HFSS). Considering the poor performance of antenna, Microstrip patch antenna loaded with parasitic Mushroom type structure has been designed. The Rectangle structure is utilized for antenna design in wireless application. In this design parasitic mushroom type Electromagnetic band gap design are used on the substrate. Electromagnetic Band gap design is a perfect electric conductor. The structure has frequency range where the surface impedance is very high. The equivalent LC circuit acts as a two – dimensional electric filter in this range of frequency to block the flow of the surface waves. The measurement and simulation result has been compared in term of Return loss, Radiation pattern and gain of the antenna.

Firstly, Microstrip patch antenna dimensions are calculated and designed. The value of dielectric constant is 4.4, Operating frequency = 2.4GHz and the substrate thickness, h = 1.6mm, the parameters are W=27.9mm and L=38mm.

PARAMETR	VALUES
Frequency	2.4GHz
Substrate material	FR_4
Permittivity	4.4
Height	1.6
Gain	2.32dB
Return loss	-27.32dB
VSWR	0.8322

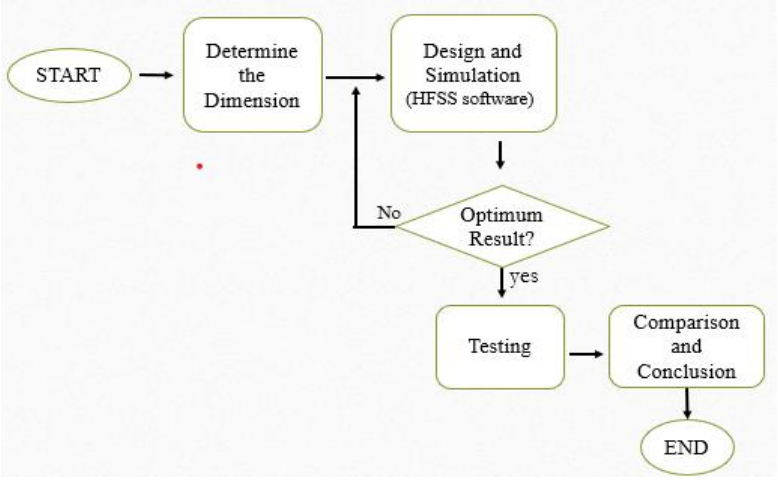

Fig. 1. Flow Chart

Secondly, the Rectangle structure is introduced to the patch antenna. In microstrip antennas, Rectangle structures surrounding patch element to suppress surface waves to achieve better radiation efficiency and antenna gain. Rectangle structures reflect back a part of the energy that propagates along the substrate of the antenna, thus acting as reflecting walls around the antenna. With Rectangle patch antenna, in addition to suppression of the surface waves, an increased bandwidth can be achieved.

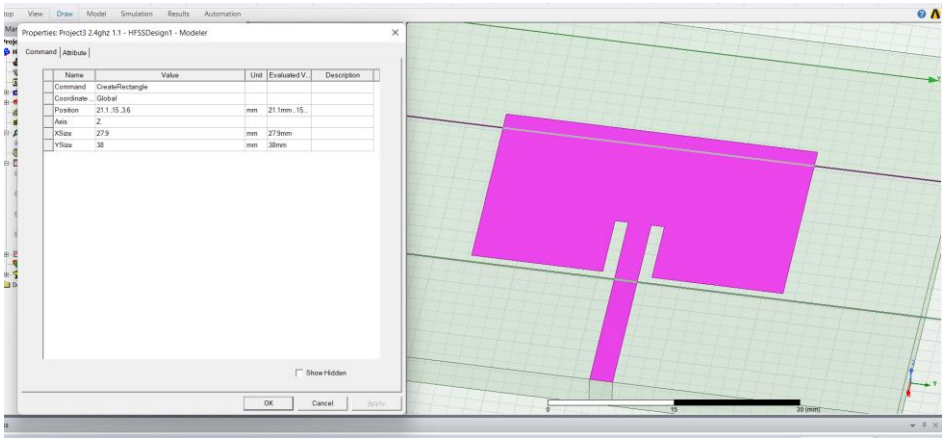

Fig. 2. Geometry of Antenna design.

PARAMETER	VALUES(Rectangle Patch)
Frequency	2.4GHz
Substrate Material	FR_4
Gain	4.4dB
Return loss	-27.32dB
VSWR	0.8

IV. RESULTS AND DISCUSSION

The results of the Rectangle based microstrip patch antenna design such as return loss, radiation pattern, antenna gain can be obtained by using the Ansys HFSS software. After simulating both the designs, Microstrip patch antenna shows the resonant frequency 2.4GHz with return loss -27.32dB. The Return loss value for Rectangle based microstrip patch antenna is about .The incorporation of the parasitic mushroom type Electromagnetic Band gap design with microstrip antenna enhances gain. Microstrip antenna without Rectangle results in antenna gain of 0.8322dB. By using Electromagnetic Bandgap design, the surface wave effect is diminished resulting to the improvement of the antenna gain to 4.4dB.

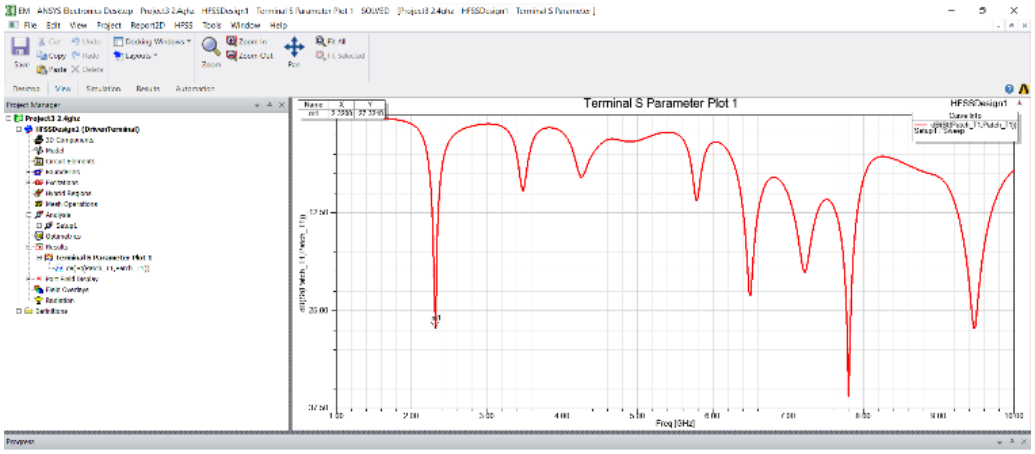

Fig.3. Microstrip patch antenna design(Return loss)

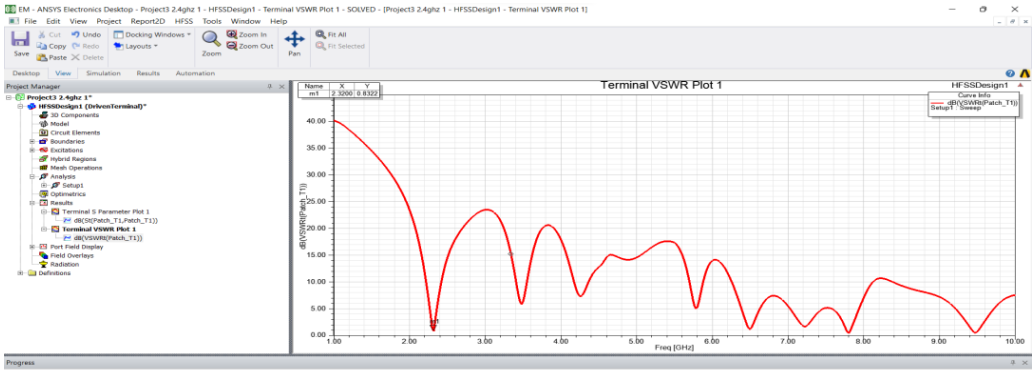

Fig. 4. Microstrip patch antenna design(VSWR)

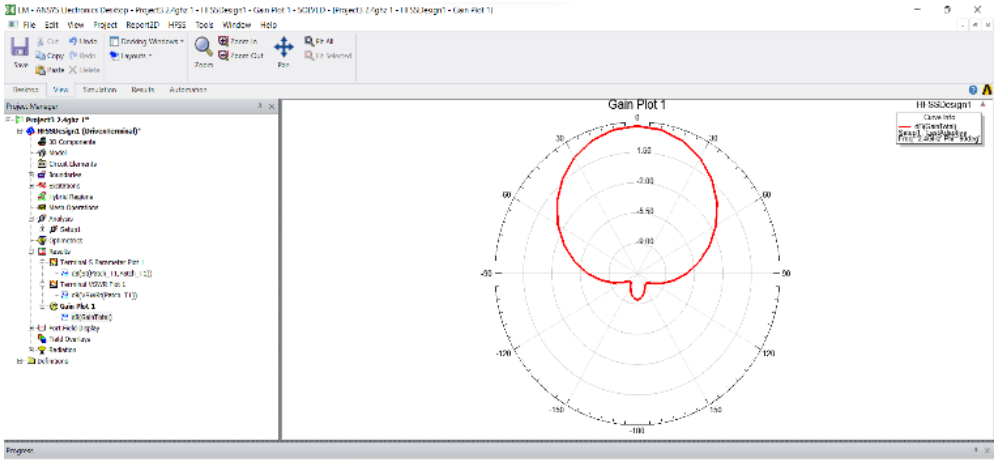

Fig. 5. Polar plot of radiation for microstrip patch antenna design.

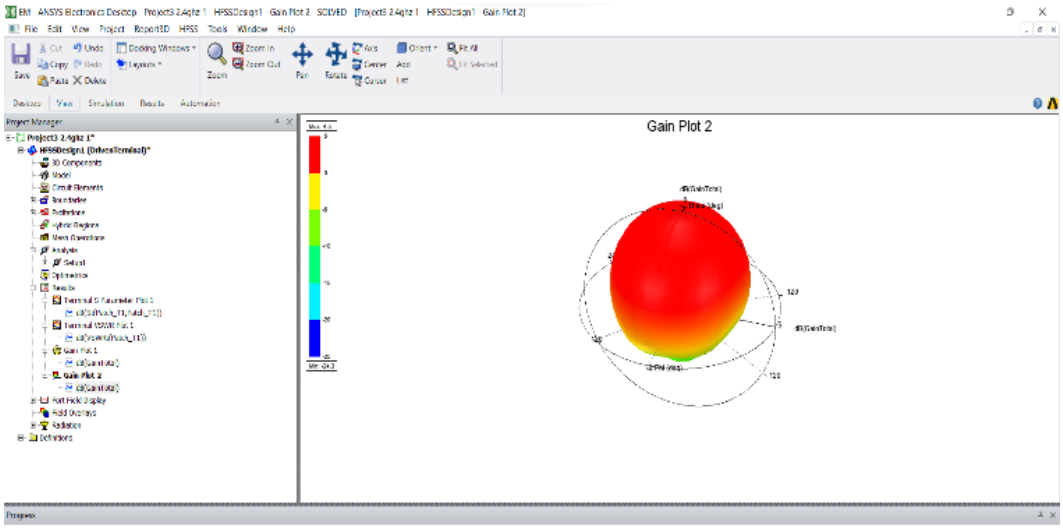

Fig.6. Three dimensional pattern of radiation for microstrip patch antenna design.

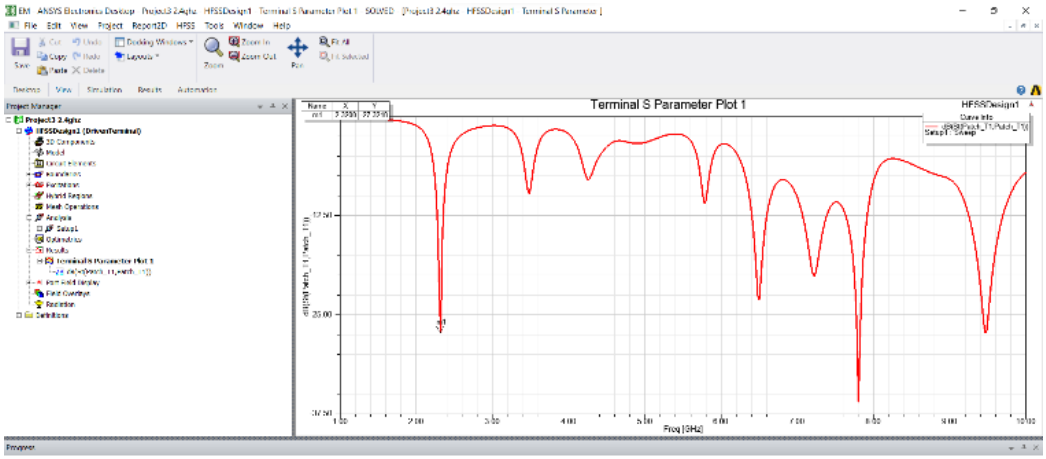

Fig.7. Rectangle Microstrip patch antenna (Return loss)

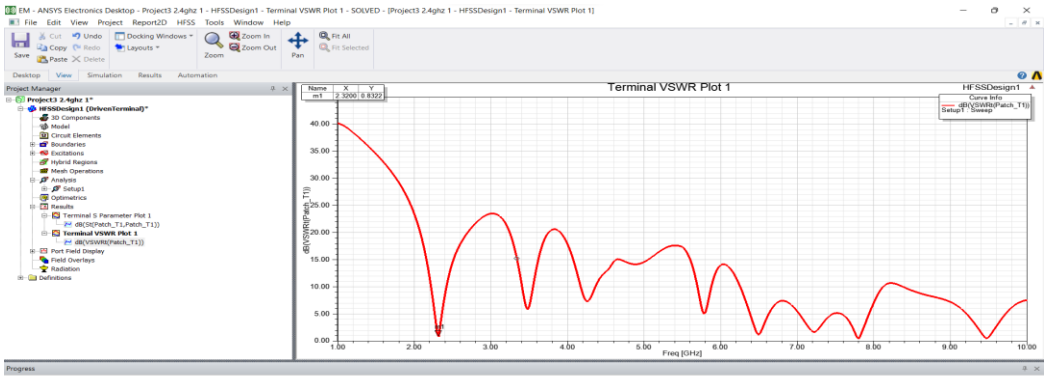

Fig.8. Rectangle Microstrip patch antenna (VSWR)

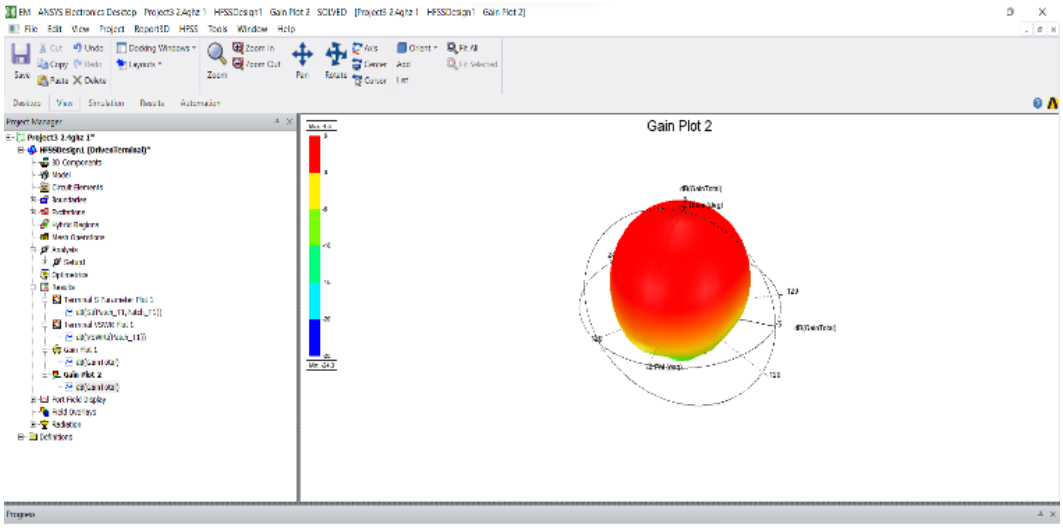

Fig. 9 .Three dimensional pattern of Radiation of Rectangle Microstrip patch antenna

V. CONCLUSION

The integration of EBG design in microstrip antenna improved the antenna performance. The Rectangle structure has been incorporated with microstrip antenna to see how the antennas perform by introducing this Rectangle structure. The antenna with Rectangle structure operates at a low frequency compared to the antenna without Rectangle structure. Normally, to design the microstrip antenna operates at lower frequency, the larger size of the substrate is needed. Integrating Rectangle structure can reduce the size of the antenna and the fabrication cost. Next, the Rectangle structure can enhance the gain of the original antenna structure. The antenna design with Rectangle structure shown a good return loss of -27.32dB. By utilizing the Rectangle structure, the gain of the antenna is increased to 4.4dB.

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