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Development of EBG Based Novel Patch Antenna for Improvement of Gain in Indoor Wireless Applications

Dr. T. Aathmanesan, E. Kushi Priya, S. Dharani, K. Vamsinath Reddy
Department of Electronics and Communication Engineering, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai, Tamil Nadu, India

ABSTRACT

Over the past decade, the production of various applications involving wireless communication has been increasing rapidly. All such wireless systems efficiency depends upon the antenna's design and its proper functioning. Microstrip patch Antenna is the most desired antenna that is being used by various communication systems nowadays. The fabrication of microstrip antenna is easy because of its low material cost, it is having a wide variety of applications. The Electromagnetic Bandgap is the artificially fabricated structures that allow the propagation of electromagnetic band of frequency at any incident angles and polarizations. The principle issue in the microstrip antenna configuration is the surface wave that proliferates inside the substrate. Because of expanding the side and back radiation, the surface wave travel on the substrate, and there is a reduction in the gain and bandwidth of the antenna. Electromagnetic bandgap structure prevent the surface wave propagation and proposes the multilayer electromagnetic bandgap structure for gain enhancement. EBG based Microstrip Novel patch Antenna with increased gain is to be developed.

Keywords - Microstrip Antenna, Electromagnetic Band gap, Antenna gain.

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.

One of the method to develop the performance of microstrip antenna for various wireless applications is using EBG structure. EBG structure is a periodic dielectric metallic or composite structures that exhibit a forbidden band of frequency in which the incident wave does not propagate. The novel EBG structures have the capability of suppressing the propagation of surface wave .As a result , the performance of antenna would get better.

II. 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 5.8GHz. 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 EBG 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 = 5.8GHz and the substrate thickness, h = 1.6mm, the parameters are W=15mm and L=11mm.

PARAMETR	VALUES
Frequency	5.8GHz
Substrate material	FR_4
Permittivity	4.4
Height	1.6
Gain	1.23dB
Return loss	-13.9dB
VSWR	3.5

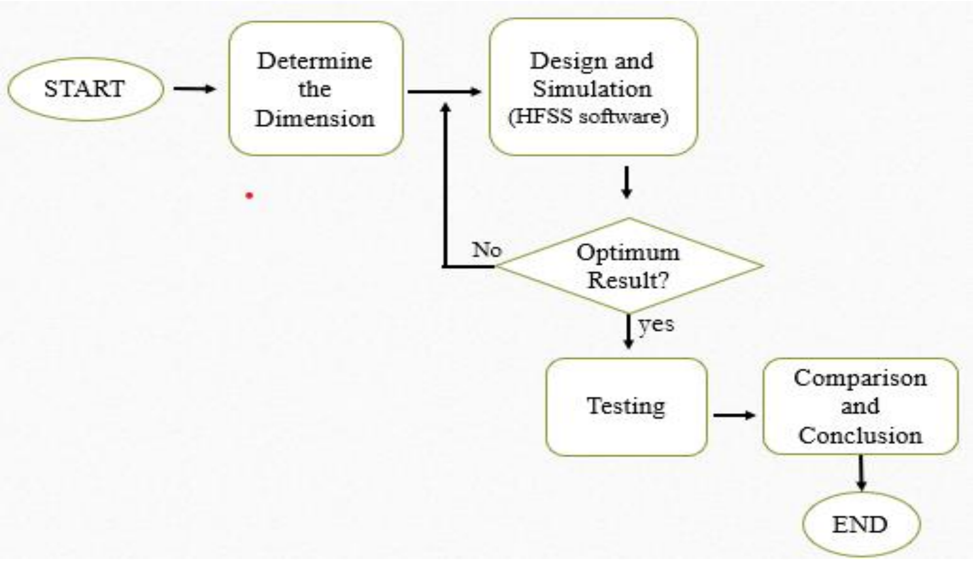

Fig. 1. Flow Chart

Secondly, the EBG structure is introduced to the patch antenna. In microstrip antennas, EBG structures surrounding patch element to suppress surface waves to achieve better radiation efficiency and antenna gain. EBG 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 EBG, in addition to suppression of the surface waves, an increased bandwidth can be achieved.

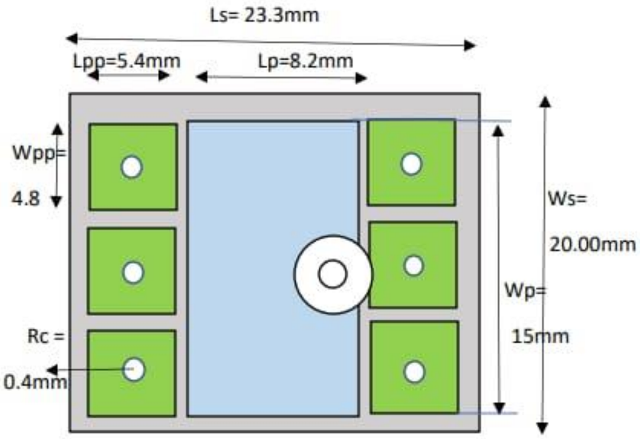

Fig. 2. Geometry of Antenna design.

PARAMETER	VALUES(EBG)
Frequency	5.4GHz
Substrate Material	FR4
Gain	7.4dB
Return loss	-24.6dB
VSWR	0.9

III. RESULTS AND DISCUSSION

The results of the EBG 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 5.8GHz with return loss -13.9dB. The Return loss value for EBG based microstrip patch antenna is about -24.6dB.The incorporation of the parasitic mushroom type Electromagnetic Band gap design with microstrip antenna enhances gain. Microstrip antenna without EBG results in antenna gain of 1.23dB. By using Electromagnetic Bandgap design, the surface wave effect is diminished resulting to the improvement of the antenna gain to 7.4dB.

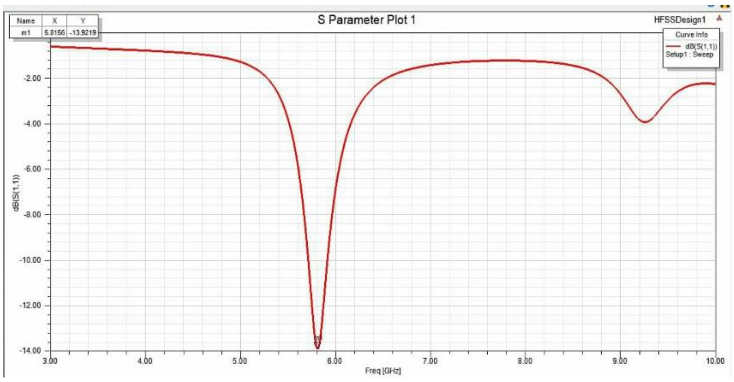

Fig.3. Microstrip patch antenna design(Return loss)

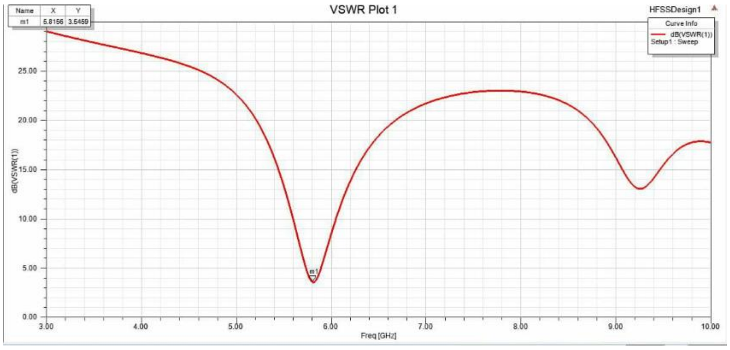

Fig. 4. Microstrip patch antenna design(VSWR)

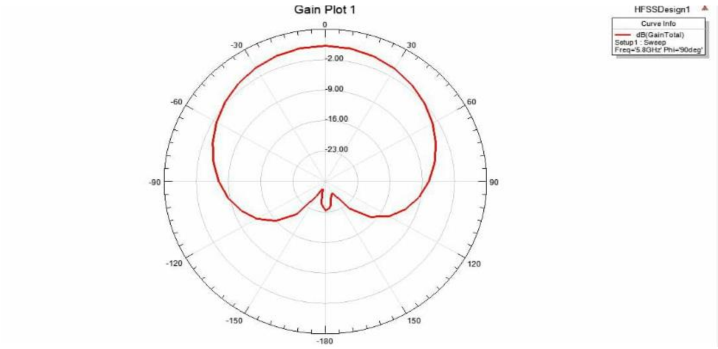

Fig. 5. Polar plot of radiation for microstrip patch antenna design.

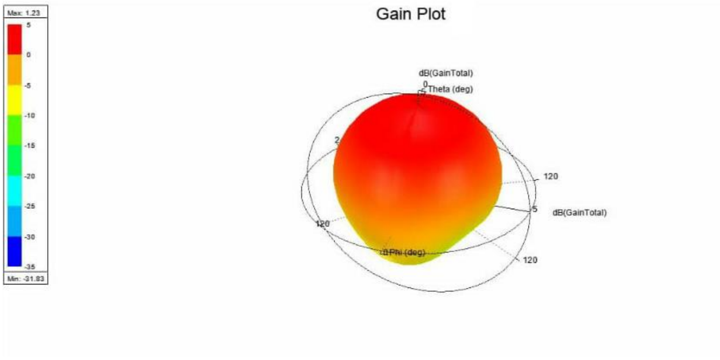

Fig.6. Three dimensional pattern of radiation for microstrip patch antenna design.

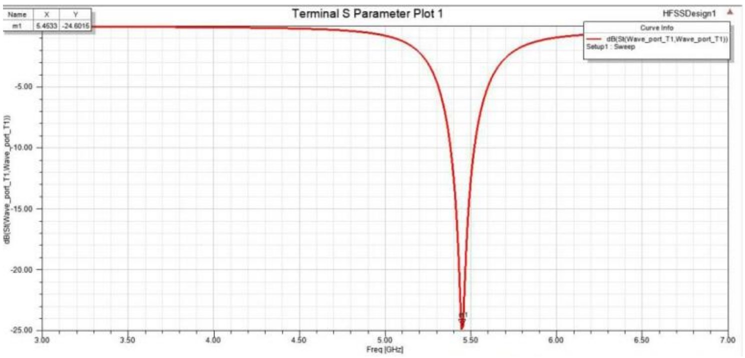

Fig.7. Microstrip patch antenna using EBG (Return loss)

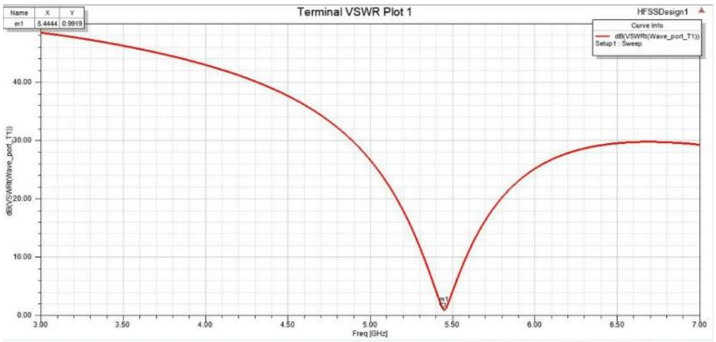

Fig.8. Microstrip patch antenna with EBG(VSWR)

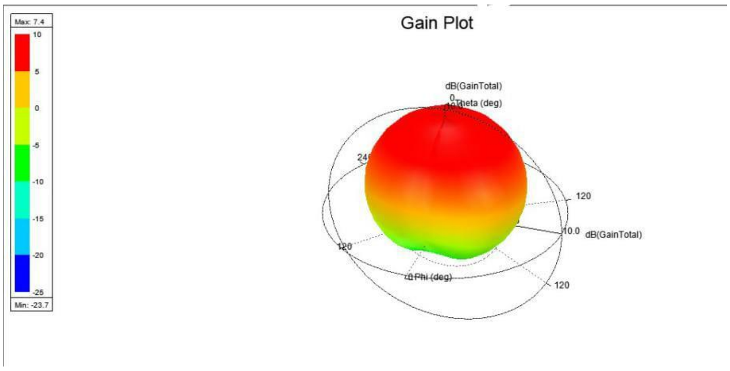

Fig. 9 .Three dimensional pattern of Radiation of Microstrip patch antenna with EBG

IV. CONCLUSION

The integration of EBG design in microstrip antenna improved the antenna performance. The EBG structure has been incorporated with microstrip antenna to see how the antennas perform by introducing this EBG structure. The antenna with EBG structure operates at a low frequency compared to the antenna without EBG structure. Normally, to design the microstrip antenna operates at lower frequency, the larger size of the substrate is needed. Integrating EBG structure can reduce the size of the antenna and the fabrication cost. Next, the EBG structure can enhance the gain of the original antenna structure. The antenna design with EBG structure shown a good return loss of -24.6dB. By utilizing the EBG structure, the gain of the antenna is increased to 7.4dB.

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