DUAL BAND DUAL CIRCULARLY POLARIZED PATCH ANTENNA FOR KU-BAND APPLICATIONS

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Abstract- This project also aims at integrating the concept of high directivity in Dual switching. Eight directive antennas are arranged in a fan shaped structure. Using appropriate switching arrangement, single or multiple Duals can be switched in the azimuthal plane. The structure is then modified into an umbrella shape by arranging eight directive antennas at the base of a cylindrical support. This arrangement helps in tilting the Dual band in the elevation plane, which is suitable for base station antenna applications. Stacking of more number of elements can further improve directivity and gain. Thus optimal coverage can be obtained with overlapping radiation patterns of high directivity. This paper designs two new dual- frequency microstrip antennas with the use of electromagnetic simulation software- High Frequency Structure Simulation (MATLAB). The two antennas adopt ordinary FR4material as a dielectric substrate, with the advantages of low cost and small size. The first antenna adopts microstrip line feeding, and the antenna radiation patch is composed of a folded T-shaped radiating dipole which reduces the antenna size, and two symmetrical rectangular patches located on both sides of the T-shaped radiating patch. The second antenna is a microstrip patch antenna fed by coaxial line, and the size of the antenna is diminished by opening a stepped groove on the two edges of the patch and a folded slot inside the patch.
Keywords: Dual Band Dual Circularly Polarized Patch Antenna for Ku-band Applications.

1. INTRODUCTION

Wireless communication technologies have become a part and parcel of human lives as a world without them is unimaginable, be it smartphones, internet, radio, or television. There has been an alarming rise in the number of wireless subscribers worldwide, which is approximated to be around eight billion. Antennas are an indispensable part of wireless communication, aptly called “the electronic eyes and ears” by J.D. Kraus in 1989 [1]. They are passive reciprocal devices used for transmitting and receiving electromagnetic waves which carry information wirelessly. Radiation of electromagnetic waves occurs due to the acceleration or deceleration of charges in a metallic wire with curves, bends, discontinuities, or terminations.The demand for high-performance antennas in Ku-band applications has led to the development of innovative designs to meet the requirements of modern communication systems. One such advancement is the introduction of a dual-band dual circularly polarized patch antenna tailored for Ku-band frequencies. This antenna configuration, featuring four square patches arranged in a sequential rotating array, offers a unique solution for achieving dual circular polarization radiation. By leveraging this novel design, the antenna aims to provide dual-band operation within the Ku-band spectrum while maintaining circular polarization characteristics essential for efficient signal transmission and reception. This paper explores the design, performance, and applications of the dual-band dual circularly polarized patch antenna, highlighting its potential to enhance communication systems operating in Ku-band frequencies.

2. INTRODUCTION OF MICROSTRIP ANTENNAS

In recent years, with the rapid development of wireless communication technology, the WLAN communication system has also flourished, and the applied range in the market is increasingly wide WLAN communication systems generally require two-way sending and receiving data in a fast, high-efficiency and reliable way, which is reflected in the antenna subsystem. The antenna is an important part of the wireless communication system. Modern society has entered into the information age, and people present higher requirements for the antenna, that is, the antenna not only has a wider frequency band, smaller size and is easier to install, but also has a high radiation efficiency and anti- interference performance, and other characteristics. Therefore, the study of multiband and miniaturized antennas becomes an important issue in the field of antennas Compared with the traditional microwave antenna, the microstrip antennas are low profile, small size, low cost and light weight, which can meet the demands of miniaturization. However, microstrip antennas inherently have narrow bandwidth; hence, the study of dual band microstrip antennas is necessary. At present, extensive studies of dual-band microstrip antennas applied in WLAN have been carried out, and a lot antenna types which work in a dual-band have been put forward, such as Dipole antennas, Planar Inverted-F antennas [8], Planar Monopole antennas [9] and Quasi-Yagi antennas. These antennas are simple in structure and low in production cost, which are suitable for the use of WLAN devices. The research of microstrip antennas is mainly focused on small scale, broadband, multi - polarization, multi band and high gain, etc. For example, Heng- Tung Hsu et al have designed a microstrip antenna for dual band operation .

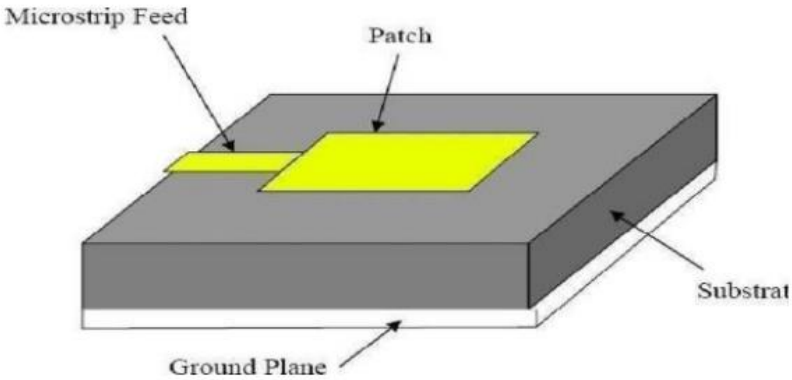

Fig. 1.1 The Typical Structure of Printed Microstrip Antenna

The typical structure of printed microstrip antenna is shown in above Figure. It has advantages of small size, light weight, easy to integrate and mass production. The feed means of the antenna is microstrip line feeding. The manufacturing process of microstrip line is simple, easy to integrate with other active and passive circuit components, which is conducive to realizing the miniaturization of the circuit system and improving the degree of integration

3. PROBLEM STATEMENT

The fabricated antenna shows dual operating bands of 3.24– 8.29 GHz (5.05 GHz) and 9.12–11.25 GHz (2.13 GHz). Moreover, the antenna is compact, and its reflection coefficient measured where a good agreement is observed with the stimulated results A dual frequency band frequency at 2.4 & 5.8GHz range that is suitable for WLAN. The gain is 2dB at the frequency The antenna is a dual band structure one which can operate in the frequency ranges from 2.4 GHz(802.11g/N) and 5.1 GHz (802.11a/N). A dual frequency band frequency at 2.4 & 5.8 GHz range that is suitable for WLAN. The gain is 2dB at the frequency of 2.4GHz and about 3.1dB peak gain at the frequency band of 5.8GHz. The peak antenna efficiency is 70% at lower bands and at the higher bands an efficiency of 60% is achieved. All three wifi frequencies require an independent antenna so the size of the system is very high. Due to the independent antenna the modem device needs more power to work. The directivity of the modem was very low.

4. OBJECTIVE

The objective of this study is to develop an equation and design formulas. To optimize the directivity of antennas and to devise ways to realize Dual Band switching of directive antenna arrays efficiently. Stacking of more number of elements can further improve directivity and gain. Thus optimal coverage can be obtained with overlapping radiation patterns of high directiviy.

4.1 Objectives of The Study

- The easiest way to reduce the size of a patch antenna is to use high dielectric constant (ϵr) material. However, this can result in lower radiation efficiency and decreased bandwidth. Other methods have been studied, such as using thicker substrates or ceramic substrates with high dielectric constants.
- Magneto-dielectric substrates have also been used to achieve size reduction. Another method is using the Sierpinski carpet fractal method, which effectively increases the electrical length of the antenna, resulting in a size reduction of up to 32%. This method involves dividing the patch into congruent rectangles and removing the central rectangle in each iteration

4.2 Significance of The Study

4.2.1 Use of sierpinski carpet fractal Method

The space-filling property of the fractal causes effectively increase the electrical length which is used to reduce the size of the antenna. Sierpinski carpet fractal method with different iterations was used to reduce the size of the patch of the microstrip patch antenna.

4.2.2 Use of shorting pins between Patch and Ground Plane

By using the shorting pins between the patch and ground plane size reduction of antenna can be achieved because it makes antenna electrically small.

4.2.3 Use of metamaterials: Metamaterials (MTMs)

Artificially engineered materials designed to provide material properties not readily available commercially. MTMs can be designed to realize materials with near zero values of permittivity; negative permittivity or permeability; or simultaneous negative permittivity and permeability.

4.3 Limitations of The Study

- The study focuses on the development of dual-frequency (14 and 35 GHz), dual-polarization microstrip antenna arrays on liquid crystal polymer (LCP) multilayer technology. However, the disadvantage of this paper is that it has a relatively low gain compared to other antenna designs.
- The study presents the design of high-gain 24-GHz CPW-fed microstrip patch antennas, but the disadvantage is that all three Wi-Fi frequencies require an independent antenna, which increases the size of the system and requires more power from the modem device.
- The study discusses the miniaturization of microstrip patch antennas by using high-permittivity substrates, but the disadvantage is that it can result in high return loss.
- The study proposes a technique to reduce the overall size of a microstrip antenna using a partially filled high-permittivity substrate, but the disadvantage is that it has a high return loss.

5. EXISTING METHOD

- Dual forming is a technique that uses directional antennas and signal processing algorithms to concentrate signals in specific directions enabling faster and more reliable communication with better data rate, gain, and range.
- A high data rate is required for services like high-resolution videos, online gaming, etc. The shape of the Dual transmitted by the access point antenna must be such as to point toward the required subscriber. The system aims to enhance communication systems operating in Ku-band frequencies by providing improved performance, versatility, and bandwidth utilization.
- Through the integration of multiple square patches and a feed network, the antenna system ensures reliable dual-band operation and circular polarization, catering to the demanding requirements of modern Ku-band applications. This configuration enables the generation of dual circular polarization radiation.
- Making the antenna suitable for Ku-band frequencies. By leveraging this innovative design, the antenna achieves dual-band operation within the Ku-band spectrum while maintaining circular polarization characteristics essential for efficient signal transmission and reception.
- Parabolic Reflector Antenna Parabolic reflector antennas are highly directional antennas with high gain and large size consisting of a parabolic reflector, feed antenna, and sometimes a sub-reflector When parallel electromagnetic waves from a distant source are incident on the reflector.
- They are reflected to form a focussed or converged Dual at focus as behavior of electromagnetic waves is similar to that of light rays.
- Similarly, if the source of radio waves or feed antenna such as a dipole antenna is placed at the focus of the r, they are reflected from the parabola to emerge out as parallel Dual. Additionally, a dual polarized microstrip patch antenna has been proposed for Ku-band applications with dimensions of 15 mm×15 mm, and such an antenna has achieved a 950 MHz bandwidth.
- This design is significant for its compact size and ability to operate within the Ku-band frequency range. In summary, the existing method in Dual Band Dual Circularly Polarized Patch Antenna for Ku-band Applications involves the use of duplex antenna designs, sequential rotating arrays of square patches, single-feed dual-band dual-sense circularly polarized stacked patch antennas, and dual polarized microstrip patch antennas.
- These designs aim to enhance communication systems operating in Ku-band frequencies by providing improved performance, versatility, and bandwidth utilization.

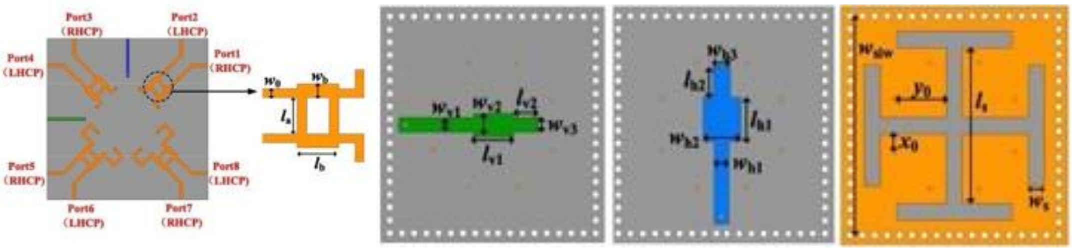

Fig. 5.1 Antenna Design

6. SIMULATION RESULTS

The proposed system in the "Dual Band Dual Circularly Polarized Patch Antenna for Ku-band Applications" involves a duplex antenna design with four square patches arranged in a sequential rotating array to generate dual circular polarization radiation.

This innovative design enables the antenna to operate in two distinct frequency bands within the Ku-band spectrum while maintaining circular polarization characteristics essential transmission and reception.

For efficient signal the system aims to enhance communication systems operating in Ku-band frequencies by providing improved performance, versatility, and bandwidth utilization.

Dual forming is a technique which uses directional antennas and signal processing algorithms to concentrate signals in specific directions enabling faster and more reliable communication with better data rate, gain and better

range.
A high data rate is required for services like high resolution videos, online gaming etc. The shape of the Dual transmitted by the access point antenna must be such as to point toward the required subscriber.
Similarly, the antenna at the subscriber end sends a signal back with a narrow Dual band so that the access point antenna receives the signal. As all the energy reaches only users in one particular direction, users in that direction get high signal level and better service.
As the transmitted and received signals have high gain in only one direction and low gain in all other directions, there is no interference from other users.

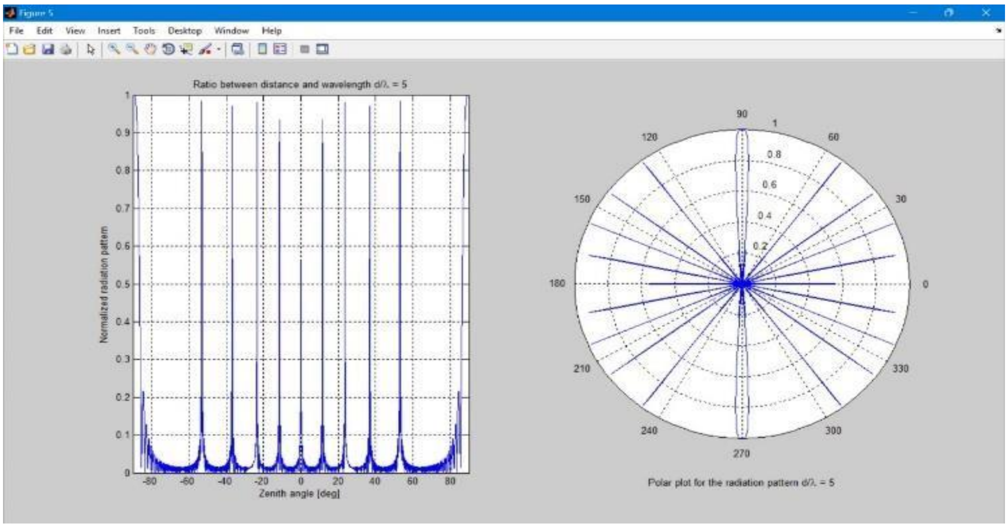

Fig. 6.1 Signal Direction

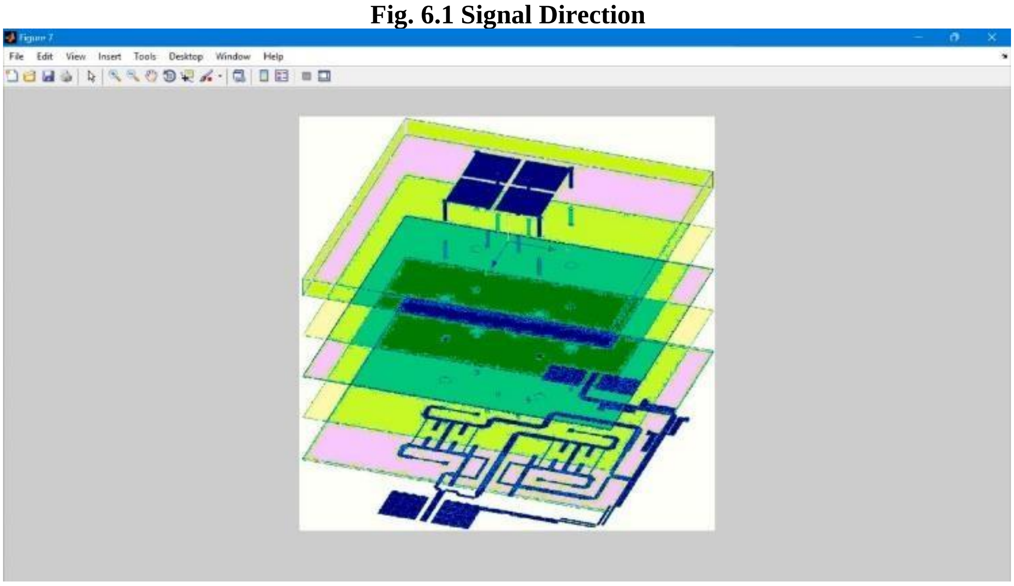

Fig. 6.2 Layers of Fabrication

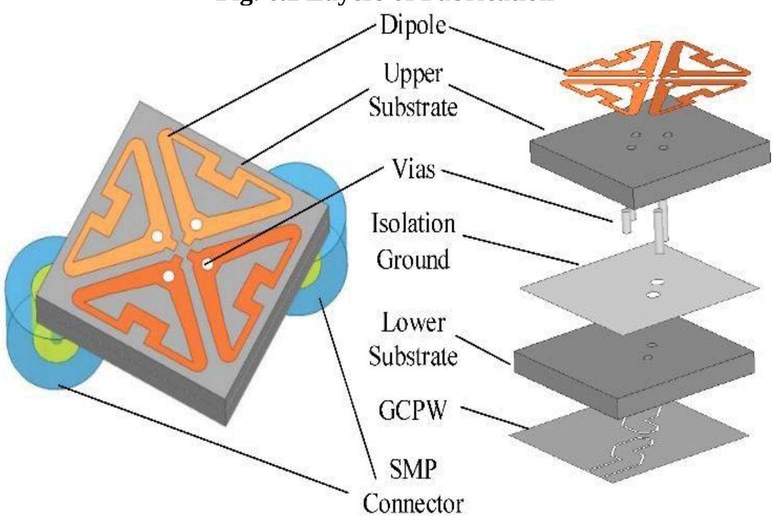

Fig. 6.3 Fabrication

CONCLUSION

Antenna gain measures the strength of the signal transmitted or received by an antenna in a particular direction. The project aims to increase the antenna's gain and directivity using a ground based electromagnetic band gap (EBG) structure, specifically PGB for mushrooms. The EBG structure is a periodic arrangement of metallic conductors, high and low dielectric substrates, and both. Cutting the top of the patches into triangular shapes with sharp edges will improve the antenna's directivity. Return loss is the measure of the reflected power when a signal is transmitted through a transmission line, and it plays a crucial role in antenna design. The S-parameter plot shows the frequency bands in which the signal can transmit, and yellow marks represent the path of the signal.

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