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A Review of Artificial Intelligence in Microstrip Patch Antenna with Rectangular Slot for Wireless communications

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ABSTRACT-

AI algorithms, such as genetic algorithms or particle swarm optimization, can be used to optimize the shape, size, and configuration of a micro-patch antenna. These algorithms can explore a large design space and find optimal solutions that maximize antenna performance metrics such as bandwidth, gain, and radiation pattern. Communication between humans was the first word through voice. With the desire to communicate over great distances, instruments such as drums were used, followed by visual methods such as signal flags and smoke signals. These optical communication devices must use the light portion of the electromagnetic spectrum. It is only recently in human history that the electromagnetic spectrum, beyond the visible region, has been used for communication through the use of radio. Microstrip patch antennas offer a possible solution and are therefore a popular printed resonant antenna for narrow-band applications.

Keywords: Compact, Dual Band, Patch. Antenna, 5G applications

1. Introduction

Microstrip patch antennas can be fed by various methods. These methods can be divided into two categories – interactive and non-interactive. In communication systems, RF energy is fed directly into the radiation path using connecting elements such as microstrip lines. In the non-contact scheme, electromagnetic field coupling is performed to transfer energy between the microstrip line and the radiating part. The four most popular forward techniques used are microstrip lines, coaxial probes (both contact schemes), aperture coupling and proximity coupling (both non-contact schemes).

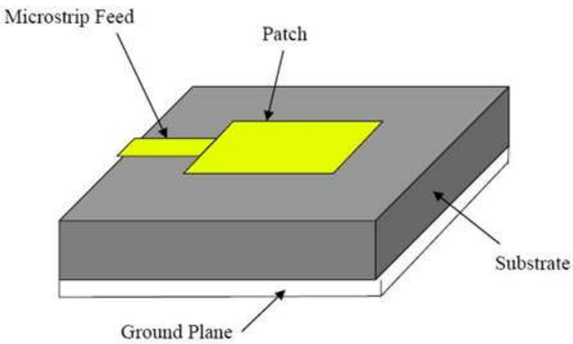

Figure 1 Microstrip Line Feed

In such a forwarding technique, a conductor strip is directly attached to the edge of the microstrip portion as shown in the figure. The conductor strip is smaller in width than the part and this type of feed arrangement has the advantage that the feed can be etched into the same substrate to give a planar structure.

The purpose of the inset cut in the part is to match the feed line impedance to the part without the need for any other matching components. This is accomplished by properly controlling the inserted position. It is therefore a simple feeding scheme, as it provides fabrication ease and simplicity in modeling and impedance matching.

The main advantage of this type of feeding scheme is that the feed can be placed at any desired location within the path to match its input impedance. This method of feeding is easy to manufacture and minimizes duplicate writing. However, a major drawback is that it provides limited bandwidth and is difficult to model because a hole has to be drilled into the substrate and the connector extends beyond the ground plane, so it is not completely plane for thick layers ($h > 0.02\lambda o$). Also, for thicker substrates, increasing the probe length makes the input impedance more inductive, leading to matching problems. The above facts show that for thick dielectric substrates, which provide wide bandwidth, microstrip line feeds and coaxial feeds face many challenges. Non-contact feeding techniques, discussed below, solve these problems.

The part can be made of conductive material such as copper or gold and can take any possible shape such as rectangular, circular, triangular, elliptical or any other general shape. The writing path and feed lines are usually photo-etched onto the dielectric substrate. Microstrip patch antennas radiate mainly due to the fields between the edges of the patch and the ground plane. For good antenna performance, thick dielectric substrates with low dielectric constants (<6) are desirable because they provide high efficiency, large bandwidth and better radiation. However, such a configuration can increase the antenna size.

2. Literature Review

Anushi Arora (2015) Microstrip patch antenna is a type of low profile radio antenna that is mounted on a flat surface. It is a narrow band, wide-beam feed antenna made by etching the antenna element pattern in a metal trace bonded to an insulated dielectric substrate such as a printed circuit board, with a continuous metal layer bonded on the opposite side of the substrate forming a grounded plane. Its various applications include biomedical diagnosis, mobile radio, remote sensing, wireless and satellite communication. A good impedance matching condition is required between the line and the part without any other matching elements. This condition can be treated using a variety of feeding techniques.

Wei Liu (2015) Microstrip patch antenna is a type of radio antenna with a low profile, mounted on a flat surface. A narrowband and broadband feed antenna is constructed by connecting the antenna element pattern to metal traces bonded to an insulated dielectric substrate such as a printed circuit board, with a continuous metal layer forming a ground plane substrate on one side on the substrate. Its various applications include biomedical diagnostics, mobile radio, remote sensing, wireless and satellite communication. A good impedance matching condition is required between the line and the part without any additional matching agents. This condition can be achieved using various deployment techniques.

Nitesh Jha (2016), Simulation of the design of sixteen phase (hexagonal) antenna of microstrip path using edge cutting is discussed here. This antenna is fed using a probe feeder model. This is done using IE3D electromagnetic simulator. The modified antenna provides radiation parameters such as propagation parameters (S-parameters), radiation pattern and voltage standing wave ratio (VSWR). For parameter S, the value of parameter S11 has reached <-10 dB at audio frequencies 0.9 GHz, 0.87 GHz to 0.90 GHz and the value of VSWR < 2 has been achieved at the same frequencies. The proposed antennas will be useful for wireless communication applications in the 900 MHz band.

Gao, Xiang-Jun et al. (2016), In this paper, the radioactive part is placed on a Teflon substrate with a dielectric constant of 1. A coaxial feeding method is used to feed the antenna with an impedance of 50 ohms. This proposed antenna improves the return loss by -14 dBi at 3.65 GHz and -28 dBi at 5.765 GHz. The results of computer simulations show low VSWR values in both 3.6-3.7 GHz and 5.7-5.8 GHz frequency bands in WLAN standards. It shows a maximum gain of 8 dB at 3.65 GHz and 9 dB at 5.765 GHz. With the advancement in modern communication systems and semiconductor technology, many types of wireless services have been successfully used all over the world in the last few years. Antenna plays a very important role in modern communication systems. With a properly designed terminal the complexity is reduced and the receiver performance is improved. Depending on the application and the antenna operating frequency, the size, type and configuration of the antenna will be determined. **Shivaranjan Goswami (2016),** A novel high-gain, broadband H-shaped microstrip path antenna is presented in this paper. The antenna is printed on an insulated substrate, supported by a metal plate, and fed directly through a 50 ohm coaxial cable. Using the AD software package according to the specified shape, the antenna is simulated. The combined effect of the combination of these techniques and the introduction of a new stabilizer section provides a low profile, wide bandwidth, high gain and gain for a built-in antenna. Computer simulation results show that the antenna can detect wide-band characters.

Devan Bhalla (2016) The most researched area in the world of communication systems today is wireless technology and the study of communication systems is incomplete without understanding how antennas work. The last years of communication systems development have required lightweight, compact and cost-effective antennas capable of maintaining high performance over a wide range of frequencies. **Bin Yu (2017)** In the world of communication systems today, the most researched field is wireless technology and the study of communication systems is incomplete without understanding the role of the stick. A. Kasinathan et al. (2017), the characteristics of the antenna are found in terms of return loss, gain, and bandwidth. It is noted that the proposed new configuration can work with good amount of bandwidth in two different bands, i.e., 12.05% bandwidth in 1.25 GHz frequency band and 19.82% bandwidth in 2 GHz frequency band. The resonance behavior at different frequency bands makes this antenna structure suitable for many different applications with an antenna gain of 5.509 dBi and an antenna efficiency of 89%.

Nasser Agharoudi (2017) In this paper, a dual-band rectangular antenna with defects embedded in the metal ground plane is proposed. First, a rectangular path antenna resonating at 5.2 GHz was fabricated. With the DGS input on the metal ground plane, the microstrip antenna is simultaneously at 3.5GHz and 5.2GHz, suitable for WiMAX and WLAN applications. The proposed antenna thus behaves as a combined, active dual frequency band. The antenna has an RT-Duriod substrate with dielectric constant of 2.2 and length of 0.762 mm. The process was experimentally verified and the measurement results were in good agreement with the simulated results. **Amandeep Singh Sappal (2018),** The antenna has a 50Ω transmission line. A T-slot is etched into the ground plane to achieve a certain degree of miniaturization of the design. The proposed antenna has a size of 82 mm × 65 mm and a frequency of 0.297 × 0.23 × at 1.09 GHz. The antenna resonates at 1.09 GHz, which is common in ADS-B systems. The expected gain of an ADS-B antenna ranges from 1 dB to 5 dB and the measured gain is about 3.10 dB. The proposed antenna is expected to comply with ADS-B specifications.

Yasser Ebazadeh (2018), This paper presents a small rectangular strip antenna for Ku-band satellite communication applications. The proposed E-shaped patch antenna is designed to cover various applications such as broadcasting, remote sensing, and space communication. To incorporate the effect of high frequency into the process, the concept of a microstrip-based Kohl scheme is adopted to form a special frequency-dependent impedance (loss). The simple method proposed in this study is compatible with computer-aided design (CAD), and therefore, the design of Ku band micro-satellite antenna from this study will be quick and easy to use. In recent years, the need for smaller antennas for wireless communications has increased dramatically, which has led to extensive research on compact microstrip antenna design among microwave and RF engineers. Small sized antennas such as VSAT systems are one of the most suitable applications to support advanced satellite communication equipment. Ku band (12-18 GHz) is one of the choices for VSAT applications. You can get VSAT via satellite television and satellite television.

Aashika Banu (2018), in this paper they fabricated a microstrip path antenna for 4G communication. The resonance frequency of the antenna is said to be 1.8 GHz. 4G connectivity. The described antenna has a square slot in a rectangular path antenna. The material used as the substrate in the proposed antenna is made of FR4 and has a corresponding permittivity of 4.4, with voltage standing wave ratio and return loss of 1.07 and -29.19 dB, respectively. To assess the effectiveness of the antenna, feed position and feed length, width and slot width were considered.

3. Construction and Working of Micro Strip Antennas

A micro strip antenna consists of a very thin metal strip placed on a ground plane with a di-electric material in between. The emitting element and the feed line are placed by the process of embedding the image in the di-electric material. Generally, a piece or strip is chosen to be square, circular or rectangular for ease of analysis and processing. The figure below shows a micro-strip or patch antenna.

4. Antenna Characteristics

An antenna is a device designed to efficiently radiate and receive radiated electromagnetic waves. Several important antenna characteristics should be considered when selecting an antenna for the application as follows:

- Antenna radiation patterns
- Power Gain
- Directivity
- Polarization

A major factor contributing to the recent advances in microstrip antennas is the current revolution in electronic circuit miniaturization brought about by the development of large-scale integration. Since conventional antennas are often large and expensive components of electronic systems, microstrip antennas using photolithographic technology are seen as an engineering breakthrough.

In its most basic form, a microstrip patch antenna consists of a radiating path on one side of a dielectric substrate with a ground plane on the other side as shown in Fig. 1 . The part consists of a conductive material such as copper or gold and can take any possible shape. The radiating patch and feed lines can be photo-etched onto the dielectric To facilitate analysis and performance prediction, the part can be square, rectangular, circular, triangular, and elliptical or some other general shape.

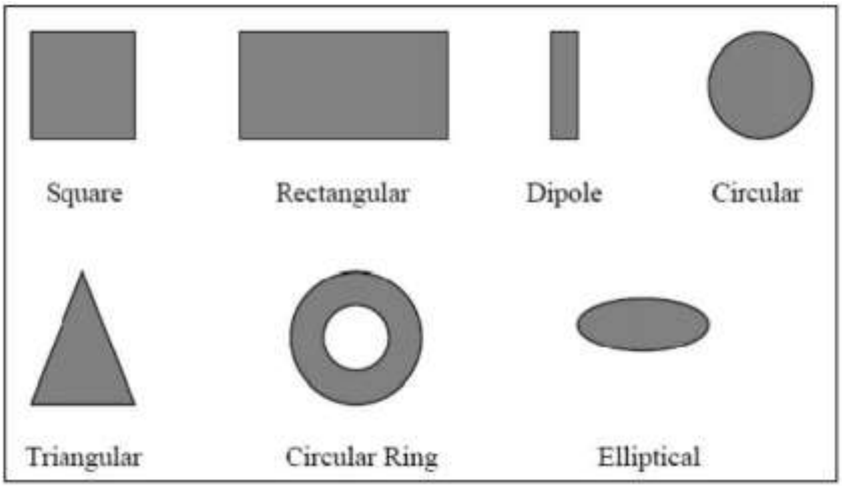

Figure 2 Common shapes of microstrip patch elements

Microstrip patch antennas radiate mainly due to the fields between the patch edges and the ground plane. To improve the antenna performance, it is desirable to have a thick dielectric substrate with a lower dielectric constant because it gives better efficiency, larger bandwidth, and better radiation.

5. Applications of microstrip antenna

Communications based applications- Microstrip patch antennas find several applications in wireless communications. For example, satellite communications require circularly polarized radiation patterns, which can be realized using square or circular patch microstrip antennas. In Global Positioning Satellite (GPS) systems, circularly polarized microstrip antennas are used. They are very compact in size and very expensive due to their location.

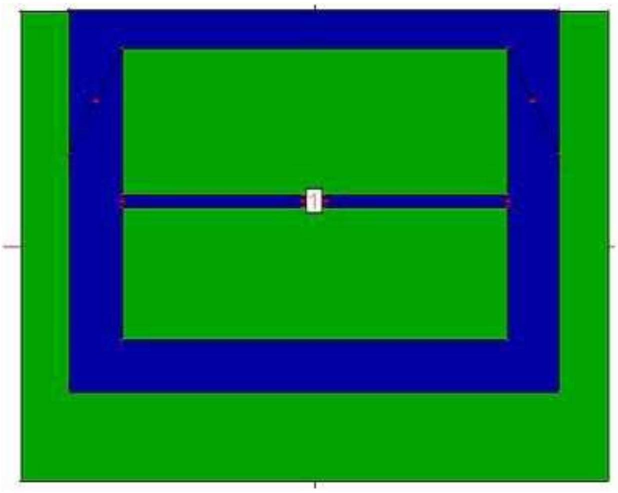

Figure 3 Geometry of textile antenna

Some communications-based applications of microstrip patch antennas include radio altimeters, command and control systems, remote sensing and environmental instrumentation, complex antenna feed elements, satellite navigation receivers, mobile radios, integrated antennas, biomedical radiators and intruder alarms , Doppler and other radios. , and satellite communications and direct broadcasting services.

Mobile communication- Mobile communications require small, low cost, low profile antennas. In some mobile handsets, semiconductor-based diodes or detectors are used as antennas. They are similar to p-n diode photo-detectors but operate at microwave frequencies. Cell phones often use widely spaced antennas. There are different types of antennas such as planar inverted-F antennas, folded inverted conformal antennas and mono poles. Also, retractable whip antennas are used in handsets. The phone consists of about 60 parts, each containing thousands or even hundreds of thousands of features.

6. Transmission Line Model

This model represents the microstrip antenna as two slots of width W and height h, separated by a transmission line of length L. A microstrip is basically a non-homogeneous line containing two dielectrics, usually substrate and air. Most of the electric field lines are in the substrate and some of the lines are in the air. Therefore, this transmission line does not support a pure transverse electromagnetic mode of transmission, since the phase velocities will be different in air and substrate. Instead, the dominant mode of propagation will be the quasi-TEM mode. Therefore, an effective dielectric constant (εreff) must be obtained for fringe and wave propagation in the line. The value of areff is smaller than er because the fringing fields around the edge of the part are not confined to the dielectric substrate but spread out in air as shown in the figure above. The expression for εreff can be given as:

Where,

εreff = Effective dielectric constant

εr = Dielectric constant of substrate

H = Height of dielectric substrate

W = Width of the patch

showing a rectangular microstrip path antenna of length L, with W lying on an elevated substrate. The coordinate axis is chosen such that length is along the x-axis direction, width is along the y-axis direction, and height is along the z-axis direction.

For operation in TM10 mode, the path length must be slightly smaller than λ/2 where λ is the dielectric mean wavelength and equal to λo/ √εreff where λo is the free space wavelength. The TM10 mode implies that the field varies by one λ/2 cycle along the length and does not vary with the width of the part. In Figure 2.7, the microstrip path antenna is shown with two slots separated by a transmission line of length L and open circuit at both ends. Along the width of the patch, voltage is maximum and current is minimum due to open ends. Edge fields can be resolved into components normal to and tangent to the ground plane.

7. Lobe Formation

In the representation of the radiation pattern, we often come across different shapes, indicating major and minor radiation fields, by which the radiation efficiency of the antenna is known.

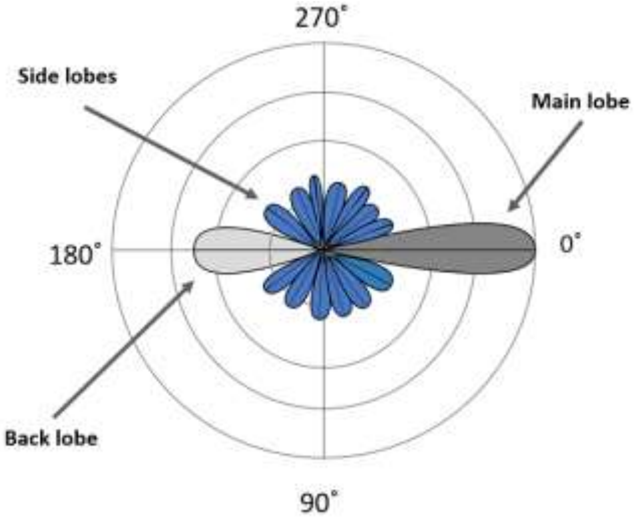

Figure 4 Lobe Formation

Here, the radiation pattern consists of main lobe, side lobe and back lobe.

• The main part of the radiated field, which covers a larger area, is the main lobe or main lobe. This is the part where maximum radiated energy exists. The direction of this lobe indicates the direction of the antenna.

• Other parts of the pattern where the radiation is distributed are side wards known as side lobes or minor lobes. Electricity is wasted in these areas.

• There are other lobes, which are just opposite in direction to the main lobe. This is known as the back lobe, which is also a minor lobe. Here also a lot of energy is wasted.

8. Conclusions

The main and unique feature of this Micro strip antenna is its simplicity for high performance. In many applications essentially in radar and satellite communication, it is necessary to design antennas with very high directive quality to meet the demand of long distance communication. The Inset feed Micro strip patch antennae array has been designed and simulated using high frequency simulation software CST. The simulation results show that the Inset feed excitation technique provides more gain and perfect impedance matching as compared to the other feed excitation technique. Also the main advantage of this feeding technique is that feed can be given anywhere within the patch making it easier to manufacture compared to other feeding techniques.

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