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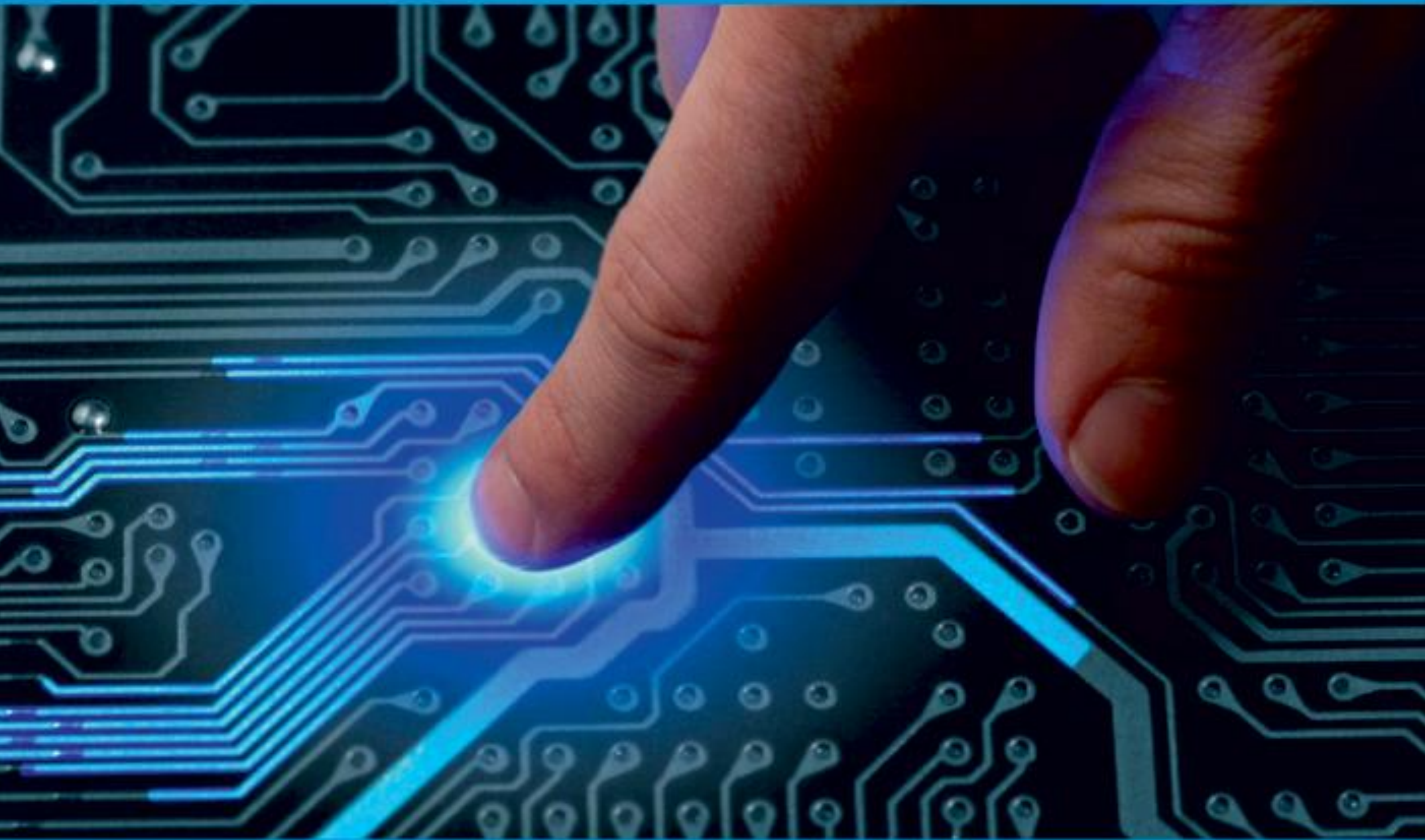

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Microstrip Patch Antenna for 5G Communication System: A Review

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ABSTRACT: - Multi band width and smaller antennas are needed formed systems. Consequently, the prolife ration of wireless Communication Networks stimulates the need of compact antennas that provide efficient operations with a broad range of frequencies covering all emerging requirements with a single antenna would be extremely desirable. In this area, the current research focuses on developing broad band or multi-band antennas covering all the desired frequencies, preserving good radiation and reducing the antenna space available. In this paper a study of microstrip antenna loading with different slot. Antennas are basic building blocks of wireless media communication. The most widely used antennas are microstrip antennas because of its viable characteristics such as compact size, low cost, simple design and light weight.

KEYWORDS:- Microstrip Antenna, Partial ground plane, Communication System

I. INTRODUCTION

Because of their low-profile shapes, light weights, and inexpensive manufacturing costs, microstrip patch antennas have been created and documented during the last many years, where different design strategies and fast solutions have been created to increase radiation efficiency. Because of their small size, weight, and affordability, low-profile antennas were utilized in airplanes, satellites, and missiles. These characteristics make it ideal for usage in airplanes, with several advantages. Despite many useful advantages they also have some drawbacks like low coefficient of performance, less power, and vary narrow bandwidth Researchers from all over the world have made tremendous fort stop and its band width. The bandwidth is increasing efficiently by either increasing the tallness of the dielectric and reduction the dielectric constant as well. The primary way to increase bandwidth is not much popular because of its low-profile structure. While the second one makes the corresponding circuit impossible to patch due to unwanted large feed lines. MPA bandwidths are also increased by using various resonators which may either directly or indirectly coupled with an antenna. That makes an impulsive impact on its bandwidth while working in different conditions. The wireless communications system has undergone enormous growth from the conventional voice signals of the first generation to the next generation (4G) of mobile technology in the last couple of decades.

Wide substrates with low dielectric constant value provide finer performance in terms of efficiency and bandwidth at the expense of size whereas narrow substrates with high dielectric constant are utilized in microwave circuitry lead to smaller element size. Basically, four configurations are used in order to feed the microstrip antennas which includes: microstrip line, coaxial probe, aperture coupling, and proximity coupling. Fabrication process and matching process for microstrip feed is quite easy but with increase in substrate thickness, surface waves also increase which limit the antenna bandwidth. In case of Coaxial-line feed, there are basically two conductors: outer and inner. The outer conductor is attached to the ground structure and inner is attached to the radiator. This is also easy to fabricate, but it provides limited bandwidth and quite tough to model, particularly considering for wide substrates whereas, modelling for aperture coupling is easy but its fabrication is tough. Proximity feed is also difficult to fabricate but provide large bandwidth in comparison to the other three configurations. Cavity model, transmission line model and full wave model are the most famous models to analyse microstrip antennas. Cavity model is little bit tough but more accurate in comparison to transmission line model. Full wave models are most complex ones but provide most accurate analysis.

II. LITERATURE REVIEW

Abhishek Javali et al. [1], Careful antenna design can have significant impact on the performance of the wireless communication link. Microstrip patch antenna has been researched for maximizing its gain and bandwidth by many

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researchers. In this paper, design of rectangular micro strip patch antenna at Wi-Fi 2.4 GHz frequency band is considered to enhance the gain and bandwidth. It is found that, by increasing the substrate height and patch length the bandwidth and gain of the rectangular micro strip patch antenna can be increased significantly.
Liya M. L. et al. [2], microstrip antennas are frequently referred to as photolithographic process antennas. The microwave frequency is where they can be used. Antennas with increased performance but reduced size and cost are always required for rapidly expanding communication technologies. Microstrip fix recieving wires are of minimal expense and simplicity of manufacture. which is utilized in numerous applications, including spacecraft and missiles. The key insight about patch antennas is examined in this paper, which will be helpful to researchers working in this field. a comprehensive look at the microstrip patch antennas and the techniques for improving their output that have helped us achieve better results.

Dipankar Saha et al. [3], common requirements in this digital version of the 5G communication system are faster data and more bandwidth. As a result, a straightforward inset feed rectangular microstrip patch antenna with a resonance frequency of 27 GHz is initially presented for use in 5G applications. A rectangular slot is later added to the microstrip patch antenna that is being proposed. An additional increase in bandwidth of up to 1.51 GHz, an acceptable return loss of -15.28 dB, a significant VSWR of 1.41, and significant directivity of 8 dBi all contribute to the inclusion of this slot. CST studio software is used for all analyses and simulations, and they are also compared to previous works. We believe that this straightforward slotted rectangular patch structure will be a suitable candidate for a 27GHz 5G antenna, even though fabrication has not yet been completed.

Maifuz Ali et al. [4], this paper presents a modification of a rectangular microstrip patch antenna (MPA) which improves the S 11 bandwidth from 6.6% to 17.5% at center frequency of 28 GHz. The gain of this antenna at center frequency has been improved by using dielectric superstate from 6.81 dB to 10.73 dB. Further, gain improvement and cross-polarization suppression are also achieved by using multi-strip frequency selective surface (FSS) as a superstrate.

M. Firoz Ahmed et al. [5], a rectangular microstrip patch antenna (MPA) is modified in this paper to increase the S 11 bandwidth from 6.6% to 17.5% at the center frequency of 28 GHz. Using a dielectric superstate has increased this antenna's center frequency gain from 6.81 dB to 10.73 dB, and using a multi-strip frequency selective surface (FSS) as a superstrate has also increased gain and reduced cross-polarization.

Bifta Sama Bari et al. [6], a Microstrip Patch Antenna (MPA) with T-shaped patch and partially grounded plane is used in this design where a T-slot is inserted into the patch. The proposed compact-size antenna is designed and simulated using Computer Simulation Technology (CST) Microwave Studio software by considering flame retardant 4 (FR-4) as substrate with a relative permittivity of 4.3 and a thickness 1.6 mm. The antenna efficiency includes, a wide impedance bandwidth of 9.31 GHz ranging from 3.19 to 12.5 GHz, for voltage standing wave ratio, VSWR < 2; 5.74 dB gain; and 6.87 dBi directivity.

Antara Ghosal et al. [7], this paper described the analysis and design of a slotted square patch microstrip antenna. Slots are introduced in a square patch to form this slotted design. This slotted square patch design is introduced to use a single structure for multi band operations. Using Ansoft HFSS software the antenna is modeled, designed and simulated. Transmission line model equation and MATLAB is used to find the design parameters for a rectangular patch antenna. The simulation and modeling of this configuration has been done using Ansoft's HFSS (High Frequency Structure Simulator) software. For TM010 mode, the resonant frequency and dimensions are computed. The antenna parameters such as return loss, radiation patterns and gain have been determined and design is optimized for best results. Network Analyzer is used for experimental results.

Robert Mark et al. [8], a semi curved formed planar microstrip reception apparatus for wideband numerous info different yield (MIMO) remote applications with wideband separation stub is displayed for remote frameworks. The radio wire comprises of two semi curved fix components with edge to edge dispersing of 0.051 λo at 3.1GHz. The stub is embedded between the two components at base of fix and a square shape indent is cut on beneath fix reception apparatus ground plane for separation upgrade and impedance coordinating improvement, separately. The structured reception apparatus has a physical components of 36×28×0.8 mm3 with estimated impedance data transfer capacity (S11<- 10dB) from 3.05-7.67GHz. The model of MIMO receiving wire with confinement stub is manufactured and reproduction results for example .Parameters, radiation design, absolute productivity and addition of reception apparatus are approved utilizing test estimations. The envelope connection coefficient (ECC) is inside 0.1, making the plan reasonable for MIMO applications.

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Pranav Srinivasan et al. [9], 3x3 reflectarray radio wire in Ku band and its components are planned and broke down in this paper. The Proposed components are titled as hexagonal coincided square shape as a result of its novel shape. The proposed recieving wire is single layered and focus bolstered. The unit cells are indistinguishable in nature what's more, the stage remuneration is accomplished by changing the postpone stubs. The primary 3x3 reflectarray reception apparatus is co-pivotally sustained utilizing a source fix resounding at a similar recurrence as the reception apparatus at 13 GHz, avoided as much as possible of 57.7mm. The return misfortune and the stage execution of the reception apparatus were agreeable and an increase of 25.978 dBi was acquired. The radio wire can discover its applications in DBS, remote getting to furthermore, fiasco the executives.

K. Vijayachandra et al. [10], subjective radio frameworks required recurrence reconfiguration, which is a basic necessity for the present remote correspondence. In this proposed work a square fix is structured at a recurrence of 4.26 GHz with two spaces on the substrate of Rogers RT/duriod 5880(tm) fix. The size of the fix is 18x18mm. Two PIN diodes are associated between the spaces for adjusting the present circulation on the fix surface what's more, it prompts re-configurability. In this investigation The planned reconfigurable fix radio wire works in nine unique recurrence groups with resounding frequencies of 2.3GHz, 3.8GHz, 4.3GHz, 6.8GHz, 8.8GHz, 12.8GHz, 13.2GHz, 14.6GHz and 16GHz. This reception apparatus reconfiguration groups are reasonable for Wi-Fi, Radio Alternatives, GSM, WLAN, RADAR and Satellite interchanges applications. Diverse recurrence groups can be stipulated by utilizing PIN diode switches. Ansoft HFSS 16 is utilized for the proposed receiving wire reproduction.

III. MICROSTRIP ANTENNA

Microstrip antennas received considerable attention starting in the 1970s, although the idea of a microstrip antenna can be traced to 1953 and a patent in 1955. Microstrip antennas, as shown in figure (2.1). It consist of a very thin metallic strip (patch) placed above ground plane. The patch and the ground plane are separated by a dielectric sheet (referred to as the substrate). There are numerous substrates that can be used for the design of microstrip antennas, and their dielectric constants are usually in the range of $2.2 \leq \epsilon_r \leq 12$.
The ones that are most desirable for good antenna performance are thick substrates whose dielectric constant is in the lower end of the range because they provide better efficiency, larger bandwidth, loosely bound fields for radiation into space, but at the expense of larger element size. Thin substrates with higher dielectric constants are desirable for microwave circuitry because they require tightly bound fields to minimize undesired radiation and coupling, and lead to smaller element sizes; however, because of their greater losses, they are less efficient and have relatively smaller bandwidths. Often microstrip antennas are also referred to as patch antennas. The radiating patch may be square, rectangular, thin strip (dipole), circular, elliptical, triangular, or any other configuration.
In high-performance aircraft, spacecraft, satellite, and missile applications, where size, weight, cost, performance, ease of installation, and aerodynamic profile are constraints, low-profile antennas may be required. Presently there are many other government and commercial applications, such as mobile radio and wireless communications that have similar specifications. To meet these requirements, microstrip antennas can be used.

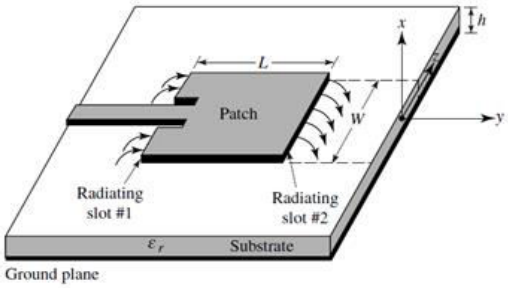

Figure 1: Microstrip Antenna

These antennas are low profile, conformable to planar and nonplanar surfaces, simple and inexpensive to manufacture using modern printed-circuit technology, mechanically robust when mounted on rigid surfaces, compatible with MMIC designs, and when the particular patch shape and mode are selected, they are very versatile in terms of resonant frequency, polarization, pattern, and impedance.
Major operational disadvantages of microstrip antennas are their low efficiency, low power, high Q poor polarization purity, poor scan performance, spurious feed radiation and very narrow frequency bandwidth, which is typically only a

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fraction of a percent or at most a few percent. However, there are methods, such as increasing the height of the substrate that can be used to extend the efficiency (to as large as 90 percent if surface waves are not included) and bandwidth (up to about 35 percent). However, as the height increases, surface waves are introduced which usually are not desirable because they extract power from the total available for direct radiation.

IV. SHAPES OF MICROSTRIP ANTENNA

The radiating patch may be square, rectangular, thin strip (dipole), elliptical, circular, triangular, or any other configuration as shown in figure 2. Rectangular patches are probably the most utilized patch geometry. It has the largest impedance bandwidth compared to other types of geometries. Rectangular and circular patch configurations have received enormous attention of researchers for their convenient analysis and design concept.

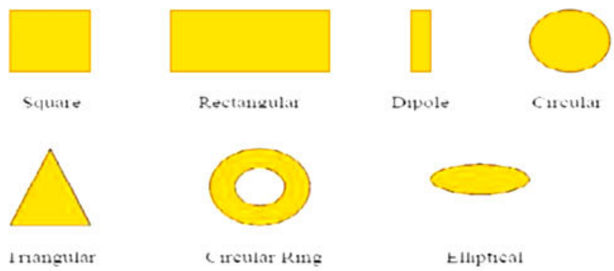

Figure 2: Common shapes of microstrip patch element

But there are certain sophisticated applications which require the analysis of other shapes such as pentagonal, triangular, patch ring, etc. But researchers paid least attention toward the analysis of the above mentioned shapes due to their structural complexity.

Circular and elliptical shapes are slightly smaller than of rectangular patches. Thus it will have smaller bandwidth and gain. This circular geometry patches were difficult to analyze due to its inherent geometry. Microstrip dipoles are attractive because they inherently possess a large bandwidth and occupy less space, which makes them attractive for arrays.

Triangular patch is even smaller than both rectangular and circular geometries. However, this will produce even lower gain and smaller bandwidth. It will also produce higher cross-polarization due to its unsymmetrical geometry. Dual polarized patch could be generated from these geometries.

Mathematical Formulation

Width of microstrip antenna is simply given as

$$W = \frac{c}{2f_0\sqrt{\frac{\varepsilon_r+1}{2}}} \qquad (1)$$

Where,

W= Width of Patch

ε_r= Dielectric constant of the substrate

Actual length of microstrip antenna is given as

$$L_{actual} = L_{eff} - \Delta L \qquad (2)$$

Where,

L_{eff}= Effective length of the patch.

ΔL = Extended electrical length

Effective length of the patch is simply given by

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}} \qquad (3)$$

Where,

ε_{reff}= Effective dielectric constant

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For low frequencies the effective dielectric constant is essentially constant. At intermediate frequencies its values begin to monotonically increase and eventually approach the values of dielectric constant of the substrate. Its value is given by,

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}} \qquad (4)$$

h = thickness of the substrate

In microstrip antenna, radiation occurs due to the fringing effects. Due to fringing effects electrical length of patch is greater than its physical length. This fringing depends on the width of patch and height of substrate [2].Now the extended electric length is given by

$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)(\frac{W}{h}+0.264)}{(\varepsilon_{reff}+0.3)(\frac{W}{h}+0.8)} \qquad (5)$$

The width of microstrip line in microstrip antenna is given as follows:

For

$$\frac{W_{eff}}{h} \geq 2$$

$$W_{eff} = \frac{2h}{\pi}\left\{\frac{\varepsilon_r-1}{2\varepsilon_r}\left[\ln(B-1)+0.39-0.\frac{61}{\varepsilon_r}\right]+B-1-\ln(2B-1)\right\} \qquad (6)$$

and for

$$\frac{W_{eff}}{h} \leq 2$$

$$W_{eff} = \frac{8he^{A}}{e^{2A}-2}$$

$$W_f = W_{eff} - \frac{t}{\pi\left[1+\ln\left(\frac{2h}{t}\right)\right]} \qquad (7)$$

Where, A and B are given as follows

$$A = \frac{Z_{ol}}{60}\left(\frac{\varepsilon_r+1}{2}\right)^{0.5} + \frac{\varepsilon_r-1}{\varepsilon_r+1}(0.23+0.11/\varepsilon_r)$$

$$B = \frac{377\pi}{2Z_{ol}\sqrt{\varepsilon_r}} \qquad (8)$$

V. CONCLUSION

The microstrip patch antenna is a resonant structure that comprises of a dielectric substrate in between a metallic conducting patch and a ground plane. It is the most advisable antenna since it has numerous points of interest such as light weight, low profile and simplicity of fabrication. Subsequently having numerous appealing highlights, microstrip antenna got extensive consideration for several applications like mobile communications, satellite communications, radar, and other many types of equipment. However, they have constrained bandwidth and inferior radiation attributes that restricts the application in practice. In this endeavour, an attempt has been made to upgrade the bandwidth with better radiation characteristics of the antenna by approach of modifying the ground plane as well as patch structures.

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