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An Analysis on Microstrip-Line Fed Different Patch Antennas for Different Band

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Abstract – In this survey paper discuss on Microstrip-Line Fed Different Patch Antennas. In the current Microstrip-Line Fed Different. Play on important role in the Microstrip-Line Fed Different. In the last decade there are many research work purposed in the Microstrip-Line Fed Different. The study reviews various patch geometries, including rectangular, circular, triangular, and modified structures, along with different substrate materials and feeding techniques, with a particular focus on microstrip-line feeding due to its simplicity and ease of integration. It examines the performance of these antennas in multiple frequency bands such as L, S, C, X, and Ku bands, highlighting key parameters including return loss, bandwidth, gain, radiation pattern, and efficiency. The survey also explores design enhancements like slots, defected ground structures, and metamaterial-inspired techniques to achieve multiband and wideband characteristics. Furthermore, a comparative analysis is presented to evaluate the advantages and limitations of different designs in terms of size, performance, and application suitability. The findings of this survey provide valuable insights for researchers and engineers in selecting and optimizing microstrip-line fed patch antennas for applications in wireless communication, satellite systems, radar, and IoT devices. In this review paper discuss on the Implementation of Microstrip-Line Fed Different. Also discuss the Microstrip-Line Fed Different Patch Antennas.

Keywords – Voltage Standing Wave Ratio (VSWR), Microstrip Patch Antenna, Gain, Returen loss (S-11) and Wireless Communication etc...

I. Introduction

The Wireless communication has been going through a radical development for the past few years. Compact antennas with proper characteristics like bandwidth, Voltage Standing Wave Ratio (VSWR) and gain are required for wireless communication. An antenna with high functionality, better performance and compact size are very important and effective. VSWR is an important parameter of an antenna. The lower the VSWR, the well-matched the antenna is. Another important characteristic of an antenna is its bandwidth (BW). The microstrip antennas (MSA) are one of the most widely used antennas due to smaller size, lower fabtication cost, dual polarization property, easy integration with pcbs (printed circuit boards).

However, it has a major drawback - a small BW. The bandwidth of MSA can be improved by using thicker substrate, by reducing dielectric constant, by using gap-coupled multiple resonator and by loading a patch. But using thicker substrate increases the antenna dimensions and also causes spurious radiation. On the other hand, practical limitations exist in decreasing the value of dielectric constant.

As previously stated, BW of an antenna can be achieved by using the concept of gap-coupled. In this case, a patch, placed close to the fed patch, gets excited through the coupling between the patches. If the resonant frequencies f1 and f2 of these patches are close to each other, then broad bandwidth is obtained. The overall input VSWR will be the superposition of the response of the two resonators resulting in a wide bandwidth [6]. Half-hexagonal gap coupled MSA (H-HMSA) with indirect microstrip line resonator (MLR) feed has been proposed. There it has been shown that this H-HMSA gives much larger BW of 8% i.e. more than twice comparing to that of a conventional co-axial fed H-HMSA. Gap-coupling, a parasitic layer to a microstrip patch antenna is a popular technique to increase bandwidth as it circumvents the need to thicker substrates or low-k dielectrics, thus achieving more efficiency. Most studies of gap-coupled structures have been carried out on rectangular patches. However, some researchers have reported that, using a semi-circular or triangular patch as the parasitic element results in a bandwidth twice that of the rectangular patch or even more. This provides evidence that the patch-geometry might have a substantial effect on the radiation efficiency of the antenna. In spite of this, a comprehensive review of this effect for different patch geometries is yet to be found in the literature. To meet this need, we report the performance of the gapcoupled antenna for various polygonal shapes of the parasitic patch.

- An antenna is defined as “a usually metallic device (as a rod or wire) for radiating or receiving radio waves.”
- The IEEE Standard Definitions of Terms for Antennas (IEEE Std 145–1983) defines the antenna as “a means for radiating or receiving radio waves.”
- In other words the antenna is the transitional structure between free-space and a guiding device, as shown in Figure.1.

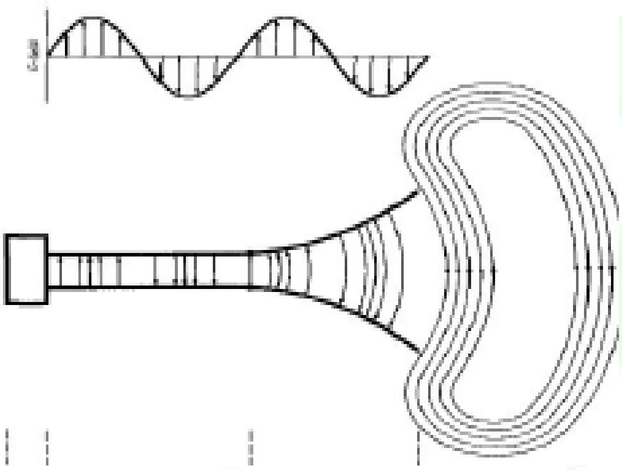

Fig 1 Defines the Antenna

There are Different Types of Antennas, like :

- Aperture Antennas
- Dipole Antennas
- Monopole Antennas
- Loop Antennas
- Travelling Wave Antennas
- Reflector Antennas
- Aperture Antennas
- Microstrip Patch Antennas
- Isotropic Antenna (or Isotropic Radiators)

II. LITERATURE SURVEY

Chandiea, L., et.al.(2017)-From the simulation results, the pentagon shaped microstrip patch antenna with three different dimensions of the substrate and patch, it can be observed that the design 3 with an operating frequency of 7.7GHz gives the finest results with a gain and bandwidth of 5.5 dB, 0.3 GHz respectively. Though design 2 gives a bandwidth of 0.7GHz and gain of 2.74 dB its performance is not at its resonant frequency of 7.7 GHZ, instead it is at 7GHz. Design 1 gives a gain of 2.67 dB which is lower than the other two proposed designs **[01] .**

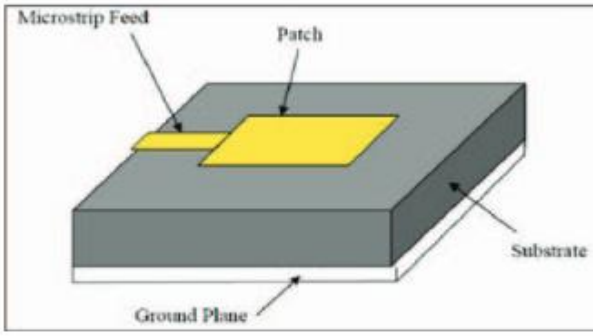

Fig 1 Microstrip Patch Antenna

Shanmuganatham, T. et.al.(2017)-Dual band Microstrip Caution patch antenna with FR4 epoxy substrate utilizing a coaxial feed scheme was designed and simulated. The two most useful frequencies included 3.52 GHz and 4.39 GHz **[02].**

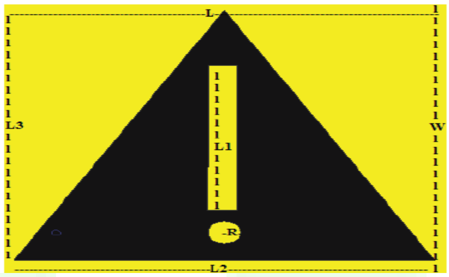

Fig 2 Geometry of the proposed antenna

Chakravarthy, S. S., et.al. (2016) **-** A microstrip patch antenna is a planar directional antenna in which a metal patch is placed on top of a dielectric substrate which in turn is placed on top of a metal ground plane. The power transfer between a source and antenna is done through a feed line. In general, the characteristic impedance of a transmission line is 50 ohms. By maximum power transfer theorem, the patch antenna should be fed at a point where input impedance is 50 ohms for maximum input power. There are several feeding techniques for patch antenna to match this condition. In this paper, a comparative study between inset feed, co-axial feed, aperture feed and proximity feed of a rectangular micro-strip patch antenna is done on the basis of S11 parameter, VSWR, directivity, beamwidth, bandwidth and radiation pattern **[03].**

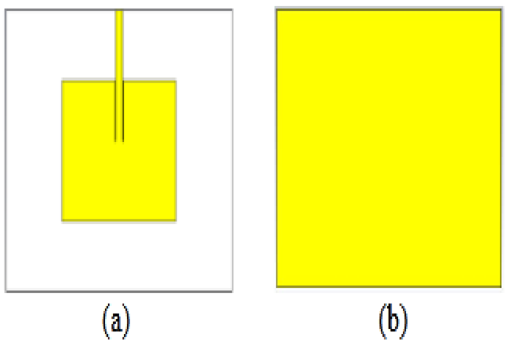

Fig 3 Inset fed antenna a) Front view b) Back view

Verma, S., et.al. (2016) - In this paper, a small microstrip patch antenna has been proposed for 5G wireless standard. The stupendous increase in mobile data, technologies are approaching from 4G i.e., fourth generation to 5G, fifth generation. The antenna resonates at 10.15 GHz with a return loss of -18.27dB and can be used in future 5G wireless devices. The proposed patch antenna shows good radiation pattern and good gain of 4.46dB. The structure of the antenna is very low profile i.e., 20 mm ×20 mm × 1.6 mm and can be easily integrated in devices where space is a major issue **[04].**

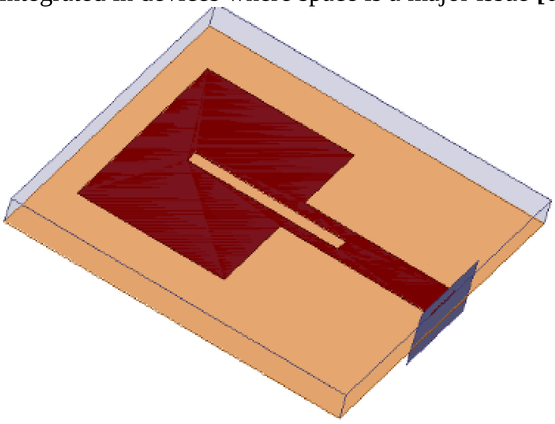

Fig 4 3D View of Proposed Patch Antenna in HFSS

Patkar, K., et..al. (2016,) -These configurations of micro strip patch antenna feed by using a micro strip feed line technique are designed for L-Band Applications. Design & simulate of rectangular, circular and triangular patch antenna at the frequency range of 1.5 GHz in CST Microwave studio software. Antenna parameters such as Directivity, Bandwidth and Return loss are found with good results.**[05]**

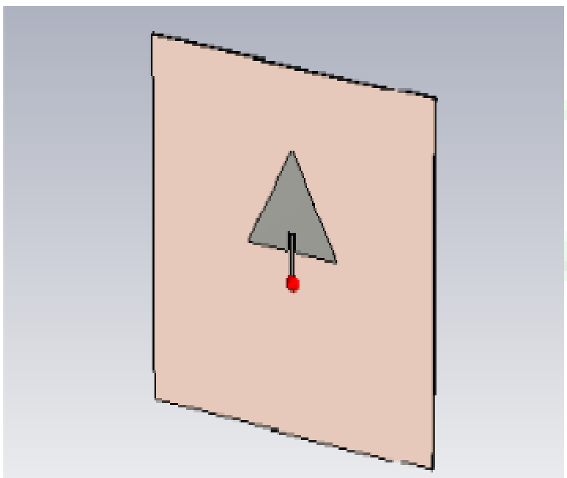

Fig 5 Micro-strip patch antenna with Rectangular micro-strip patch antenna

Joshi, A., et.al.(2015, December) - In this paper, effect of polygonal slot in polygonal patch antenna design to improve gain characteristics is studied. The pentagon and hexagon shaped patch antenna with pentagonal and hexagonal slot is analyzed respectively. The central polygonal slot is analyzed by varying the radial distance of the slot from 0 to 26 mm. It was observed that pentagon shaped patch antenna with pentagonal slot of 15 mm radial distance improves the gain at 18 GHz. Similarly, hexagon shaped patch antenna with hexagonal slot improves the gain at 18 GHz at a radial distance of hexagonal slot of 16 mm. It is observed that bandwidth, input impedance, farfield gain and surface current of a pentagonal patch antenna are optimum at radial distance of pentagonal slot of 15 mm. Similar observations were found with hexagonal patch antenna with the hexagonal slot of 16 mm. Optimum gain for both the patches is between 18 to 20 GHz [**06].**

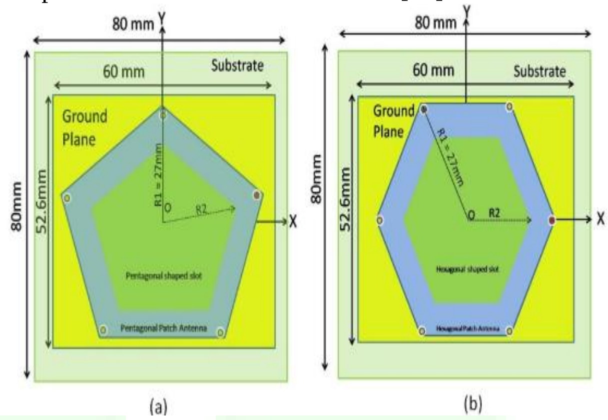

Fig 6 chematic of (a) Pentagonal shaped patch antenna with pentagonal slot (Antenna:A1) (b) Hexagonal shaped patch antenna with hexagonal slot (Antenna:A2).

Sidhu, S. K., et.al. (2015) **-** From the simulation analysis of the rectangular, circular, square, elliptical, pentagonal and hexagonal microstrip patch antennas it is observed that at 7.5 GHz of operating frequency the pentagonal patch antenna gave the bestresults with a gain of 9.09943 dBand bandwidth of 1.24 GHz [**07].**

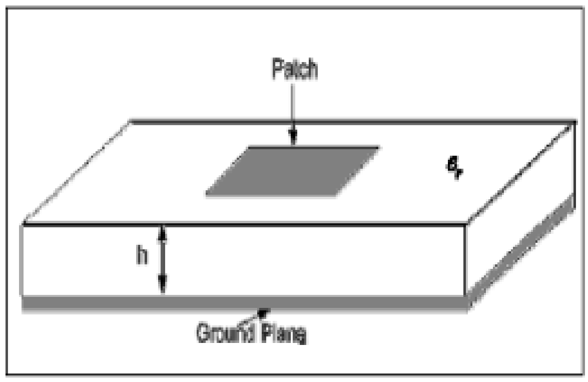

Fig 7 Microstrip patch antenna

III. MICROSTRIP PATCH ANTENNA

A Microstrip Patch Antenna consists of a conducting patch on a grounded dielectric substrate .

- The patch can be of different shapes like, rectangular, square, circular, elliptical, triangular, ring shape etc., where rectangular and circular are the most commonly used patch shapes.
- Now a days triangular shape patches are also gaining interest because of their physically smaller area than other patch shapes at the same resonance frequency.

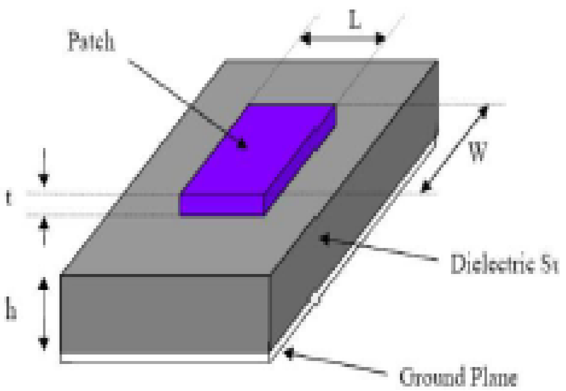

Fig 8: Microstrip Patch Antenna

IV. Feeding Techniques in Microstrip Patch Antenna

- Feeding technique is an important issue in designing of a micro-strip patch antenna.
- Feeding method is actually a way to excite the electromagnetic fields in the patch antenna such that the patch radiate the maximum accepted EM fields.
- There are different feed techniques defined under two broad categories i.e. contacting and non contacting feed methods. These are :

Microstrip Feed Line

- Coaxial Probe Feed
- Aperture Coupled Feed
- Proximity Coupled Feed

Table 1: Compare the different type of feeding techniques

Feeding Technique	Structure Type	Bandwidth	Spurious Radiation	Fabrication Complexity	Impedance Matching	Efficiency	Advantages	Disadvantages
Microstrip Line Feed	Planar	Narrow (2–5%)	High	Very Low	Easy	Moderate	Simple design, low cost, easy integration with PCB	Higher radiation losses, limited bandwidth
Coaxial Probe Feed	Non-planar	Narrow–Moderate	Low	Moderate	Good	Moderate	Better matching, low spurious radiation	Inductive effect at high frequency, difficult fabrication for thick substrates
Aperture Coupled Feed	Multilayer	Moderate–Wide (10–20%)	Very Low	High	Good	High	Improved bandwidth, good isolation between feed and patch	Complex design, multilayer alignment required, higher cost
Proximity Coupled Feed	Multilayer	Wide (>20%)	Very Low	Very High	Excellent	Very High	Highest bandwidth, high efficiency, minimal radiation loss	Very complex fabrication, precise alignment needed

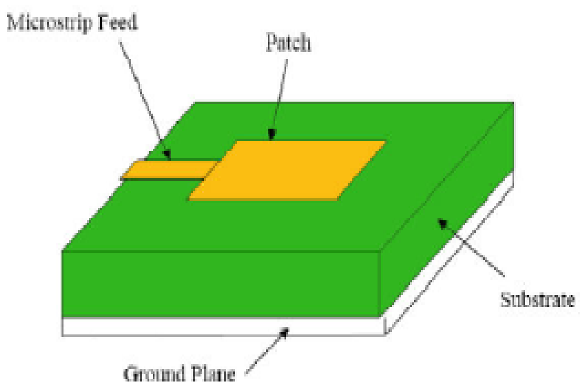

Fig 9 Microstrip Feed Line

- Microstrip Feed Line is a conducting strip, usually of much smaller width compared to the patch .
- It is easy to fabricate, simple in impedance matching and rather simple to model

V. Conclusion

In conclusion, this survey has presented a comprehensive analysis of microstrip-line fed patch antennas and a detailed comparison of various feeding techniques used in Microstrip Antenna (MSA) design for different frequency bands. The study highlights that the performance of patch antennas is significantly influenced by the choice of feeding method, substrate material, and patch geometry. Among the feeding techniques, microstrip line and coaxial probe feeds offer simplicity, low cost, and ease of fabrication, making them suitable for compact and low-frequency applications, although they are limited in bandwidth and may suffer from higher losses. On the other hand, aperture-coupled and proximity-coupled feeding techniques provide enhanced bandwidth, improved efficiency, and reduced spurious radiation, making them more appropriate for high-frequency and broadband applications such as satellite communication, radar, and modern wireless systems. The survey also emphasizes that no single feeding technique is universally optimal; instead, the selection depends on specific design requirements, including bandwidth, gain, efficiency, size, and fabrication constraints. Overall, this work provides valuable insights into the trade-offs involved in different feeding mechanisms and serves as a useful reference for researchers and engineers in designing efficient and application-specific microstrip patch antennas for emerging communication technologies.

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