A Review Paper On Microstrip Patch Antenna

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Abstract— Dual or multiband antenna has been playing a crucial role for communication in this rapidly evolving wireless communication world. Antennas are based on transmission or reception of electromagnetic waves. Microstrip antennas have several advantages over conventional microwave antennas and is widely used in various wireless communication systems due to its compact size, low profile, and ease of integration with other electronic components. It consists of a thin metallic patch, typically made of copper, mounted on a dielectric substrate, which is usually a thin layer of fiberglass or ceramic material. The patch is fed by a coaxial cable or a microstrip transmission line, which is connected to a feeding point on the patch. The radiation pattern of the antenna is determined by the shape and dimensions of the patch, as well as the substrate material and thickness. Microstrip patch antennas can be designed to operate at different frequencies, and can be used for various applications such as in mobile phones, wireless routers, and satellite communication systems. This paper presents a review of Microstrip antennas with different feeding techniques.

Keywords: Coaxial feed, Microstrip line feed, Inset feed, Electromagnetic coupling.

I. INTRODUCTION

Wireless communication is rapidly increasing in recent years. Wearable technology has a long history, dating back to the early 20th century. The first true wearable technology device was the calculator watch, which was introduced in the 1970s. This device combined a digital watch with a calculator, and was popular among students and professionals who needed to perform quick calculations on the go. Heart rate monitors, Smart watches also were introduced. In recent years, wearable technology has continued to evolve and expand, with devices like the Apple Watch and the Google Glass pushing the boundaries of what is possible. Today, wearable technology is used in a variety of applications, including healthcare, fitness, entertainment, and more. With advances in artificial intelligence and machine learning, the potential for wearable technology to transform our lives in new and exciting ways is greater than ever before. Wearable technology refers to electronic devices that can be worn on the body, either as clothing or accessories, and are designed to perform a specific function. This can include tracking and monitoring health and fitness data, receiving notifications and alerts, controlling other devices, and even augmenting reality. Wearable technology can also include the use of antennas for communication purposes. Fig 1 represents the microstrip patch antenna. Antennas are used to transmit and receive signals wirelessly, and can be incorporated into wearable devices to enable communication with other devices or networks.

A conventional microstrip antenna in general consists of a conducting patch printed grounded microwave substrate with ground plane. A microstrip patch antenna (MPA) is made up of a ground plane on one side of a dielectric substrate and a conducting patch of any non-planar or planar geometry on the other. It is a printed resonant antenna for semi-hemispherical coverage narrow-band microwave wireless connections. The planar design of the microstrip patch antenna and ease of integration with microstrip technology have made it

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popular. The most basic and widely used microstrip antennas are rectangular and circular patches. The substrate thickness, strip, width, and dielectric constant determine the microstrip line's characteristic impedance. In Microstrip Patch Antennas Bandwidth is directly proportional to the thickness of the substrate used, however, it may increase the total volume of the microstrip patch antenna.

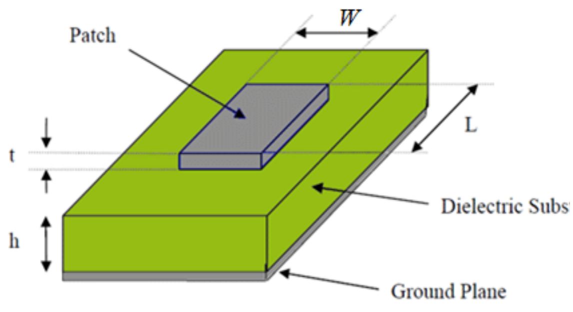

*Fig 1***:** Structure of microstrip patch antenna

II. LITERATURE SURVEY

Antenna is one of the important element in the publication by Constantine A. Balanis [1] system for receiving, transmitting signals from and into the air as medium. Without proper design of the antenna, the signal generated by the RF system will not be transmitted and no information or signal can be received at the receiver. Antenna design is an active field in communication for future development. Many types of antenna have been designed to suit withmost devices. The concept of microstrip antenna with conducting patch on a ground plane separated by dielectric substrate was undeveloped until the revolution in electronic circuit miniaturization.

In the paper by Sakshi Singh & Jitesh Kumar [2], a theoretical survey on microstrip patch antenna is presented. It describe the Micro strip antenna with different substrates and radiating elliptical patch of fixed dimensions. Lower gain and low power handling capacity can be overcome through an array configurationand slotted patch. The effects of the dielectric constant of the perfect and lossy substrates on the resonant frequency, bandwidth and gain are investigated. A gain decrement of 1.3 dB per decade is observed. Return loss, input impedance, radiation patterns and current distributions are investigated and presented with the help of Ansoft-HFSS. Performance evaluation of the microstrip elliptical patch antenna on different substrate materials with permittivity varying from 1.006 to 4.4 is simulated. Bandwidth of 88% is obtained in the case of RT-duroid, whereas FR4 only 63% is achieved.

In the publication of M. Ramkumar Prabhu and S. Shanmugapriya [3], the performance of a microstrip elliptical patch antenna is investigated using different substrate materials Fig 2 Process of building star shaped patch antenna. A new wideband and compact star-shaped patch antenna is suggested, which is capacitively supplied by a tiny diamond-shaped patch shown in Fig 3. The proposed antenna has bandwidth of 81% over the frequencies 4-8.8 GHz. HFSS high frequency simulator is employed to analyze the proposed antenna and simulated results on the return loss, the E- and H-plane radiation patterns and Gain of the proposed antenna are presented at various frequencies. The antenna is able to achieve in the range of 4-8.8 GHz an impedance bandwidthof 81% for return loss of less than -10 Db.

In the paper by Norbahiah Misran & Mohammed N. Shakib [4], a new design technique for enhancing bandwidth that improves the performance of a conventional micro strip patch antenna is proposed and is shown in Fig 4. It presents a novel widebandprobe fed inverted slotted micro strip patch antenna. The design adopts contemporary techniques; coaxial probe feeding, inverted patch structure and slotted patch. The composite effect of integrating these techniques and by introducing the proposed patch, offer a low profile, broadband, high gain, and low cross-polarization level.

Adil Hameed Ahmad and Basim KhalafJar'alla [5], are suggested many techniques and analyses for rectangular micro strip antenna (RMSA) operating in X-band for 10 GHz .The design of a RMSA is made to several dielectric materials, and the selection is based upon which material gives a better antenna performance with reduced surface wave loss. Fig 5 represents the modified microstrip patch antenna. Duroid 5880 and Quartz are the best materials for the proposed design to achieve a broader Bandwidth (BW) and better mechanical characteristics than air. Broadening the bandwidth of the rectangular microstrip antenna was achieved by using a method of lowering quality factor, shift feeding point position, reactiveloading and modification of the patch shape The overall antenna BW for RMSA is increasedby 11.6 % with Duroid 5880 with shifted feeding point and with central shorting pin while thatfor Quartz is 17.4 %.

Publication by Marcus Grilo and Fatima Salete Correra [6] presents a rectangular patch antenna fed by proximity coupling fabricated on textile substrate. The design and performance of textile rectangular patch antennas fed by proximity coupling and by coaxial probe are presented in Fig 6 and Fig 7. Feeding structure employs a quarter-wavelength transformer cascaded to an open-ended transmission line electromagnetically coupled to the radiator. The measured antenna bandwidths were 5.7% for the coaxial probe fed antenna and 11.8% and 15.5% for proximity coupling fed antennas using 5 mm and 6 mm input line widths, respectively. It was noticed that distinct bandwidths can be achieved by adjusting the feeding line dimensions and radiator width.

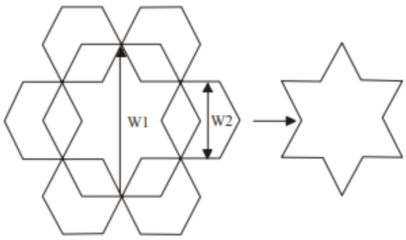

Fig 2: Process of building star shaped

Patch antenna

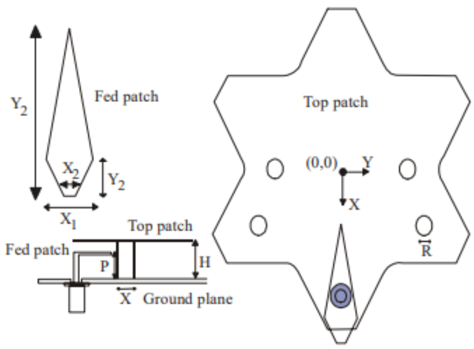

Fig 3: Geometry of proposed antenna with diamond shaped patch antenna

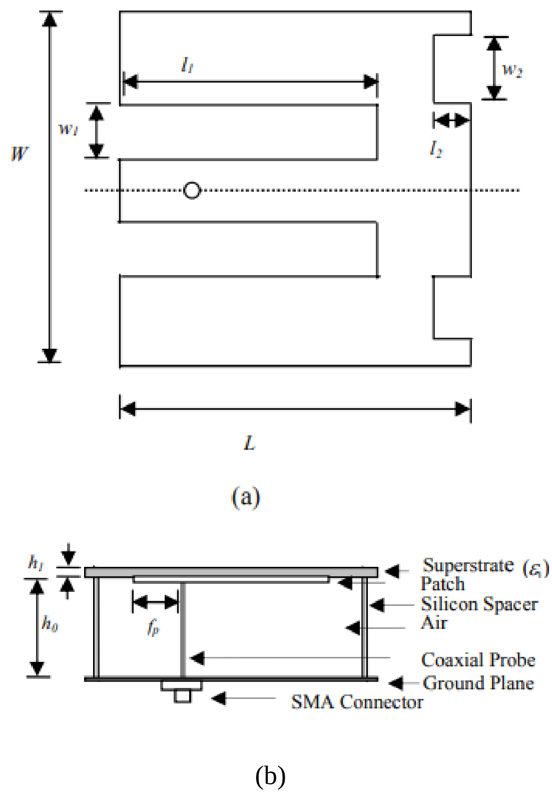

Fig 4: Geometry of proposed antenna
(a)Top view
(b)Side view

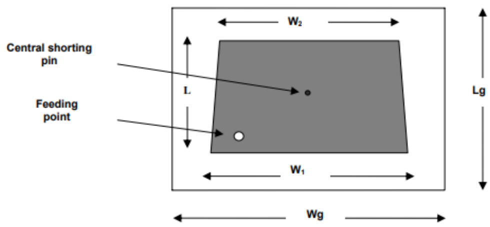

Fig 5: Modified microstrip patch antenna

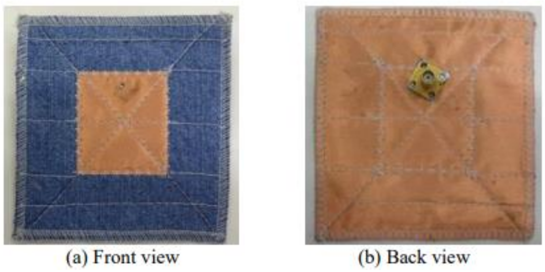

Fig 6: Antenna fed by coaxial probe

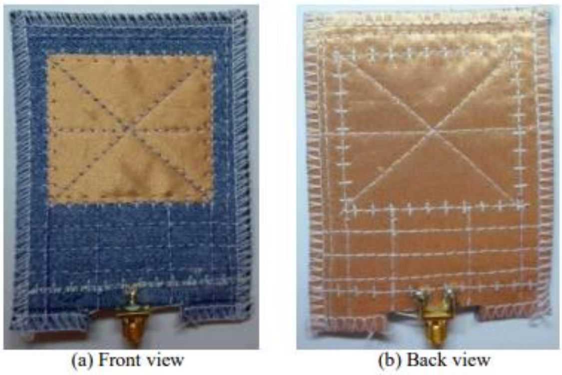

Fig 7: Antenna fed by proximity coupling

III. FEEDING TECHNIQUES

A. *Coaxial probe feed:*

The coaxial feed or probe feed is very common feeding technique used for the microstrip patch antenna. In this feeding technique, the inner conductor of the coaxial cable is connected to the radiating patch of an antenna and the outer conductor is directly connected to the ground plane shown in fig 8(a).

Coaxial probe feed is easy to fabricate and match but more difficult to model. The main advantage of the coaxial probe feed method is that feed can be placed at any desired location in order to match the input impedance. And its disadvantages are narrow bandwidth, difficult to model especially for a thick substrate.

B. *Microstrip Line Feed:*

Microstrip Line Feed showed in Fig 8(b). It is one of the easier methods to fabricate and it is a just a conducting strip connected directly to the edge of the patch which is smaller in dimension as compared to the patch. It is very simple in modelling and easy to match with input impedance 50Ω or 75Ω and this can be achieved by controlling the inset position. However, the drawback of this method is that as substrate thickness increases, spurious radiation increases which limit the bandwidth (typically 2-5%). Perfect matching can be performed by controlling the length and width of the patch.

C. *Inset Feed Line:*

Inset feed causes the voltage minimum to the shift away from the Centre of the patch and moves towards the edge of the patch. The parameters Return Loss and Impedance of inset feed microstrip patch mainly depend upon the inset gap “Gpf” and inset distance “Fi” as shown in Fig 8(c).

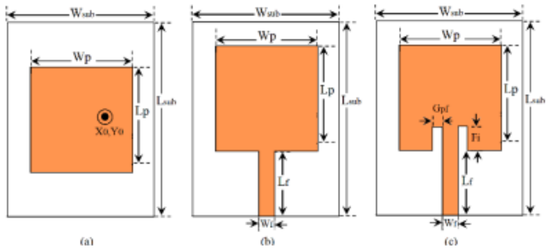

Fig 8: Geometries of the antenna
(a) Coaxial
(b) Microstrip line feed
(c) Inset feed

IV. ANTENNA GEOMETRY AND DESIGN

The geometry of micro strip patch antenna consist of four parts; radiating element patch, dielectric substrate, ground plane and feed line. Patch is a radiating and it can be available in different shapes like square, rectangular, circular, triangular etc. Feed line distributes RF power to different Part of antenna. A patch radiates from fringing fields around its edges. Microstrip patch antennas can be fed by a variety of methods. These methods are classified into two types- contacting and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting feed. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch. The Antenna is designed using following equations (1) to (6).

Width of the patch:

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

Effective dielectric constant:

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

Length extension:

$$\Delta L = 0.412h[\frac{(\varepsilon_{reff}+0.3)}{(\varepsilon_{reff}-0.258)}][\frac{(\frac{W}{h}+0,264)}{(\frac{W}{h}+0.8)}] \qquad (3)$$

Length of patch:

$$L = \frac{c}{2f_r \approx \sqrt{\varepsilon_{reff}}} - 2\Delta L \qquad (4)$$

Width of substrate:

$$W_s = w + 6h \quad (5)$$

Length of substrate:

$$L_s = L + 6h \quad (6)$$

V. CONCLUSION

The microstrip antennas has wide range of application because of its obvious and noticeable advantages but the traditional microstrip antennas also have some disadvantages low gain, narrow bandwidth and larger size. From this review, it is understood that many efforts are going on to overcome some of the limitations of conventional microstrip antenna characteristics. A theoretical survey on microstrip patch antenna is presented in this paper. Some characteristics of feeding technique and various antenna parameters are discussed. It can be deduced that using the coaxial fed can improve the results further, leading to a better antenna design. MSA are still considered under-development, although they have already replaced traditional antennas in application.

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