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A Survey of Microstrip Patch Antenna for MIMO

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ABSTRACT: Gradual improvement of design of microstrip patch antenna for multiple inputs and multiple output system researcher have been urged to deploy wideband antenna to enhance the features of MIMO. MIMO technology has attracted consideration in wireless communications, because it present significant increases in data throughput and link range without requiring extra bandwidth or transmit power, higher spectral efficiency and reduced fading, A few techniques can be applied to improve the microstrip antenna bandwidth. These include introducing parasitic element either in coplanar or stack configuration, increasing the substrate thickness and modifying the shape of a patch by inserting slots and explore new possibilities of new wideband microstrip patch antenna for next generation.

KEYWORDS: MIMO, MICROSTRIP PATCH ANTENNA,LTE

I. INTRODUCTION

Multiple transmit and multiple receive antennas has emerged as one of the most significant technical breakthroughs in next generation wireless communications. MIMO is considered a key technology for improving the throughput of future wireless broadband data systems; MIMO is the use of multiple antennas at both the transmitter and receiver to improve communication performance. MIMO technology has attracted attention in wireless communications, because it offers significant increases in data throughput and link range without requiring additional bandwidth or transmit power, higher spectral efficiency and reduced fading. Because of these properties, MIMO is an important part of modern wireless communication standards such as IEEE 802.11n (Wifi), IEEE 802.16e (WiMAX), 3GPP Long Term Evolution (LTE), 3GPP HSPA+, 4G and 5G systems to come.

MIMO systems employing wideband microstrip patch antenna is the fastest growing field of technology which has captured the attention of day to day life in the future Wireless Communications due to their tremendous spectral efficiency. The most pressing problems in Wireless Communications will be spectral efficiency and interference in the next decade. Wireless Internet, mobile video and data communication will push the spectrum to its limitations. In the same way interference with other services will be increased by the increasing use of spectrum. Taking this into the account the most prominent task is to increase the spectral efficiency and to introduce measures for interference reduction. MIMO systems promise to reach very large data rates and there with high spectral efficiencies.

The role of microstrip antennas in the current wireless scenario and different types of microstrip antennas that are used in the design of MIMO systems are presented. These antennas are narrowband elements, which limits their application in modern high data rate wireless systems. The mutual coupling is another major issue that degrades the performance of the MIMO systems, which arises due to the smaller spacing between the antennas.

II. HISTORY OF MICROSTRIP PATCH ANTENNA

Antenna [1] is a transducer which transmits or receives electromagnetic waves. Microstrip antennas have several advantages over conventional microwave antenna and therefore are used in a variety of practical applications. Microstrip antenna was first

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introduced in the 1950s. However, this concept had to wait for about 20 years to be realized after the development of the printed circuit board (PCB) technology in the 1970s. Since then, microstrip antennas are the most common types of antennas with wide range of applications due to their apparent advantages of light weight, low profile, low cost, planar configuration, easy of conformal, superior portability, suitable for array with the ease of fabrication and integration with microwave monolithic integrate circuits (MMICs).They have been widely engaged for the civilian and military applications such as radio-frequency identification (RFID), broadcast radio, mobile systems, global positioning system (GPS), television, multiple-input multiple-output (MIMO) systems, vehicle collision avoidance system, satellite communications, surveillance systems, direction founding, radar systems, remote sensing, missile guidance, and so on. Microstrip antenna in its simplest design is shown in Figure 1. It consists of a radiating patch on one side of dielectric substrate ($\epsilon_r \leq 10$), with a ground plane on other side.

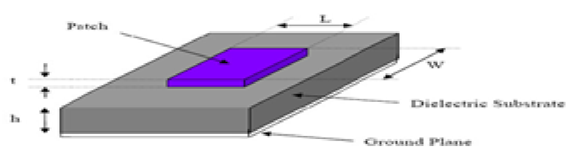
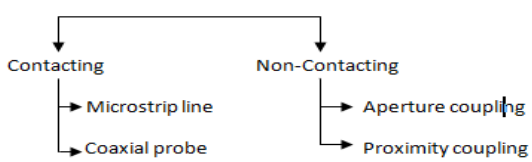


Figure 1: Microstrip antenna configuration

A microstrip patch antenna (MPA) consists of a conducting patch of any non-planar or planar geometry on one side of a dielectric substrate and a ground plane on other side. It is a printed resonant antenna for narrow-band microwave wireless links requiring semi-hemispherical coverage. Due to its planar configuration and ease of integration with microstrip technology, the microstrip patch antenna has been deeply. The rectangular and circular patches are the basic and most commonly used microstrip antennas.

III.FEEDING TECHNIQUES

Microstrip patch antennas can be fed by a variety of methods. The methods can be classified into two categories contacting and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line. In the non contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch. The four most popular feed techniques are



Microstrip Line Feed

In this type of feed technique, a conducting strip is connected directly to the edge of the Microstrip patch. The conducting strip is smaller in width as compared to the patch and this kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure. This method is advantageous due to its simple planar structure.

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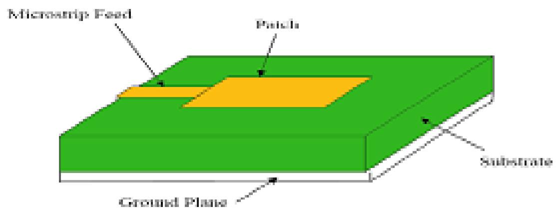

Figure 2 Microstrip Line Feed

Coaxial Probe Feed

The Coaxial probe feed is a very common technique used for feeding Microstrip patch antennas. The inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane. The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance.

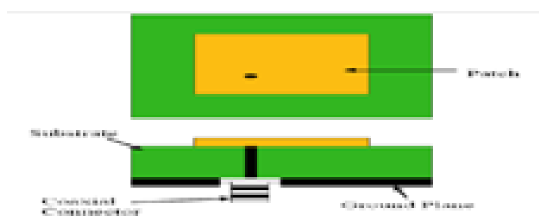

Figure 3 Coaxial probe Feed

Proximity coupled Feed

This type of feed technique is also called as the electromagnetic coupling scheme. Two dielectric substrates are used such that the feed line is between the two substrates and the radiating patch is on top of the upper substrate. The main advantage of this feed technique is that it eliminates spurious feed radiation and provides very high bandwidth (as high as 13%) due to overall increase in the thickness of the microstrip patch antenna. This method is advantageous to reduce harmonic radiation of microstrip patch antenna implemented in a multilayer substrate.

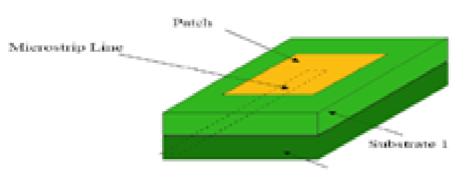

Figure 4 Proximity coupled Feed

Aperture coupled feed

In this type of feed technique, the radiating patch and the microstrip feed line are separated by the ground plane. Coupling between the patch and the feed line is made through a slot or an aperture in the ground plane and variations in the coupling will depend upon the size i.e. length and width of the aperture to optimize the result for wider bandwidths and better return losses. The coupling aperture is usually centered under the patch, leading to lower cross-polarization due to symmetry of the configuration.

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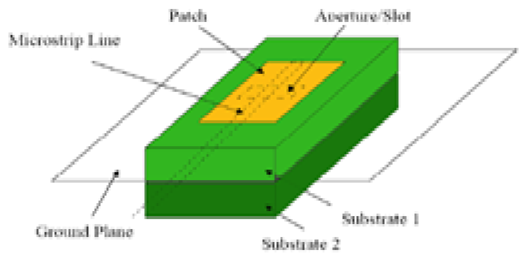


Figure 5 Aperture coupled Feed

IV. CURRENT CONFIGURED PATCH ANTENNAS TECHNOLOGY

Hamid reza Dalili [2] described a new planar microstrip ultra wideband antenna for multi input and multi output applications. To reduce the interference problems, UWB antennas with various band notch properties have used. His proposed antenna consists of hexagonal patch and a partial ground which the both of its edge have been etched. And using semi circular slot in different position to increase the bandwidth with semi-circular slot become better on the upper band with creating a resonant frequency at nearly 16.3Ghz. Also two element array of such antenna in four different configurations for MIMO applications were analyzed. Slot important roles to create the notches but leads a disadvantage i.e when this type of antenna is integrated with printed circuit board, the RF circuit cannot be very close to ground plane.

Ghyda'a M et.al [3] focuses on to enhance the bandwidth of the printed slot antenna with center E-shaped patch the overall size of this antenna is 37x37 mm2 mounted on top of FR4 dielectric material with relative permittivity of Er =4.4, and fed by a microstrip feed line printed on the bottom of the dielectric material. From the simulation results, it has been found that the antenna is able to operate at wide BW ranging from (2.35-6.91) GHz.

K. Jagadeesh Babu et.al [4] have been presented a two element MIMO system is using a multi slot patch antenna employing orthogonal polarization diversity. The proposed antenna array resonates at dual band offering an improved bandwidth of 16% with return loss and mutual coupling < -27dB. These characteristics are well suited for all 4G MIMO applications. The proposed MIMO system, the separation between the elements is 10 mm which is 0.17λ. This separation is much smaller compared to the conventional arrays which are separated by 0.5λ. The proposed MIMO array exhibits improved return loss (s11) and excellent isolation properties (S12) at the resonant frequencies 5.35 GHz and 5.81GHz. The antenna gives the -10dB bandwidth of 16%. At the resonant frequencies the values of S11 are -27dB and -32dB respectively, which gives good impedance matching for the antenna.

Rezaul Azim et all [5] described a compact planar antenna operating at a frequency range of 3–16 GHz is presented for wideband applications. The antenna is composed of a square patch fed by a microstrip line and a partial ground plane with a rectangular slot. The proposed antenna is very easy to be integrated with microwave circuitry for low manufacturing cost. The Experimental result shows that the measured impedance bandwidth (VSWR≤ 2) of the proposed antenna is 3.2-15.44 GHz, with a notch from 4.7 to 5.8 GHz.

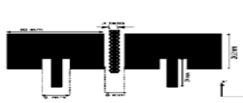
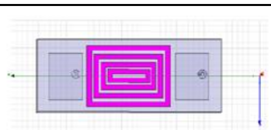
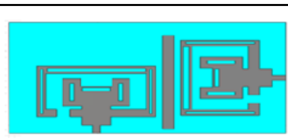
Henridass Arun et.al [6] has been proposed MSS acts like a band-reject filter to reduce the coupling between the radiators in the antenna array. The serpentine structure along with resonators helps in reducing the mutual coupling between the antenna elements operating at a frequency of 2.45 GHz. The proposed modified serpentine structure (MSS) occupies only 3 mm spacing between the antenna elements. This compactness brings the suitability of the structure at high frequencies. An isolation improvement of 34 dB has been achieved with an edge-to-edge spacing of between the radiators. The antenna array is constructed using square patch radiators designed to operate at a frequency of 2.45 GHz. The dimension of the square patch radiator is 30X29.52 mm^2. The antenna elements are placed in H-plane, and the spacing between the elements is chosen to be 6 mm, which is 1/20 of the free-space wavelength.

Arvind Kumar [7] et al focused on novel approach for gain enhancement in microstrip patch antennas using metallic rings. The design forces conversion of the surface wave energy into the space wave energy by scattering of surface waves. Electric field intensity of antenna with ring is eight to nine times higher as compare to antenna without ring and from the several simulations it is observed that whenever there is higher field intensity, antenna exhibits higher gain and the patch antenna with metallic rings achieves average gain of 10.88 dB in the frequency range of 5.5–6 GHz Hence patch with metallic ring have higher average gain as compared to patch without metallic ring.

A.A. Asaker[8]et al design of a wideband microstrip patch antenna for LTE-A. The bandwidth of the conventional patch is enlarged by using etched slots at the antenna patch. The designed antenna has been fabricated by using thin film and photolithographic technique and has been measured by using the Vector Network Analyzer. Isolation between the microstrip elements is increased by placing metal structure between antenna elements. For more isolation between antenna elements, Slotted Ground Plane SGP is utilized.

V. DIFFERENT CONFIGURATIONS TO REDUCE THE MUTUAL COUPLING FOR MIMO IN THE PRESENT LITERATURE

In Multiple inputs multiple output (MIMO) system the mutual coupling is the major issue that degrades the performance of the MIMO system and arises due to smaller space between the antennas. Researcher have been urged to deploy different techniques to reduce Mutual coupling is by including the increasing space between the antenna, polarization diversity and serpentine structure between antennas below tables shows the current technology used to reduce the mutual coupling between the MIMO system

Ref paper	Proposed Geometry of Antenna	Methods to reduce Mutual coupling	Resonance Frequency	Mutual Coupling Reduction	Edge to Edge Spacing
[9]		Simple microstrip patch element in between the antennas	**6.8 GHz**	reduced to around **−33 dB**	**0.45λ0 (20mm)**
[6]		Modified Serpentine structure (MSS)	**2.45 GHz**	**-34dB**	**0.05λ0 (6mm)**
[10]		Metamaterial with Split Ring Resonators(SRR)	**2.38GHz**	**< -25dB**	**0.125λ0 (16mm),**
[8]		Metal strip between two elements and slotted ground plane(SGP),orthogonally polarized	**2.522GHz**	**-17dB to -22dB**	**0.075λ0 ,9mm**

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VI. CONCLUSION

This paper is a survey on the technological advancements in microstrip patch antenna over 40 years. A lot of research work is going on microstrip antenna for its better utilization in the next generation wireless communication. MIMO is considered a key technology for improving the throughput of future wireless broadband data systems. Many techniques are coming into existence by compensating the gain and bandwidth of the Microstrip Antenna. Survey shows that to enhance the features of microstrip patch antenna and enhance the bandwidth by using techniques such as introducing parasitic element either in coplanar or stack configuration, increasing the substrate thickness and modifying the shape of a patch and inserting slots to explore new possibilities of new wideband microstrip patch antenna to enhance the features of MIMO and next generation

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BIOGRAPHY

NAGARAJ HANCHINAMANI was born in Karnataka, India in 1988. He received the B.E Degree in Electronics and Communication engineering and the M.Tech degree in Digital Communication and Networking from the Visvesvaraya Technological University, Belgaum in 2010 and 2012 respectively. He is currently working an Lecturer in Electronics & Communication engineering department at Government Polytechnic Bankapura, Haveri. . He is pursuing PhD at Jain University Bangalore. His research interest is on Antennas design and Wireless communication.

C.R.BYRAREDDY was born in Karnataka, India in 1967. He received the B.E. degree in Instrumentation technology and the M.E. degree in Electronics from the Bangalore University, Bangalore in 1990 and 1999 respectively. He is received Ph.D. from S V University of engineering college, Tirupathi. He is currently a professor in Electronics & Communication engineering department at Bangalore institute of technology. His research interest is on Microwave communication, Antennas and Wireless communication, Includes Analysis and design of patch antenna for Wireless communication.