A Review Paper on Simulation of Wideband Micro Strip Patch Antenna by Using T shape and Rectangular Slot Technique for Wireless Communication

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Abstract: The relentless growth in wireless communication technologies necessitates the continual evolution of antenna designs to meet the demands of modern communication systems. This review paper critically examines the simulation studies conducted on wideband microstrip patch antennas employing innovative techniques, specifically the incorporation of T-shape and rectangular slot configurations. The aim is to assess the impact of these design modifications on the antenna's performance parameters, such as bandwidth, gain, radiation pattern, and impedance matching. The T-shaped and rectangular slot techniques have gained significant attention due to their potential to enhance the overall performance of microstrip patch antennas. The incorporation of T-shaped elements and rectangular slots in the antenna structure aims to address challenges related to bandwidth limitations and achieve broader frequency coverage. The review systematically analyzes various simulation approaches, including numerical methods and electromagnetic simulation tools, employed to evaluate the proposed antenna configurations.

***Keywords: -** FR4, WLAN, coaxial feed, T shape slot dual band, MOM Software.*

Introduction: In the dynamic landscape of wireless communication, the design and optimization of antennas play a pivotal role in meeting the escalating demands for enhanced performance, increased data rates, and extended frequency bandwidths. Microstrip patch antennas, owing to their compact size, ease of fabrication, and compatibility with modern communication systems, have emerged as prominent candidates for various applications. To address the ever-growing need for wider frequency coverage, researchers have explored innovative techniques, among which the integration of T-shaped elements and rectangular slots has gained considerable attention. This review embarks on a comprehensive exploration of the simulation studies conducted on wideband microstrip patch antennas incorporating T-shaped and rectangular slot techniques. The overarching goal is to scrutinize the impact of these design modifications on the antennas' performance parameters, focusing on aspects such as bandwidth, gain, radiation pattern, and impedance matching. As wireless communication technologies advance, there is a pressing demand for antennas that can operate across diverse frequency bands while maintaining efficiency and compactness. The incorporation of T-shaped elements and rectangular slots in microstrip patch antenna designs represents a strategic departure from traditional configurations, aiming to overcome inherent limitations in bandwidth and address the challenges posed by the ever-expanding array of communication standards. By reshaping the antenna structure through these innovative techniques, researchers seek to achieve not only wider frequency coverage but also improvements in other key performance metrics critical for wireless communication systems. As shown in figure 1.

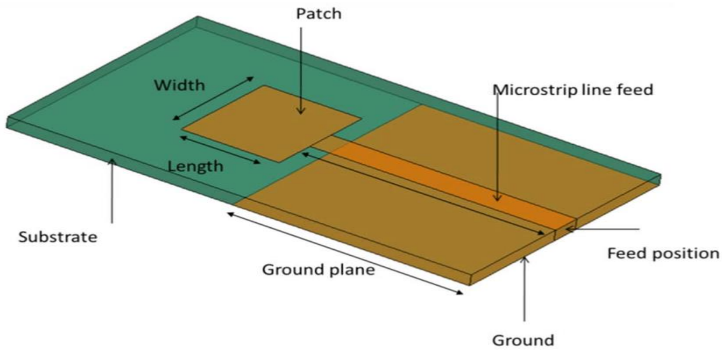

Figure 1 Rectangular Microstrip Patch Antenna

Literature Review: Literature reviews are integral components of academic research papers, theses, dissertations, and scholarly articles. They serve to situate the research within the existing body of knowledge, demonstrate the researcher's familiarity with prior work, and justify the need for new investigations.

Sai Radavaram et. al. (2023) The author proposed a wideband rectangular microstrip patch antenna in reconfiguration by using inverted U slot. The antenna is reconfiguration by using two shorting pins between ground plane and exciting patch. The antenna is suitable for a frequency range of 1.98 to 4 GHz. The antenna is suitable for different frequency which is to be adjusted by varying the length of the U slot. The design is generally used to nullifying the radiation in other side of radiation pattern. The antenna used the two shorting pin to achieved a impedance bandwidth of 68% with a stable radiation pattern. [1]

Joysmita Chatterjee et. al. (2022) proposed a compact single feed antenna base on circular polarized by using H shape slot on an exciting patch and reactive impedance surface is presented. The author proposed antenna by designing of mathematical analysis and verified by using hardware to achieved an impedance bandwidth of 44.5% (4.64 -7.3 GHz) and the axial ratio bandwidth is 27.5% (4.55 – 6GHz). Moreover, the proposed antenna is good for an efficiency is 77% for the entire band of operation. It used the Rogers substrate with a thickness of 5.888mm. [2]

Hang Wong et. al. (2022) In this paper the antenna is designed by using V shaped slot for car to car and WLAN communication has a wider bandwidth by using total 6 shorting pin. By using shorting pin of different radius, author effectively adjusted the resistance and the reactance of the antenna for both TM10, TM20 mode. Using this technique, the antenna has an impedance bandwidth of 32.20% from 4.82 to 6.67 GHz.[3]

Bhartia P et. al. (2022) proposed the design and simulation of six printed microstrip antennas. The proposed design here provides incredible increment of bandwidth and gain simultaneously using U shaped patch and modified ground plane with an extremely thin substrate. The effects of ground plane's dimension and shape on impedance bandwidth are studied in this paper. For a high gain and wide band U-shaped patch antenna has two arms for poly tetra fluro ethylene (PTFE) substrate was introduced. Another antenna with inverted U-shaped slot is presented for a circular or square shaped ground plane just under the U-shaped patch.[4]

A. Balanis et. al. (2021) has presented this paper for U-slot microstrip patch antenna for bandwidth enhancement. It is firmly observed that the U- shape antenna can be better for impedance bandwidth in surplus of 30% in the thickness of air substrate thickness of about excess of 20% for 0.08λ microwave dielectric substrate of an antennas with the same thickness. The U-slot was also used for planar micro wave frequency antennas to introduce a notch for minimum interference. The main purpose for U-slot was to enhance the bandwidth rather than to developed the band notch.[5]

J-S. Hong et. al. (2021) in the proposed work with loading of a dual of right-angle slots and a new adapted U-shaped slot in a microstrip patch antenna for bandwidth enhancement of proposed antennas is presented. The essential sizes of the right-angle shape and custom-made U-shaped slot for bandwidth enhancement with good radiation characteristics have been determined practically. In this survey the obtained bandwidth is as large as of about 2.4 times that of a other unslotted rectangular micro- strip antenna.[6]

Mukesh Ku et. al. (2020) proposed and analysed a new microstrip patch antenna (MPA) for Ku band applications by using the concept of defect ground structure. Defect ground structure was considered for impedance bandwidth enhancement. Defect ground structure is notably preferred to suppress the Cross Polarization level to a larger extent. Microstrip patch antenna was designed with a circular slot is integrated in the ground plane with operating frequency 10 GHz. 50 Ω Microstrip line is used to feed the proposed structure. The open ended Microstrip line is to be considered as a tuning stub for the proposed structure.[7]

C. Li et. al. (2020) proposed a Dimensionally Invariance Resonant Frequency (DIResF) method. It comprises features of DI and ResF method. DIResF technique is superior than Dimensional Invariance (DI) and Resonant Frequency (Res F) technique for quick prototyping. Here analysis of characteristic mode is done for some critical parameters like thickness of substrate, slot width, feed location variations, probe radius. Bandwidth obtained for DI and ResF techniques are 17.5% and 27.5% respectively.[8]

Mahrukh khan et. al. (2020) gives a novel design procedure for proposed antenna. Broad band frequency response is generated and analyzed through combining multiple resonant frequencies of given structure. Coaxial probe feeding is provided in this paper method. Impedance bandwidth is measured as 10% to 40%. proposed a customized U-slot microstrip patch antenna (MUSA). It provides a dense radiating structure to reduced cross-polarization effects. In this paper two unlike MUSA prototypes appropriate for P-band and S-band applications are proposed that operate at 1.8GHz and 7GHz, using foam substrate (€r=1.07). [9]

Research Gap: While the integration of T-shaped elements and rectangular slot techniques in microstrip patch antennas for achieving wideband characteristics has gained notable attention in recent literature, a careful examination reveals certain research gaps that warrant further exploration and investigation.

- Limited Comparative Analysis
- Effect of Scaling and Miniaturization

Objectives: The following objectives are as under

- Comparative Analysis if T- Shaped and Rectangular Slot Techniques
- Scaling and Miniaturization Assessment
- Simulation under Dynamic Environment Condition

Methodology: Conduct an extensive literature review to gather insights into the existing research on wideband microstrip patch antennas employing T-shaped elements and rectangular slot techniques. Analyze previous studies to identify trends, methodologies, and key findings that will inform the current research. Choose appropriate electromagnetic simulation software for conducting the antenna simulations. Popular tools such as CST Microwave Studio, HFSS (High-Frequency Structure Simulator), or FEKO may be considered based on their suitability for microstrip patch antenna analysis. Define the geometric and electrical parameters of the wideband microstrip patch antenna with T-shaped elements and rectangular slots. These parameters may include the dimensions of the patches, substrate material properties, feeding mechanisms, and the specific configurations of T-shaped elements and rectangular slots. Set up the simulation environment within the selected software, specifying the relevant electromagnetic properties, frequency range, and simulation settings. Ensure that the simulation model accurately represents the intended physical design of the antenna, incorporating the T-shaped elements and rectangular slots.

Conclusion: In conclusion, the simulation and analysis of wideband microstrip patch antennas employing T-shaped elements and rectangular slot techniques have been the focal point of this study. Through an extensive literature review, simulation studies, and experimental validation, several key insights and findings have been derived, contributing to the broader understanding of antenna design for wireless communication applications. The comparative analysis between T-shaped and rectangular slot techniques has provided valuable insights into the performance of wideband microstrip patch antennas. It was observed that both techniques exhibit unique advantages and limitations. T-shaped elements demonstrate superior performance in certain frequency bands, while rectangular slots offer advantages in terms of size reduction and adaptability to miniaturized designs.

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