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A Review Paper on Dual Port Shared Aperture Antenna

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ABSTRACT: Dual port shared aperture antennas represent a cutting-edge development in antenna design, integrating the advantages of shared aperture technology with dual-port functionality. Shared aperture technology allows multiple antennas to share a common physical aperture, optimizing space utilization and reducing system complexity. Dual port capability enhances these antennas by integrating two distinct input/output interfaces within the shared aperture, enabling independent operation for simultaneous transmission and reception tasks. This configuration supports advanced functionalities such as diversity reception, dual-band operation, and multiple input multiple output (MIMO) techniques, crucial for maximizing spectral efficiency and enhancing communication reliability. The advantages of dual port shared aperture antennas include compactness, efficiency in space utilization, and flexibility in adapting to various communication protocols and frequency bands. In this paper a brief review is done on different dual port shared aperture antenna.

KEYWORDS: dual port, shared aperture antenna, antenna design, communication systems, radar systems, MIMO, spectral efficiency.

I. INTRODUCTION

In antenna design, the concept of a dual port shared aperture antenna represents a significant advancement aimed at achieving enhanced functionality, efficiency, and versatility in communication and radar systems. This innovative antenna architecture integrates the benefits of shared aperture technology with dual-port capability, thereby offering several advantages over traditional antenna configurations [1]. Based on the meta surface with fractal geometry, dual-band radiation capabilities are realized with slot-coupling feedings. Because the high-band elements are nested inside the low-band radiator in this design, more compact volume is achieved compared with separated or stacked placement [2]. In this paper, a depth review has done on different co-design which shares same aperture to perform in dual band.

II.LITERATURE REVIEW

The author proposed an integrated MIMO antenna design for Sub-6 GHz & millimeter-wave applications with high isolation. The described MIMO antenna system integrates multiple antennas optimized for both sub-6 GHz and millimeter-wave frequency bands, addressing the requirements of 4G LTE, 5G, and WLAN standards. It includes triple-band monopole antennas operating at 2.5 GHz, 3.5 GHz, and 5.2 GHz, alongside dual-band, dual-function millimeter-wave antennas operating at 24 GHz and 28 GHz. These millimetre-wave antennas also serve to improve isolation between the monopole antennas in the lower frequency bands. The design achieves high isolation of -22 dB across the sub-6 GHz band and maintains a maximum envelope correlation coefficient of 0.284, indicating low correlation between antenna elements crucial for MIMO performance. The monopole antennas offer bandwidths of 1.75 GHz and 1.08 GHz, while the millimeter-wave antennas provide a 7 GHz bandwidth with gains of 8.5 dBi and 11.4 dBi at 24 GHz and 28 GHz, respectively. The antenna system is compact, straightforward in structure, and suitable for applications such as WLAN, 5G communication, and 4G LTE, offering broad bandwidth coverage, high gain, and efficient performance.

The author proposed, A shared-aperture Dual Band Antenna Design with Low profile. The antenna utilizes a meta surface featuring fractal geometry to achieve dual-band radiation using slot-coupling feedings. By nesting high-band elements within the low-band radiator, it achieves a more compact form compared to separate or stacked configurations. The lower band has a -10 dB impedance bandwidth from 4.9 GHz to 5.6 GHz, while the upper band spans from 7.4 GHz to 10.2 GHz. Excellent isolation between the ports of the two bands is achieved, exceeding -20 dB across the entire frequency range.

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The author proposed a compact dual-function antenna designed to operate at both 3.5 GHz and 28 GHz for 5G mobile applications, utilizing frequency reconfiguration technology. The antenna design features a microstrip patch connected to a meandered radiating structure via a radio frequency PIN diode, enabling seamless switching between the two frequency bands. By employing a meandered line structure and truncated ground plane, the antenna achieves significant size reduction, measuring 15.3 mm × 7.2 mm × 0.508 mm. The antenna supports 8x8 multiple-input multiple-output (MIMO) configurations with flexible antenna placement options, demonstrating robust MIMO performance with wide −10 dB bandwidths of 7.4% and 4.8% at the lower and higher frequency bands, respectively, without requiring external decoupling structures. Simulation results are validated through prototype testing, confirming accurate performance. Furthermore, a comprehensive safety analysis based on specific absorption rate (SAR) and power density guidelines for realistic human models indicates compliance with safety standards. This integrated antenna system, combining sub-6-GHz and mm-wave bands within a compact form factor and ensuring excellent MIMO capabilities, shows promise for future 5G mobile handheld devices [3].

A compact dual-band phased-array antenna system is proposed for fifth-generation (5G) smartphone communication. This antenna, designed on a single-layer substrate, features dual-band operation, wideband coverage, high gain, and beam-steering capabilities. The dual bands are achieved by integrating meandered lines and a microstrip patch antenna with a dual-stub-based filter. The antenna array, measuring 56.65 mm × 4.95 mm × 0.508 mm, is strategically positioned vertically on both the top and side metal frames of a smartphone, enabling wide beam coverage and high gain. The proposed design exhibits −6 dB bandwidths of 250 MHz and 3520 MHz at 3.5 GHz and 28 GHz, respectively, and −10 dB bandwidths of 110 MHz and 1890 MHz at these frequencies. Detailed analysis of the radiation performance with a smartphone model and a hand phantom was conducted. Additionally, a safety assessment considering power density (PD) and specific absorption rate (SAR) was performed using frequency-dependent hand and head models. A prototype of the antenna array was fabricated, and comparison with simulation results demonstrated good agreement [4].

III. RESULT AND DISCUSSION

The outcome of a dual-port shared aperture antenna refers to the performance and characteristics of an antenna system that shares a common aperture (or radiating surface) between two different ports or channels. This configuration allows the antenna to simultaneously handle signals from multiple sources or to operate in different frequency bands, offering several advantages:

1. **Increased Efficiency**: Shared aperture antennas can achieve higher efficiency compared to separate antennas for each port, as they minimize redundant radiating elements and reduce losses associated with multiple antennas.
2. **Compact Design**: By sharing a single radiating structure, the overall size and weight of the antenna system can be reduced, which is particularly beneficial for applications where space is limited, such as in mobile devices or small satellites.
3. **Improved Isolation**: Proper design of shared aperture antennas can provide adequate isolation between ports, ensuring that signals transmitted or received through one port do not interfere with signals on the other port. This isolation is crucial to maintain signal integrity and prevent degradation of performance.
4. **Versatility**: Dual-port shared aperture antennas are versatile, capable of supporting various functionalities such as diversity reception/transmission, MIMO (Multiple Input Multiple Output) communication, and simultaneous operation in multiple frequency bands.
5. **Performance Metrics**: The performance of such antennas is typically evaluated based on parameters like impedance matching, radiation patterns, gain, bandwidth, and isolation between ports. These metrics determine how effectively the antenna can operate in its intended applications and environments.

In summary, the result of a dual-port shared aperture antenna is a versatile and efficient antenna system capable of handling multiple signals or frequencies with improved performance and reduced size compared to traditional antenna configurations.

IV.CONCLUSION

In conclusion, the dual-port shared aperture antenna represents a significant advancement in antenna technology, offering several key benefits and outcomes:

1. **Enhanced Efficiency**: By sharing a common radiating aperture, the antenna system achieves higher efficiency compared to using separate antennas for each port. This efficiency gain is crucial for improving overall system performance and reducing power consumption.

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2. **Compact and Lightweight Design**: Integration of multiple ports into a single antenna structure leads to a more compact and lightweight design. This is particularly advantageous for applications where space and weight are critical considerations, such as in mobile devices, UAVs (drones), and satellite communications.
3. **Versatility and Flexibility**: Shared aperture antennas support diverse functionalities including simultaneous operation in multiple frequency bands, MIMO (Multiple Input Multiple Output) configurations, and diversity reception/transmission. This versatility makes them adaptable to various communication scenarios and environments.
4. **Improved Isolation and Crosstalk Management**: Proper design techniques ensure adequate isolation between ports, minimizing interference and crosstalk. This capability is essential for maintaining signal integrity and optimizing overall system reliability.
5. **Performance Metrics**: Evaluation metrics such as impedance matching, radiation characteristics (patterns, gain), bandwidth, and isolation between ports are critical in assessing the antenna's performance. These metrics determine its suitability for specific applications and operational environments.

Overall, the dual-port shared aperture antenna represents a sophisticated solution that combines efficiency, compactness, versatility, and robust performance. Its integration capabilities make it well-suited for next-generation communication systems, where maximizing spectral efficiency and minimizing hardware footprint are paramount. As technology continues to evolve, further advancements in shared aperture antenna designs are expected to drive innovation across various wireless communication applications.

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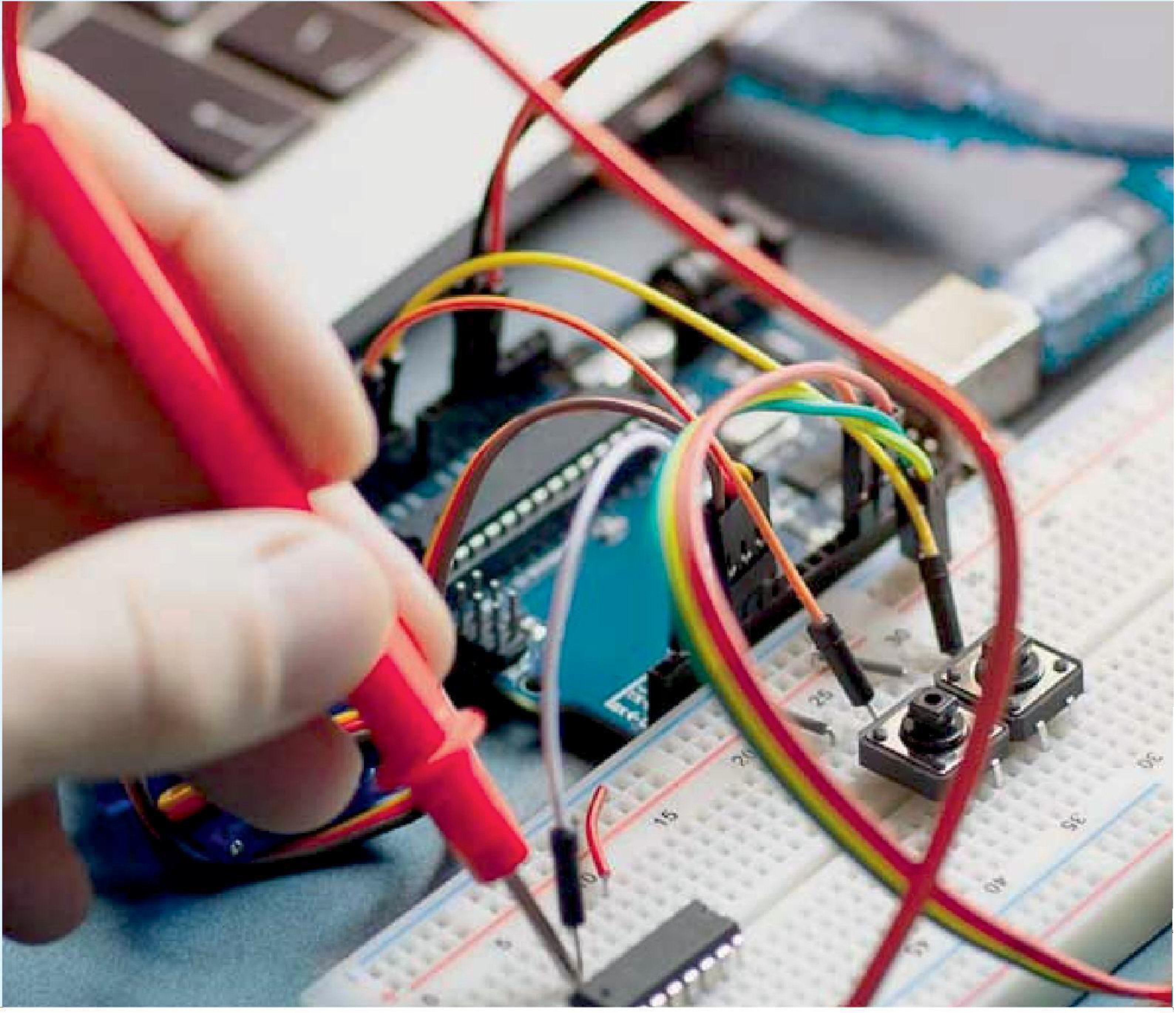

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