Printed Monopole Antenna for Multiband Applications

SARVESH S. VAZARKAR[1], ABHISHEK V. SHETE[2]
[1, 2] *Student, Department of Electronics and Telecommunications, Pune Institute of Computer Technology*

Abstract—The design and analysis of a small antenna that can be used in wireless communication systems is presented in our research study. The antenna's performance is optimized in terms of bandwidth, gain, and radiation pattern using a combination of electromagnetic simulation software Ansys HFSS. The suggested antenna is based on a microstrip patch antenna arrangement, which has a number of benefits including low profile, simplicity in manufacture, and low cost. This antenna has a T-shaped arm with two L-shaped arms on either sides forming a radiator which is excited by a microstrip feed line, printed on top of FR4 substrate material with a thickness of 2 mm on one side, while on the other side a partial ground plane is fixed. We have designed the rectangular printed monopole antenna for dual and triple band applications that include modern wireless applications such as wifi and bluetooth (@ 2,4 GHz), WLAN(@ 5.8GHz) and Wi-Max(@ 3.5GHz). Various research papers regarding topics including these multiband printed monopole antennas have been studied and a thorough literature survey has been presented in this paper.

Indexed Terms—**Printed antenna , monopole antenna , multiband applications**

I. INTRODUCTION

In the area of wireless communication, antenna design is crucial. The performance of a wireless system, including its range, data throughput, and signal quality, is determined by the design of an antenna. The printed monopole antenna is one sort of antenna that has attracted a lot of attention lately.

GSM, WiMAX, and WLAN are just a few of the applications that use printed monopole antennas. They have a number of benefits over conventional antennas, including as compact size, low profile, and simplicity of electronic circuit integration. These antennas are perfect for multiband applications because they are made to work across various frequency bands. The GSM cellular network technology uses the 900–1800 MHz frequency range and is widely utilized. A wireless communication standard known as WiMAX (Worldwide Interoperability for Microwave Access) uses the 2.3-2.7 GHz and 3.3-3.8 GHz frequency ranges for operation. WLAN (Wireless Local Area Network) is a wireless network that uses the 2.4–2.5 GHz and 5.1–5.8 GHz frequency ranges. Due to its versatility in terms of operating in several frequency bands, the printed monopole antenna has grown to be a popular option for these applications. The performance of these antennas has been further enhanced by recent advancements in printed monopole antenna design. For instance, several recent designs have concentrated on enhancing the antenna's bandwidth, which is crucial for making sure a wireless communication system is reliable and stable.

Printed monopole antennas may now be produced with greater precision and accuracy because to the advancement of manufacturing technology. These developments have made it possible to produce printed monopole antennas that perform better and are more dependable.

In summary, printed monopole antennas are a crucial component of wireless communication systems, particularly for multiband technologies like GSM, WiMAX, and WLAN. These antennas are now more efficient, dependable, and cost-effective thanks to recent advancements in printed monopole antenna design. The printed monopole antenna will undoubtedly be essential in allowing dependable and high-performance wireless communication as wireless communication systems continue to develop.

II. LITERATURE SURVEY

[1] involves a detailed description of the design process required for a printed rectangular monopole antenna for multi-band applications. Detailed

mathematical analysis is provided for the dimensions of the substrate , and that of the rectangular patch along with the microstrip feed line. Information regarding monopole antenna construction has also been presented. Relationship between feed gap (separation between patch and the ground plane) and the return loss , bandwidth ,efficiency and antenna resistance is studied and analyzed.

[2] In this paper , triple band antenna has been presented with ear shaped or circular arc shaped radiating elements. The length of the individual arc shaped strips is equal to the quarter wavelength of operation. The return loss with respect to the central angle for each strip is studied and the effects are noted. In this paper , as opposed to research papers in which rectangular strips or L shaped strips , strips with circular arc shape are used in order to provide current paths and these paths or structures , resonate at different application frequencies , according to the lengths which is approximately equal to λ/4 and the dimensions are optimized using simulation software. Three resonating frequencies are observed with sufficient bandwidths for the 2.5GHz , 3.5GHz and 5.5GHz bands.

[3] This paper presented a triple band antenna with a meandered element , a straight monopole strip and a circular arc shaped strip for WLAN and WiMAX applications. A combination of a meandered element resonating at 2.45GHz and a circular arc shaped strip resonating at 3.6GHz is a novel approach not seen previously. The current distribution obtained is consistent with the intended design of each strip. A defected ground plane is also added along with the three resonating structures in order to improve the accuracy of the resonating frequency which is achieved successfully.

[4] In this paper a novel printed monopole antenna is presented with multiband WLAN operation. It consists of two radiating elements namely a C shaped patch and a L shaped patch. The target frequency bands include the 2.4GHz,5.2GHz and the 5.8GHz bands. The longer C shaped strip resonates at the lower frequency band while the shorter strip resonates at the two higher frequency bands. The lengths of the strips are close to quarter wavelength at 2.4GHz and 5.4GHz respectively.CST optimizer is used to finalize the dimensions of the resonating strips.

[5] In this paper a T shaped monopole antenna has been presented with a single band for WLAN application at 2.4GHz.Equations for the length and width of the monopole elements are mentioned for the design part of the antenna creation process. The T shaped element is fed using a microstrip feed line. The antenna offers low values of VSWR and return loss , high gain and a good radiation pattern at the target frequency. The design is simplistic , compact and efficient.

[6] In this paper, a triple band antenna has been proposed for WLAN and WiMAX applications. The antenna structure involves a straight microstrip feedline , a rectangular patch element and two horizontal protruding elements on either side of the rectangular patch. Lengths of the radiating elements are equal to quarter or half the wavelength of operation and calculated using an empirical relation. A trapezoidal semi infinite ground plane is printed on the bottom side of the substrate which impacts the antenna radiation parameters. Three different current paths are created due to the antennas structural design which corresponds to the three different frequency bands of 2.5GHz, 3.5GHz and 5.5GHz.The simulated results are consistent with the measured results apart from minor fluctuations.

[7] A triple band monopole antenna has been proposed in this paper. WLAN and WiMax frequency bands have been considered as the application bands. The antenna consists of a Toothbrush shaped path (resonating at 3.5GHz) , a meandered line (resonating at 2.4GHz) and a horizontal U shaped patch (resonating at 5.5GHz). The antenna dimensions are optimized using the simulation software Ansys HFSS.As observed from the paper , changing length of the meandered line element lowers the resonating frequency. Altering the length of the individual bristle of the toothbrush patch affects the resonating frequency. As the length of the U shaped element is increased, the resonance frequency of 5.5GHz goes on decreasing. The size of the antenna is much more compact as compared to several of the other triple band proposed antennas.

The radiation pattern observed is omnidirectional and good values of return loss are observed.

[8] The research paper introduces a multiband low profile printed monopole antenna with a Defected Ground Structure (DGS) for future 5G wireless applications. The antenna design achieves multiple frequency bands within the 5G spectrum which are 13.6GHz, 22.12GHz and 28GHz also exhibits good radiation characteristics, and is suitable for integration into small wireless devices. The proposed design holds potential for enhancing the performance and functionality of 5G wireless communication systems. The DGS is strategically embedded in the ground plane of the antenna to enhance its impedance matching and reduce surface waves. This allows for the realization of multiple frequency bands within the 5G spectrum. The experimental results demonstrate that the antenna achieves impedance bandwidths that cover the required frequency bands for 5G communication, including the sub-6 GHz and mm Wave bands.

[9]This research paper introduces a compact multiband printed monopole antenna with hybrid polarization radiation for GPS, LTE, and satellite applications. The antenna design achieves multiple frequency bands and hybrid polarization characteristics, while maintaining a small form factor. The proposed design holds promise for improving the functionality and efficiency of wireless communication systems in these applications. To enable hybrid polarization radiation, the antenna incorporates a modified feeding structure and a dual-feed mechanism. This allows the antenna to radiate both linearly and circularly polarized waves, making it suitable for applications requiring diverse polarization options. The experimental results demonstrate that the proposed antenna achieves good impedance matching and radiation performance across the desired frequency bands. The antenna exhibits stable radiation patterns, high gain, and low side lobes, ensuring reliable and efficient communication in GPS, LTE, and satellite systems.

[10] This research paper introduces a printed double S-shaped monopole antenna designed for wideband and multi-band operation in wireless communications. The antenna design achieves broad frequency coverage, excellent impedance matching, and radiation performance. Its compact size and multiband capability make it a promising solution for various wireless communication systems requiring wideband and multiband operation. The proposed antenna design utilizes a double S-shaped monopole configuration, which offers advantages such as compact size, ease of fabrication, and wideband characteristics. The antenna structure is carefully optimized to achieve the desired wideband and multiband operation. Through comprehensive simulations and measurements, the experimental results demonstrate that the proposed antenna design achieves wideband coverage across a broad frequency range. The antenna exhibits excellent impedance matching and radiation performance, enabling reliable and efficient wireless communication. The multiband operation capability of the antenna is realized by introducing resonant modes at different frequencies

[11] This research paper presents the design and photolithographic fabrication process of a microstrip patch antenna. The paper details the design considerations and highlights the photo-lithographic technique as an effective method for fabricating microstrip patch antennas. The successful implementation of the fabrication process opens possibilities for producing customized and compact antenna systems for various wireless communication applications. To fabricate the antenna, the photo-lithographic technique is utilized. This process involves transferring the design pattern onto a substrate using a photomask and ultraviolet (UV) light exposure. The paper describes the steps involved in preparing the substrate, applying the photoresist material, exposing the pattern, and developing the antenna structure through subsequent etching processes. The experimental results demonstrate the successful fabrication of the microstrip patch antenna using the photolithographic method. The fabricated antenna exhibits the desired operating frequency, impedance matching, and radiation characteristics as per the design specifications. The research paper emphasizes the advantages of the photo-lithographic fabrication process for microstrip patch antennas, including precision, repeatability, and scalability

CONCLUSION

The above studied research papers highlight the development of compact printed antennas for various wireless communication applications. The studies focus on achieving efficient communication across multiple frequency bands, catering to the needs of modern wireless systems. The printed monopole antennas offer advantages such as simplicity, low cost, and ease of integration into small wireless devices. The experiments validate their wideband and multiband operation, demonstrating stable radiation patterns and good impedance matching. These antennas hold promise for enhancing the functionality and versatility of wireless communication systems. The research in the above studies articles focus on achieving resonance at multiple frequency bands, enabling efficient wireless communication across the targeted bands. The experiments performed confirm the antenna's satisfactory radiation characteristics, including stable patterns, acceptable gain, and wide bandwidth. Its compact size and multiband capability make it suitable for integration into diverse wireless devices and systems

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