Literature Review for Improved Mutual Coupling Techniques in UWB MIMO Patch Antenna

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Abstract

This paper discussed literature review of different authors who tried different technique to improve the mutual coupling in UWB MIMO patch antenna. Ultra-wideband (UWB) systems have been received a growing interest due to the successful applications of high throughput, multimedia streaming, radar and biomedical imaging. Federal Communications Commission (FCC) has approved the use of the frequency range of 3.1–10.6 GHz without license for low power emitting systems. The UWB systems operate over a wide bandwidth with low spectral power level. The signal to noise ratio (SNR) is hence too low at the receiver. The throughputs of the systems have been also extremely increased thanks to the recent developed data coding techniques. However, it has been almost restricted, since the emitted signals are inherently subjected to interference and multipath fading in propagating environments. The transfer rate can be excessively increased and the fading effects can be reduced by utilizing multiple input multiple output (MIMO) concept because of introducing spatially multiplexing and diversity. Designing MIMO systems with multiple antenna elements for mobile terminals has been more difficult since the mobile terminals have been towards to be smaller, and thus MIMO antenna elements must be accommodated in these constricted terminals with the other electronic components. At the same time, the elements are inevitably exposed to high mutual coupling among them, because of operating closely each other. Mutual coupling must be minimized to isolate the channels electrically to provide an efficient MIMO system.
Keywords: UWB, MIMO antenna, diversity gain, ECC, Mutual coupling and Miniaturization

I. Introduction

The wireless communication uses MIMO antenna which requires high data rate and this high data rate can be achieved by integrating UWB technology in MIMO, When MIMO is combined with UWB it mitigates the data rate, when circuits are made compact the problem of isolation also arises. While simulating antenna in MIMO these are the prime challenges faced one of this is to make size of antenna compact and the second is to increase the isolation between the all conducting antennas and to take care of fading of all the signals, so one of the challenges is to configure MIMO antenna in portable devices. MIMO antenna has gained lot of attention for research today due to various advantages such as increase in capacity, low signal loss and less multipath fading. Although it has many benefits, the main challenge lies in the design of MIMO Antenna i.e to reduce the mutual coupling between the antenna element and to provide high isolation. To reduce the mutual coupling and for improving the isolation, various techniques are employed such as Defected Ground Structure such as slits, slot, spiral square structure, EBG structure, U shaped parasitic element, stubs, neutralization line, parasitic elements, etc. The mutual coupling of more than 20 dB is obtained by employing all these techniques. Electromagnetic Band Gap (EBG) insertion but this takes more area in the antenna, another method to improve isolation is using Diffused Ground Structure (DGS) which gives more compactness, less return loss and higher bandwidth. The isolation between the MIMO antenna can also be improved by using polarization diversity technique, in which the two antennae are placed orthogonally to each other. The antenna can have different types of transmission feeding lines like CPW, lumped port feeing, waveguide feeding. To achieve better compactness the radiating antenna can share the same ground plane, in order to improve the isolation between the radiating elements stubs of different shapes can be included. Better isolation can be achieved by introducing frequency selective surfaces (FSS) and photonic band gap (PBG), Asymmetrical structures can also be included to reduce the interference between radiating parameters. Circular antenna provides high impedance in collaboration with defected ground structure and extended ground plane (EGP).

II. Literature review

Avnish Kumar Giri et. al. has proposed a compact shaped multiple-input-multiple-output (MIMO) antenna system for UWB application. The proposed design is composed of two hour glass shaped monopole radiating element, a T-shaped grounded stub and Y-shaped slot on the ground plane to reduce mutual coupling. The performance parameters of this antenna are analyzed in terms of reflection coefficient (S 11 /S 22), transmission coefficient (S 12 /S 21), radiation pattern and peak gain using ANSYS HFSS 14.0. The proposed design operating in the frequency range from 3.0 GHz to 30.0 GHz satisfying UWB criteria with an isolation of 30 dB and gain of almost 4 dB. A Y-shaped slot is etched in the ground plane to reduce the mutual coupling. The complete antenna dimension is 30 mm × 15 mm treating it as a compact antenna. The simulated results reveal that the antenna is a potential candidate for Ultra-Wide Band (UWB) applications. [1]

Shuai Zhang (2012) studied a closely-packed ultrawideband (UWB) multiple- input multiple-output (MIMO)/diversity antenna (of two elements) for USB dongle applications. In this paper the author has achieved wideband isolation can be through the different patterns and polarizations of the two antenna elements. Moreover, the slot that is formed between the monopole and the ground plane of the half slot antenna is conveniently used to further enhance the isolation at the lower frequencies and to provide an additional resonance at one antenna element in order to increase its bandwidth. The underlying mechanisms of the antenna's wide impedance bandwidth and low mutual coupling are analyzed. Based on the measurement results, the proposed antenna can cover the lower UWB band of 3.1-5.15 GHz, and within the required band, the isolation exceeds 26 dB. The gains and total efficiencies of the two antenna elements are also measured. Furthermore, a chassis mode can be excited when a physical connection is required between the ground planes of the two antenna elements. Without affecting the performance of the half slot element, the monopole can now cover the band of 1.78-3 GHz, apart from the UWB band. The proposed antenna structure is found to provide good MIMO/diversity performance, with very low envelope correlation of less than 0.1 across the UWB band.[2]

Amjad Iqbal, Omar A. Saraereh, Arbab Waheed Ahmad, and Shahid Bashir studied Mutual Coupling Reduction Using F-Shaped Stubs in UWB-MIMO Antenna A compact, high performance, and novel-shaped ultra-wideband (UWB) multiple-input multiple-output (MIMO) antenna with low mutual coupling is presented in this paper. The proposed antenna consists of two radiating elements with shared ground plane having an area of 50 x 30 mm 2. F-shaped stubs are introduced in the shared ground plane of the proposed antenna to produce high isolation between the MIMO antenna elements. The designed MIMO antenna has very low mutual coupling of (S 21 <; -20 dB), low envelop correlation coefficient (ECC <; 0.04), high diversity gain (DG > 7.4 dB), high multiplexing efficiency (η Mux > -3.5), and high peak gain over the entire UWB frequencies. The antenna performance is studied in terms of S-Parameters, radiation properties, peak gain, diversity gain, envelop correlation coefficient, and multiplexing efficiency. A good agreement between the simulated and measured results is observed. [3]

Tayyab Shabbir, Rashid Saleem and Muhammad Bilal in this paper analyzed and designed a dual port Ultra-wide-band Multiple-Input Multiple-Output (UWB-MIMO) systems. This MIMO system has an elliptical UWB antenna elements along with split ground plane decoupling structure. A low-cost FR-4 substrate is employed with compact size of 34 mm × 48 mm. The antenna elements are decoupled by employing defected ground structures and frequency selective surface based split decoupling structure. The MIMO system provides an isolation of more than 20 dB over entire UWB Bandwidth. The antenna elements are decoupled by employing an efficient decoupling structure while keeping the individual antenna match with compact size. The decoupling structure consists of square rings and dipole shape frequency selective elements and defected grounds. The defected ground plane is created by coupling a circular ring. [4]

R. Chithradevi, B. S. Sreeja designed compact Ultra-Wide Band (UWB) Multiple Input Multiple Output (MIMO) monopole antenna is presented in this paper. It consists of two identical semi-circular radiators with symmetrical stepped elliptical structure. In order to enhance the bandwidth, curved-I shaped defective ground is introduced in the ground plane. The proposed MIMO antenna accomplish a compact size of 0.333 λ 0 X 0.233 λ 0 (λ 0 is the wavelength at first lower frequency) and features a UWB ranges from 1.99 -10.02 GHz with a fractional bandwidth of 133.7 % covering Wi-Fi, Wi-MAX and WLAN applications. The inter-element edge-to-edge spacing between the antenna elements is 8.6 mm. It provides a good isolation of better than 13 dB over 1.99 GHz-4.5 GHz and 22.5 dB over 4.5 GHz -10.02 GHz without any additional isolating elements. The minimum correlation achieved in this proposed UWB MIMO antenna is <; 0.0036. The proposed antenna offers a good diversity performance. Moreover, it offers a peak gain of 8.18 dB and maximum radiation efficiency of 99.8 % and the stable radiating fields are radiates in nearly omni direction.[5]

III. Conclusion

This paper presents the detailed study and comparison of various techniques to reduce the mutual coupling in MIMO antenna which is proposed by the different authors. The various method to reduce the mutual coupling such as EBG, sliited groundplane, Rectangular DGS, U shaped parasitic element, protruding stubs, etc has been studied. These each method described above has its own advantages and disadvantages in term of complexity, cost, fabrication technique and mode of operation. The researcher had also tried to improve capacity of system, bit error rate, gain, and diversity of the MIMO antenna system. Further the stated MIMO antenna can be used for single, dual and multiband applications. There is more scope of doing research in printed MIMO antennas with compact size and multiband for various applications.

References

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