Literature Review of UWB Filtenna for Wireless Applications

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Abstract

This paper discussed literature review of different authors who tried different technique to implement the UWB Filtenna for wireless applications. The Federal Communication Commission (FCC) has released the unlicensed frequency band from 3.1–10.6 GHz for ultra-wideband (UWB) commercial communications and applications, therefore the race for commercializing this UWB technology is heating up. This UWB provides a wide frequency range and therefore it is overlapped with many other commercial wireless services; such as Wi-MAX and WLAN bands having a bandwidth of around 3.4–3.6 GHz and 5.7–5.8 GHz respectively. The power radiated by these frequency bands have more power level compared to that of the UWB communications; therefore, these services interfere with UWB signals, causing signal distortion and loss of sensitivity. Hence, filtering out these wireless services is needed for using the UWB band in an optimum way. A possible and effective solution is to realize notches at the unwanted frequencies. In order to achieve this, a number of techniques can be employed, such as including stubs [2], [3] applying slots on the patch [4] and using capacitive loops [4] or SRR or CSRR resonators [5] for filtering the unwanted wireless services or using defected ground structures technique.
Keywords: Ultra-Wide Band (UWB), Filtenna, Defected Ground Structure (DGS), Split Ring Resonator (SRR), Bandnotch

I. INTRODUCTION

Microstrip antenna configuration has numerous benefits in wireless communication systems applications. This is due to its small size, low cost, less weight, and easy to fabricate. Furthermore, microstrip antenna has an excellent compatibility with the MMIC planar circuits. Microstrip Filter_Antenna structure “MFA” is a planar antenna circuit having a built-in filter(s), and it is referred to as microstrip filtenna. In fact, it is employed in the receiver front end to relieve the necessity of using a band pass and/or band rejection filter. These filters having different specific characteristics which depend upon the antenna patch and ground geometries. Little work has been done to investigate and analyse different MFA structures. These structures can be with arrays of bandpass frequency-selective surfaces or with band-rejection elements and or fractal defected ground structure.

Ultra-wideband (UWB) technology has recently received much attention due to the characteristics such as low cost, low complexity, low spectral power density, high precision ranging and become the most potential candidate for shortrange high speed wireless communication systems. Stemming from military radar applications, ultra-wideband (UWB) communications are being researched intensively in both academic and industrial environments since the Federal Communications Commission (FCC) released 3.1 to 10.6 GHz unlicensed band for radio communication. Researchers have made many efforts to investigate different UWB antennas. Until now, various structures have been developed to achieve wideband antennas. However, in practical applications, antenna design for UWB systems is still facing many challenges. The designs of antenna for ultra-wideband (UWB) applications face many challenges including their impedance matching, radiation stability, compact size, low manufacturing cost, and EMI problems. The EMI problems are quite serious for UWB systems since there are several other existing narrowband services, which occupy frequency bands within the UWB bandwidth. A few examples of hostile systems are IEEE 802.16 Wi-MAX (3.3–3.7 GHz), IEEE 802.11a wireless-LAN (WLAN) 5 GHz (5.15–5.825), and ITU 8 GHz (8.025–8.4 GHz) band. Therefore, it is necessary for UWB antennas performing band notch characteristics in those narrow frequency bands to avert the potential interferences. Several UWB antennas have been attempted to overcome interference problem using frequency band rejected characteristics design.

In these cases, UWB filtennas with notched characteristics at certain bands are desired. Filtennas are antennas that also perform filtering operations. Filtennas are employed to relieve the necessity of a band-pass (or band-stop) filter in the receiver front end. Ultra-wideband (UWB) frequencies (3.1 to 10.6 GHz) often employ filtennas to notch out the IEEE 802.16 Wi-MAX (3.3–3.7 GHz), IEEE 802.11a wireless-LAN (WLAN) 5 GHz (5.15–5.825), and ITU 8 GHz (8.025– 8.4 GHz) band to remove EMI problems. Hence, in order to keep the antenna footprint unaltered, designers have resorted to the approach of embedding parasitic strips or slots of different shapes in the radiating element or ground plane of the antenna systems.

The main problem of band rejection design is the difficulty of controlling the bandwidth of the notched band in a limited antenna space. Moreover, while adequate band rejection is highly desirable, the performance of the antenna should remain essentially the same for the rest of the band.

II. RELATED WORK

Recently, a number of UWB antennas with band-notched properties were presented where various methods have been used to achieve the band notching. Examples of approaches used are:

- cutting slots with different shape in the radiation patch.
- inserting slits on the feed line.
- adding parasitic strips or split rings near the feed line or around the ground plane.
- embedding resonator to filter to achieve the desired band rejection.
- combination of above mentioned any two techniques.

Integration of external band-reject filters increases system complexity and size. Hence, in order to keep the antenna footprint unaltered, designers have resorted to the approach of embedding parasitic elements or slots of different shapes in the radiating element or ground plane of the antenna systems.

III. LITERATURE REVIEW

J. R. Kelly, P. S. Hall, P. Gardner discussed and designed Ultrawideband (UWB) antenna having band notch filters in order to prevent sensitive components, within the front-end of the receiver, from being overloaded by strong signals. Recently, it has been shown that these filters can be integrated into the UWB antenna, to great advantage. This communication presents a new method for forming a notch band within the frequency response of a UWB antenna. An open loop notch band resonator is located on the back of the substrate, used to support the UWB monopole. The act of separating the resonator from the antenna means that they can now be designed in isolation, using the standard approach described in the literature, and then combined. A prototype was constructed and good agreement has been obtained between simulation and measurement. The radiation patterns are consistent over the frequency range of interest. [1]

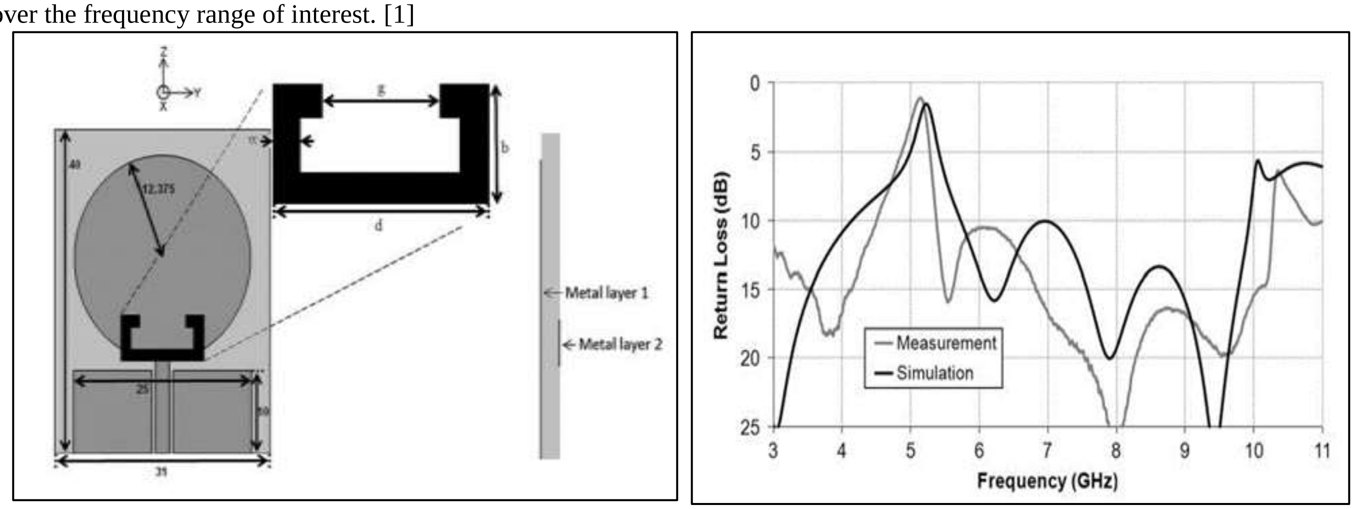

Fig. 1: Proposed Filtenna with notch band using open loop notch [1] and its return loss.

In this paper Y. Sung. presented printed microstrip-fed monopole ultra-wideband (UWB) antenna with triple notched bands. By embedding a modified H-shaped resonator with an additional outer line beside the microstrip feedline, band-rejected filtering properties around the 3.5 GHz WiMAX band, the 5.2/5.8 GHz WLAN band, and the X-band satellite communication band are generated. The notched frequencies can be adjusted according to specification by altering the modified H-shaped resonator. Sharp gain reductions occur at 3.7, 5.2, 7.5, and 7.9 GHz. However, for other frequencies outside the notched bands, the gain is stable in the entire UWB band.[2]

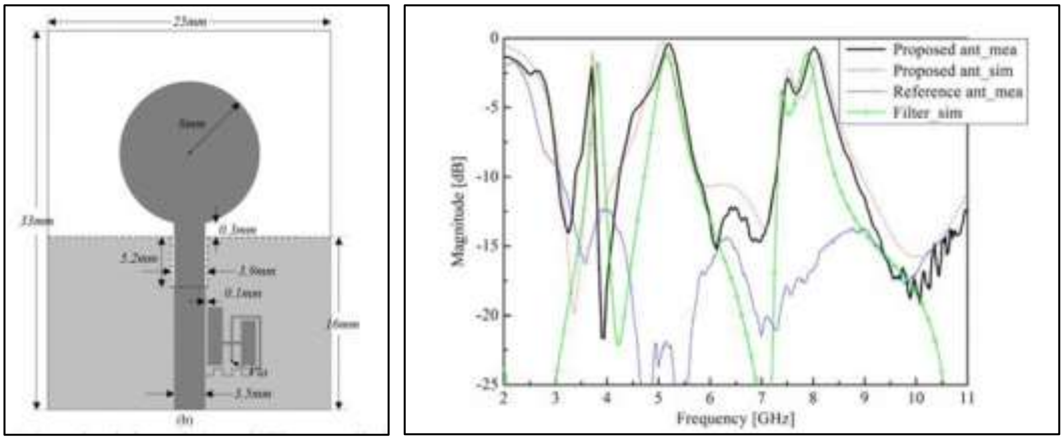

Fig. 2: Proposed Filtenna with triple notch characteristics [2] and its Return Loss

C. Lin, P. Jin, R. Ziolkowski designed two compact, printed, ultrawideband (UWB) monopole antennas with tri-band notched characteristics. The notched filters are achieved by introducing printed, electrically small, capacitively-loaded loop (CLL) resonators. The directly driven elements consist of printed top-loaded CLL-based monopoles and 50 Ω microstrip feed lines. By adding three CLL elements close to the feed line, band-notch properties in the WiMAX (3.3-3.6GHz), lower WLAN (5.15-5.35GHz) and higher WLAN (5.725-5.825GHz) bands are achieved. Each antenna system is contained on a 27×34mm^2 sheet of Rogers Duroid 5880 substrate. One is designed with three additional CLL elements; the other is achieved with only two. Comparisons between the simulation and measurement results show that these UWB antennas have broadband matched impedance values and stable radiation patterns for all radiating frequencies. [3]

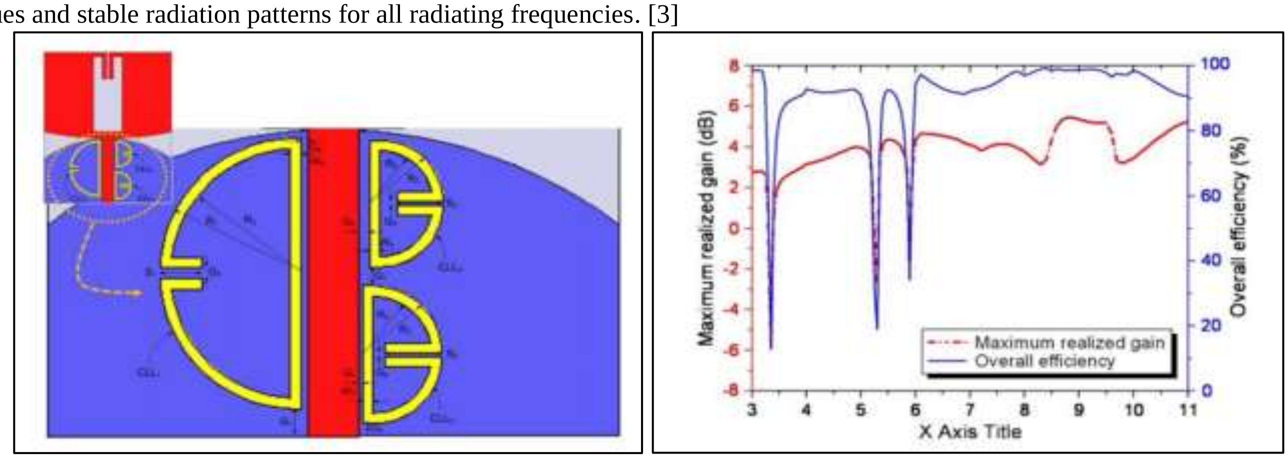

Fig. 3: Filtenna with triple notch characteristics achieved using CLL resonators [3] and its Gain

J. Y. Siddiqui, C. Saha, Y. Antar presents the design of a compact dual-split-ring-resonator (SRR)-loaded coplanar waveguide (CPW)- fed ultrawideband circular monopole antenna exhibiting dual frequency notch and wideband notch characteristics. The SRR pairs are inductively coupled to the radiator and loaded on the back side of the CPW line. Fabricated prototypes were measured and compared to simulations, and good agreement was obtained. [4]

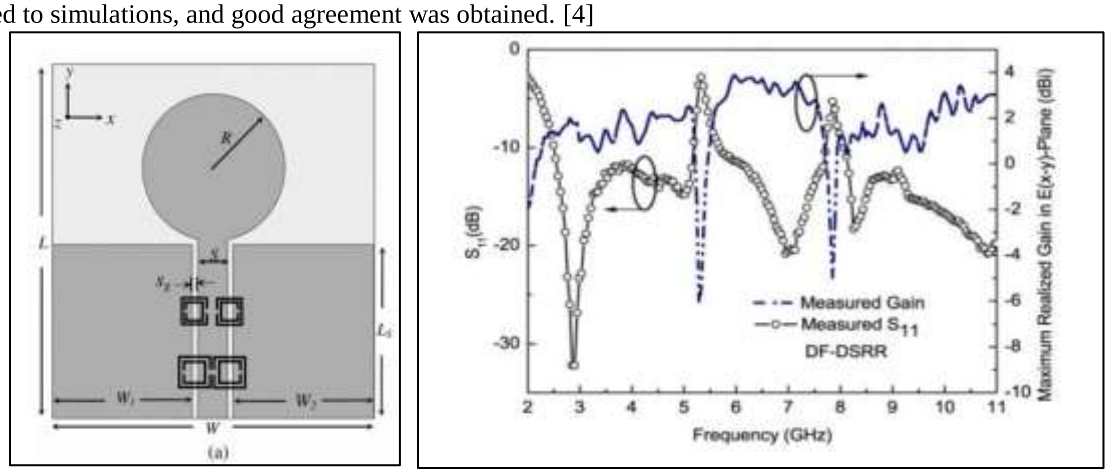

Fig. 4: Proposed Filtenna with dual notch characteristics using SRR [4] and its measured Gain & Return loss

In the paper, Martin Kufa, Zbynek Raida discuss the design of a planar low-pass filter with a fractal defected ground structure which can behave like a filtenna in the second pass-band frequency range. When removing the output port, the filter behaves like an antenna with the same operation range about 6.80 GHz. A rough model of the filtenna was optimized by CST Designer Studio and functionality of the designed filtenna was verified by simulations in full wave CST Microwave Studio. At present, we prepare an experimental verification. [5]

In this paper, Rongda Wang and Peng Gao presented a compact ultra-wideband antenna with filtering functions is presented. It has a compact size of 32mm*26mm*0.8mm. The filtenna is fabricated on a common and low-cost FR4 substrate, with a relative dielectric constant of 4.4, and a loss tangent of 0.02. With the use of an umbrella-shaped radiating element, and a modified ground plane structure, this filtenna meets a 10dB impedance from 2.8 to 12 GHz. By employing U-shaped slots on the feed line and on the ground, a stop band in 5.5GHz, also with high selectivity, is achieved. These electrical characteristics make it attractive for use in ultra-wideband (UWB) systems. [6]

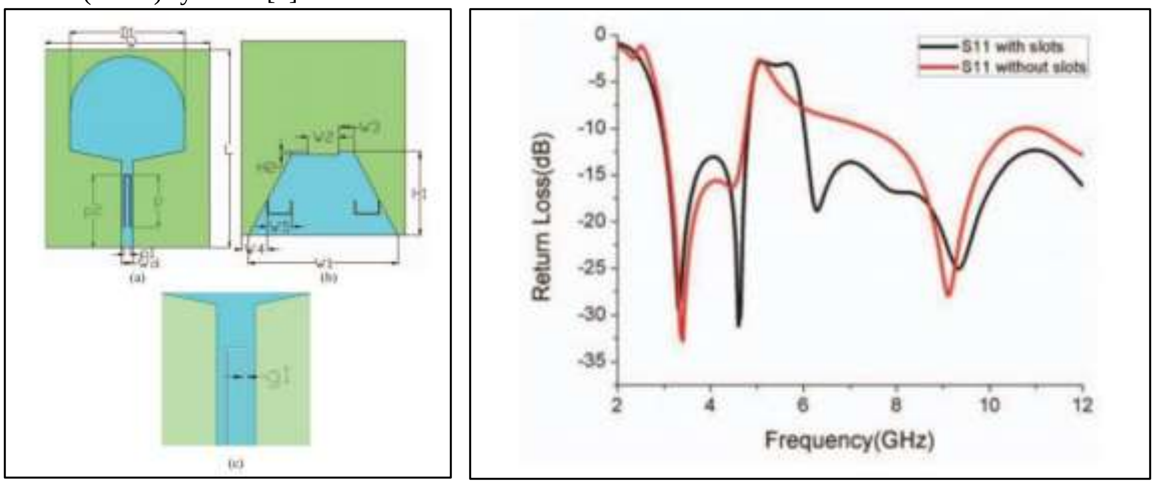

Fig. 5: Proposed Filtenna with notch characteristics [6] and its measured Return loss

IV. 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.

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