Review analysis on improving isolation methods in UWB MIMO Antenna

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Abstract: **In this paper the UWB MIMO Antenna isolation methods are been analyzed and compared in order to get better isolation techniques. Microstrip patch antenna is mostly preferred in modern communication appliances over conventional antennas this is because of the reduction in size. In this review paper a analysis is done on commonly used isolation improvements techniques. The various mutual coupling method or isolation methods explained in this paper shows the importance of isolation in MIMO antenna system in terms of its antenna characteristics. The isolation methods are basically used to improve the coupling among antenna ports and increase overall efficiency of the system.**

Keywords: **UWB, Slotted, Fractal, Isolation Techniques, Meandering Line Patch and Miniaturization.**

I. INTRODUCTION

Ultra wide band (UWB) is one of the important wireless communication systems which is used for monitoring, microwave imaging, positioning, security, and various communication based application. Due to its high gain, omnidirectional radiation pattern, high data resolution, low complexity, inexpensive properties, it is becoming more attractive research phenomena for students and wireless communication. The antennas which has ultra wideband frequency are researched in detail and then are developed with unlicensed bandwidth of 3.1 to 10.6 GHz as UWB by Federal Communication Commission (FCC) [1].Printed slot type antennas are mostly accepted for UWB application. It is a tough nut to crack regarding the antenna designing in which one has to achieve features like miniaturization of antenna, high gain, ultra wideband antennas and cost efficient.

In upcoming years, due to its various numbers of additional benefits which includes, high gain, stable radiation pattern, low profile and inexpensive fabrication of the printed microstrip slot antennas are increased to a greater extent. For UWB applications many antennas were designed. Among them, one of the antenna requires a large ground plane that results in increasing of dimension. As a resultant, that are not included in microwave integration [2]. Various different feeding techniques which has line feeding and waveguide feeding antennas were proposed for UWB applications. For achieving the characteristics of wide impedance bandwidth monopole architectures are commonly used, such as elliptical, pentagon, rectangular, square, hexagonal, annular ring and circular ring antennas [3-7].

A small elliptical ring antenna with a coplanar waveguide for UWB application was inspected by Ren et al. Wideband frequency has been attained by this antenna ranging 4.6 – 10.3 GHz which doesn't cover whole UWB. Again the full UWB was not attained by this antenna despite compacted size [8]. A

printed rectangular with dual circular slot patch monopole antenna is proposed which acquires operating bandwidth with a range of 3 – 11.5 GHz which covers the entire UWB region. Although the size of the proposed antenna has been reduced and antenna performance has been enhanced significantly. The antenna is compact in size than antenna stated in ref [9] and In expensive for fabrication for using low-cost FR4 substrate. The spectacles slot shape patch with microstrip line-fed and tapered slot ground make it perfect for UWB applications.

In this paper explained the basics antenna parameters which are used in antenna measurements such as S parameters, Bandwidth, return loss, Antenna Gain, directivity, radiation pattern, bandwidth, VSWR etc. The single input single output antenna has very low capacity and poor data rate which is overcome by Multiple input multiple output technology. The MIMO technology enables the higher data rate with great enhancement in capacity of the system. In this paper the design process that covers the simulation of calculation process and analysis part using the development of microprint antenna with the computer simulation technology.

II. UWB-MIMO ANTENNA SYSTEM

Ultra-wideband (UWB) formerly known as '*pulse radio*' is a modern technology for transmitting information over a large bandwidth (> 500 MHz), promising high data rates with low power consumption. The unlicensed use of 3.1 -10.6 GHz has been authorized by the Federal Communications Commission for short distance high data rate indoor applications like PAN wireless connectivity. Recently, International Telecommunication Union Radiocommunication Sector (ITU-R) defined UWB as the transmission in which the bandwidth of the emitted signal exceeds the minimum of either 500 MHz or 20% of the center frequency.

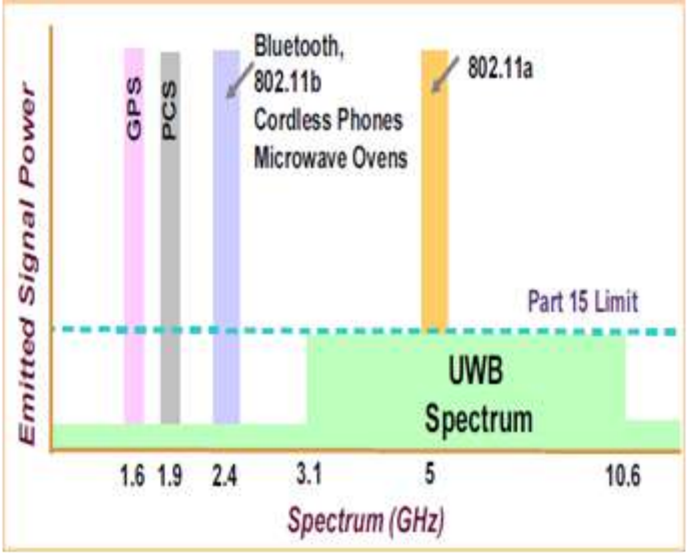

Fig 1 UWB spectrum allocation.

The extremely large bandwidth occupied by UWB gives the potential of very high theoretical capacity, yielding very high data rates. This can be seen by considering Shannon's capacity equation [12],

$$C = B\log_2\left(1+\frac{S}{N}\right) \quad \text{-------------------(1)}$$

where *C* is the maximum channel capacity, *B* is the signal bandwidth, *S* is the signal power, and *N* is the noise power.

III. DESIGNING MATHEMATICAL EQUATIONS FOR MIMO MICROSTRIP ANTENNA [13]

Step 1: Calculation of Lambda (λ)-
Lambda (λ)=c/f=3x10^8/6.8^9
(λ)=44mm at 6.8 GHz
Because (3.1+10.6/2=centre freq=6.8GHz)

Step 1: Calculation of L & W -
The center frequency will be approximately given by:

$$f_c \approx \frac{c}{2L\sqrt{\varepsilon_r}}$$

$$L = \frac{C}{2fc\sqrt{\varepsilon_r}} \quad \text{------------ (1)}$$

Where fc=is centre freq=6.8GHz
εr=4.4 and c=3x10^8
L=9.84mm

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \quad \text{------------- (2)}$$

For c=3*10^8 m/s2, *fr*=6.8GHz, ε *r*=4.4

We get **W=12.42mm.**

Step 3-Feed width calculation

$$Z_0 = \frac{60}{\sqrt{\varepsilon_r}}\ln\left(8\left(\frac{H}{W_f}\right)+0.25\left(\frac{W_f}{H}\right)\right) \quad \text{---------- (3)}$$

We get **Wf=2.8mm**
Step 4: Calculation of Feed length (Fl)-
Feed length (Fl)=λ /4*sqrt (4.4)
Fl=5.5mm

Step 5: Calculation of Substrate dimension-
Ls=L+6h=10+6*1.6=19mm
Ws=W+6h=13+6*1.6=23mm
This is standard dimension for getting better isolation in MIMO Antenna.

IV. DIFFERENCE BETWEEN NARROWBAND AND WIDEBAND SCHEMES

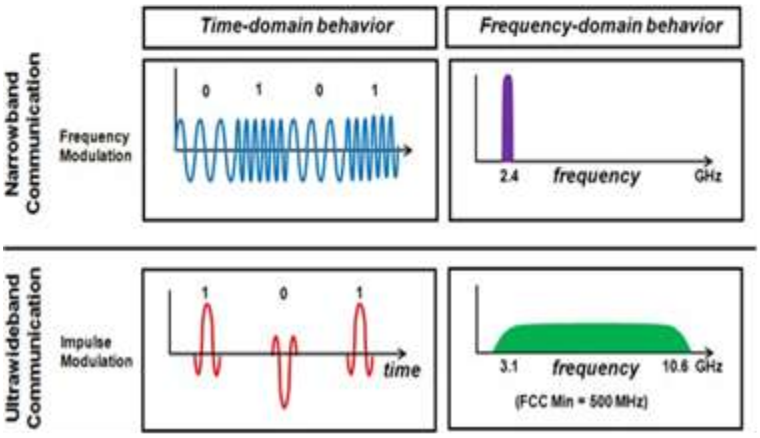

Fig 2. Comparison of UWB and narrowband modulation schemes

V. METHODS TO IMPROVE ISOLATION AND BANDWIDTH ENHANCEMENT

1. Modifying the patch

The mirostrip antenna which will be used must be modified from the traditional available patches for better results in the antenna simulation.

2. Introducing Electromagnetic Band Gap

EBG structures will be used as a filters for unwanted signals, it will offer an efficient suppression of the interferences by introducing wide Omni-Directional stop band in the operating frequency

3. Introduction of Stub

In this isolation enhancement can be done by adding external feed network or stub to the antenna without making any changes to the already designed antenna's structure.

Ref paper	Bandwidth [GHz]	Isolation [dB]	ECC [GHz]	Gain [dB]	Size [mm2]
[12]	3.1-5.0	>15	0.5	>3	37*45
[11]	3.1-10.6	>15	0.04	>3	32*42
[10]	3.1-10.6	>15	0.2	>3	26*40
[9]	2.8-13.0	>18	0.03	>2	20*45
[8]	3.1-10.6	>20	NA	NA	34*48
[7]	2.8-10.4	>20	0.08	>3	30*27
[6]	4.5-11.5	>10	0.5	>3	22*24
[4]	2.7-11.6	>10	0.05	>2	35*35
[3]	3.0-11.2	>15	0.03	>3	50*35
[2]	4.5-11.5	>10	0.02	>3	54*35

Table 1: Mutual Coupling Comparison for MIMO

VI. CONCLUSION

A theoretical survey and comparison of microstrip patch antenna is presented in this paper. A tabular comparison gives brief overview of which isolation methods will give what kinds of result. This will help new researchers to get overview in one glance. The MIMO technology enables the increase in h data rate with much higher enhancement in the capacity of system.

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