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Review on Isolation Mechanisms in MIMO Antennas

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Abstract

Mtultiple Input Multiple Output (MIMO) antenna technology had undergone in depth research and study which resulted in increased data rate, channel capacity and transmission speed. Compared to conventional wireless systems,. Placement of multiple transmitting and receiving terminals in a slim mobile equipment without coupling between terminals is a major challenge faced by the designers. So isolation improvement between the antenna elements is a major area of research and lot of papers were published .A review on techeniques like modification in ground plane, Use of metamaterials, Providing neutralization strips, Introduction of resonating structure, use of lumped component filters, Decoupling structures is included in this paper.,

Key Word: MIMO, Isolation, meta materials, neutralization strips.

1. Introduction.

A MIMO antenna system is a well-known technique to enhance the performance of wireless communication systems. Channel capacity of a MIMO antenna system is much larger than that provided by a conventional wireless system . The use of multiple antennas for diversity, including MIMO (Multiple Input Multiple Output), is one of the most promising wireless technologies for broadband communication applications. In a situation rich in scattering , a MIMO can provide parallel orthogonal transmission channels. .Mimo finds extensive applicatios in wireless transmission schemeslikeWi-Fi,WiMAX,3G,4G.

In order to achieve high data rates and multimedia capabilities MIMOantenna systems have to be integrated within user terminals. By usig multiple antennas at both transmitter and receiver multiple independent channels can be detected In free space by MIMO technique, and this provides a higher bit rate compared to SISO and SIMO systems. The major challenges faced bby a MIMO designer are related to small size, poor mutual coupling, good impedance matching, and radiation pattern. Achieving an ideal design satisfying all these factors is a major challenge, due to the trades off existing between these characteristics.

Miimizing the elemet size to fit the MIMO into limited space ad reducing the mutual coupling between highly integrated elements are the major challenges. Different papers were published in this field aimed at reducing the mutual coupling between the placed elements.A review based on different methods for providing isolation between elements is presented here.

2. Literature Survey:

A multi-input multi-output (MIMO) system is regarded as a promising solution, to the problem of data rate transmission since it can increase the channel capacity without sacrificing spectrum efficiency or consuming additional transmitted power.Spatial diversity and spatial multiplexing are the two main modes of operation of MIMO. Spatial multiplexing form of MIMO is used to provide additional data capacity by utilizing the different paths to carry additional traffic.

Spatial diversity refers to transmit and receive diversity. And is used to provide improvements in the signal to noise ratio .

MIMO is often traced back to 1970s research papers concerning multi-channel digital transmission systems and interference (crosstalk) between wire pairs in a cable bundle: AR Kaye and DA George (1970) [1], Brander burg and Wyner (1974) [2], and W. van Etten (1975, 1976) [3]. In the mid-1980s Jack Salz at Bell Laboratories took this research a step further, investigating multi-user system.

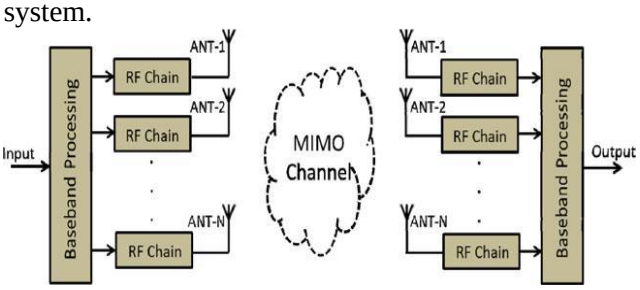

Fig-1 MIMO system

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In the MIMO system, two or more antennas are used on both the transmitter and receiver sides. A critical point is to arrange compact antenna elements without impairing antenna performance and system requirements. To do that, mutual coupling or isolation between adjacent antennas is a key factor. However, the antenna elements are strongly coupled with each other as well as with the ground plane, because they share common surface currents. Several techniques have been introduced to improve the isolation characteristic, such as, changing the orientation using the resonating slot on the ground plane [2–6] and using the isolation elements between the radiating elements [7]. Alternative method utilizing the neutralization line was suggested in [8–11]. Metamaterials are artificially engieered materials that posses properties not found in nature. Metamaterials can exhibt stop band filter propertieswhichcan be used to isolate closely packed antenna elements. So designing with Metamaterial to have stop band at desired frequency provides better isolation. Metamaterials structures have the ability to concentrate electromagnetic fields and currents near antenna structures instead of spreading them along the antenna ground, which results in higher coupling between antennas. Metamaterial technology has the advantage of reducing the circuit size while providing equivalent or better performance in both antenna and passive circuit applications. Therefore, the circuit size is independent of the operational frequency and can be significantly reduced to fit in a small area.

Isolation between MIMO elements can be improved by placing metamaterial based channel walls which prevets radiating elements from coupling through magnetic field. A work was proposed to improve isolation between MIMO elements working in sub –GHz frequency by using spiral like Capacitive Loaded Loops in [4].

A neutralisation network consists of symmetric neutralisation lines , and through the lines signals propagate from one port to adjacent port which has same amplitude but inversed phase to original coupling signal. So orthoganal coupling signal is reduced and mutual coupling is reduced. Such a network was proposed in [5],[6]. A newly designed neutralisation network consists of 3 rotationally symmetric neutralisation lines which re uses the electric length existing in the feeding lines and hence minimizes its length to fit into the limited space was proposed in [7].

Defecting Ground Plane (DGP)structure can be used to reduce mutual coupling.A dumb like pattern is used to Defect the ground plane in [8]. Ground slits disperse the surface currents at specific frequency bands. A MIMO antenna with ground slits was proposed in[9]

Table -1: Comparison on isolation performance from different structures

	4-Shaped MIMO [8]	MIMO With Ground Slits[9]	MIMO with Neutralization elements[7]	MIMO with Capacitive Loaded Loops[4]
Isolation between antenna element	-20.51dB at 5.04 GHz	-12.7Db at low band	Less than -15dB	Improvement of 10db in low band and 2.5 dB in High band

3. CONCLUSION

Difeerent isolation methods for MIMO proposed in Literature were compared. The major challenges in designing MIMO wireless antenna; are miniaturization, efficient bandwidth high gain , directivity and allthese can be achieved by providing good isolation etc. All these parameters have trade-off between each other. We need to design the efficient MIMO which can provide better bandwidth, high gain, and isolation with reduction in size of the MIMO system antenna.

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