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Closely Packed MIMO/Diversity Antenna using Semielliptical Monopoles

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Abstract: *In this paper, a compact two element printed diversity antenna is proposed. Two closely spaced semielliptical shape monopoles are used. The inter-element separation between the monopoles is less than 0.25λ. A broad impedance bandwidth of 1.8 GHz including frequencies from 4.5 GHz to 6.3 GHz is achieved. Inter-element isolation is achieved using the ground stub which is the extension of the ground plane. The isolation between the elements is always greater than or equal to 17 dB throughout the frequency range of interest. The proposed antenna structure is fabricated and tested.*
Hence forth the above study showed that antenna structure provides good diversity performance.

I. Introduction

Modern communication technology especially in MIMO applications such as Wi-Fi, FMC, UMA the role of multiple antenna is becoming more popular. Day by day most electronic devices are becoming compact. So advanced technology needs to pack antennas closely. MIMO technologies help to provide a high-speed data transmission and high channel capacity. Due to limited space for antenna implementation which cause various mutual coupling problems that degrade the performance of antenna, special decoupling techniques are required for closely packed antennas.

Several methods to improve mutual coupling and matching have been reported. A slit is carved on the ground to reduce mutual coupling between two closely packed antennas[1]. A two-port compact printed monopole antenna array with decoupling structure based on partially extended ground plane applicable for small terminals is presented. The distance between the printed monopole elements is less 0.25λ. A broad matching and decoupling bandwidth up to 1.5 GHz (5.1 to 6.6 GHz) is achieved[2].

The idea of capacitively loaded loops (CLL) magnetic resonators to decorrelate two monopole antennas is introduced.Although the coupling had been reduced in CLL, the antenna elements were not well-matched[3].Matching and decoupling networks between the radiating elements and input ports are implemented. For this approach, Eigen mode excitation and multiport conjugate matching are two general theories mostly adopted. The problem of such a method is that the operating bandwidth is limited at least for one of the inputs. Additionally, the matching and decoupling network is complex and lossy, which increases the fabrication expense and affects the radiation Efficiency[4,5].

Parasitic elements are used to reduce mutual coupling[6,7]. By adding parasitic elements a double-coupling path is introduced and it can create a reverse coupling to reduce mutual coupling[6].This technique is sensitive to phase relationships, which are related to relative positions between parasitic elements, and relative positions between active element and parasitic element.However, the parasitic elements are not viable in compact devices.

Various regular shaped printed monopole antennas for different feed positions are reported[8].Circular and Elliptical shape monopoles provide maximum impedance bandwidth[8] compared to other category of monopole antennas.

In this paper a closely spaced two element MIMO/diversity antenna using printed semielliptical shape monopoles is proposed. Mutual coupling of two port array is achieved by using a ground stub which is extension of the ground. The proposedMIMO/ diversity antenna operates between 4.5 GHzand 6.3 GHz. Achieved matching and decoupling band width is wider and structure ismuch simpler as compared to other techniques.

II. Antenna Geometry and Design Theory

The geometry of the proposed MIMO/diversity antenna is shown in fig.1. Semicircular shape monopoles are used to achieve wider bandwidth. A ground stub which is extended ground structure is designed to isolate theelements. The length of the ground stub is selected to achieve the isolation better that 15 dB. The ground stub acts as a reflector between the two antennas which not only isolates the two monopoles but also helps to achieve better impedance matching. The ground stub provides an alternate path to the ground plane current which directly flows from one element to the other. It increases the current path length and weaken it when it reaches to the other element. Antenna is fabricated using low cost FR4 substrate, with dielectric constant

4.4 and tan δ= 0.02. The structure is modelled on IE3D simulator. Initially, the semielliptical monopoles are designed. The semielliptical monopoles are formed using rectangle of length ‘L3’ and semi ellipse of radius ‘r’ as shown in fig 1. The stub of length ‘L1’ is integrated with ground plane. ‘L1’ is selected greater than ‘L3’ to achieve better isolation

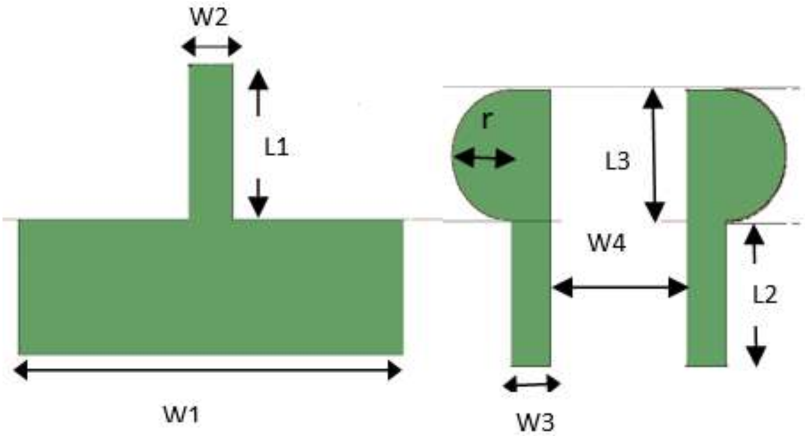

Fig. 1 shows two element MIMO/Diversity antenna using printed semielliptical monopoles w1=35, w2=4, w3=3, w4=10.4, L1=11.5, L2=10, L3=9, r=4.5 Unit millimeters

The detailed dimensions are shown in fig 1. The radius ‘r’ of semi-ellipse is varied to observe the effect on return loss and insertion loss. Fig 2 shows the effect of ‘r’ on variation of S_{11} and S_{21} vs frequency. Increase in the primary radius ‘r’ of semi-ellipse results in better impedance matching as well as isolation. It not only widens the impedance bandwidth but also improves the isolation till 35 dB for ‘r’ = 4.5 mm.However, increase in the value of ‘r’ increases the antenna dimensions also. Because, the impedance bandwidth widening is achieved at ‘r’=4.5 with better isolation levels, ‘r’=4.5 mm is considered as the optimum value.

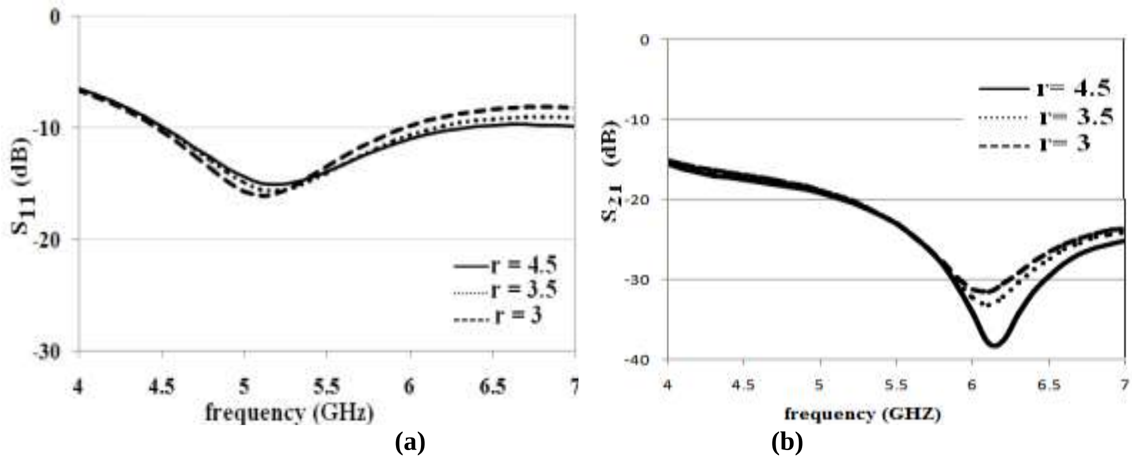

Fig. 2 Shows simulated (a) S_{11} variation vs frequencyof the proposed antenna for different primary radius (r) of semi ellipse

III. Antenna fabrication and measurements

The proposed antenna is fabricated and measured using Agilent’s Fieldfox N9916A vector network Analyzer. For measurements, port 1 of the antenna is fed while port 2 is terminated using matched load. Fig 3 shows the fabricated prototype.

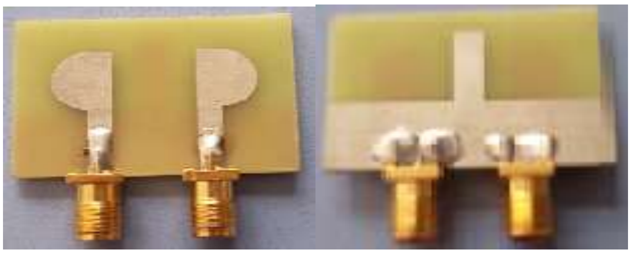

Fig. 3shows Fabricated prototype of the proposed MIMO/Diversity antenna

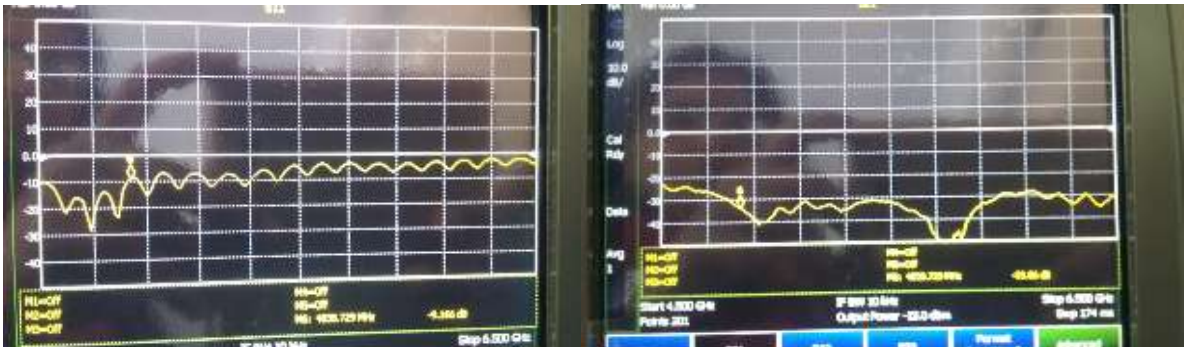

Fig.4 Measured S parameters of the proposed MIMO/Diversity antennaS_{11} and S_{21} vs frequency

Measured S parameters are shown in fig 4. It is observed that antenna shows satisfactory results. Measured isolation between the element is greater than 30 dB throughout the frequency band

IV. Conclusion

The proposed MIMO/Diversity antenna using semi-elliptical monopole antennas is designed and fabricated. The semi-elliptical shape monopoles help to improve decoupling as well as impedance matching. The structure is much simpler and cost, complexity of the design is very low. The impedance bandwidth and inter-element isolation of the structure are measured and found satisfactory.

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