International Research Journal of Engineering and Management Studies (IRJEMS)
Volume: 03 Issue: 03 | March -2019 e-ISSN: 2395-0126

DUMB-BELL SHAPE MIMO DIVERSITY ANTENNA FOR UWB WIRELESS APPLICATIONS

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Abstract - *A compact ultra-wideband (UWB) multi-input multiple-output (MIMO) spatial diversity antenna with circle shape designed on an FR-4 substrate is proposed in this project and is investigated experimentally. The lower capacity, reliability and low data date solutions for single input single (SISO) antenna systems are multiple input multiple output (MIMO) solutions. MIMO has high capabilities, high data speed, low latency and high noise (SNR) ratio. The MIMO antennas provide a large coverage of the growing mobile device population for both current and future generation of wireless applications. Two ports have been proposed for wireless applications, planar MIMO in form of a hook with dumb-bell radiators and partial floor structure and perfect border conditions. The proposed prototype with broadband characteristics can resonate in 2:1 VSWR, covering frequencies in a band of 2 GHz -10 GHz. Bandwidth of -10 dB is 5.84 GHz for return-loss. In the entire band, the MIMO antenna gain is over 3.6 dB, while radiation efficiency exceeds 66 %. The proposed work on a dielectric 45.9x45.9 mm2 substrate is performed. The design work is carried out. The proposed design covers 5.15-5.85 GHz Wireless Band (WWB), 7.1-7.76 GHz satellite band, and 5.9-8.5 GHz point-to-point wireless band (HSB).*

1. INTRODUCTION

Microstrip patch antennas are now widely used to transcend single input single output disadvantages (SISO) such as demand for bandwidth, data frequency, power demand and capacity requirements for wireless transection. MIMO offers a growing wireless and mobile device population the best solution. The range of wireless communication solutions is available to address the indoor and outdoor needs of the local wireless network (WLAN), microwave access wireless interoperability (WiMAX), and satellite communication. In the design of antennas, various diversity techniques are helpful. Dumbbell shape UWB MIMO diversity antenna with dimensions 18mm*21mm with 3 notches operating with a band width of 2.9-20 GHz with an isolation of -22 dB having Radiation efficiency of 75%-85%[1]. Triple band notched DGCEBG structure based UWB MIMO/diversity antenna with dimensions 58mm*45mm with 2 notches operating with a bandwidth of 2.3-10.6 GHz with an isolation of -15dB [2]. Compact offset micro strip-fed MIMO antenna with dimensions of 38.5mm-38.5mm with 1 notch operating with a bandwidth of 3.08-11.8 GHz with an isolation of -15 dB having radiation efficiency above 75% [3]. A dual notched band MIMO slot antenna with dimensions of 30mm*60mm with 3 notches operating with a bandwidth of 2.8-11 GHz with an isolation of -20dB having radiation efficiency of 80% [4]. Compact CPW-fed UWB MIMO antenna with dimensions of 26.75mm*41.5mm with 3 notches operating with a bandwidth of 3.1-11.5 GHz with an isolation of -15dB having radiation efficiency of 75% [5]. Dual notched band MIMO slot antenna with dimensions of 22mm*26mm operating with a bandwidth of 3.1-11.8GHZ with an isolation of -20dB having radiation efficiency of 85% [6]. A triple notched band antenna with dimensions of 23mm*40mm operating with a bandwidth of 2-11 GHz with an isolation of -7db [7]. A triple band notched

antenna with dimensions 64mm*45mm operating with a bandwidth of 2-10.6 GHz with an isolation of -17db [8]. A triple band notched antenna with dimensions 50mm*50mm operating with a bandwidth of2.76-10.75 GHz with an isolation of -15db [9]. A triple band notched antenna with dimensions 40mm*40mm operating with a bandwidth of 3.4 -12 GHz with an isolation of -15db [10]. A new wideband slot array for MIMO performance enhancement with dimensions of 112.3mm*112.3mm having isolation of 25 dB [11].

2. PROPOSED METHODOLOGY

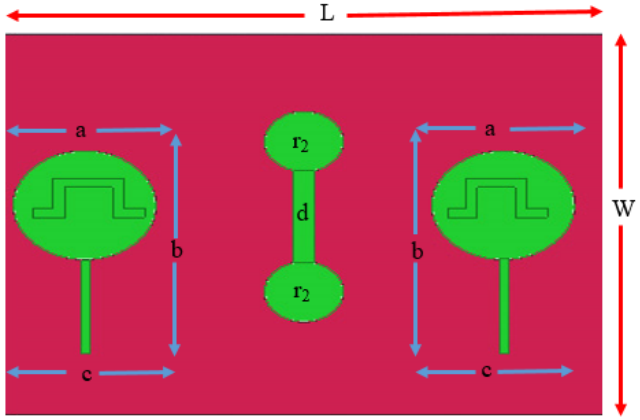

Fig. 1 Design of Dumbbell shape Design

Table 1: Dimensions of the design

Parameter	L	W	a	b	C	D	r_2
Vale (mm)	60	60	20	30	20	3	4

In the proposed the antenna having a size of 60 x 60 mm^2 using FR-4 substrate. Each patch have a dimension of 20 x 30 mm^2 and shifted the same patch to right hand side. A dumbell is inserted between the patched to reduce the mutual coupling between the patches. This reduces greatly mutual coupling between them.

3. RESULTS AND DISCUSSION

The proposed design having the S-parameters are shown in Fig. 2 & Fig. 3. The proposed design is resonate at dual-band of operations at 4.9 GHz and 7.8 GHz these are used in the applications of C- band & S-bands. At these frequencies the mutual coupling is -36 dB & -48 dB is observed. This reduces the mutual coupling is greatly achieved.

These graphs shows the S-parameter calculations of the proposed MIMO structure. Cutting the slots in the form of circle and is attached a rectangular slot on the both sides to form a MIMO structure. In order to improve the mutual coupling between the antennas.

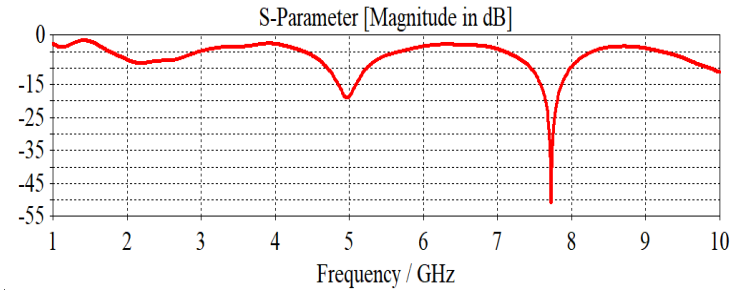

Fig. 2 Return loss of proposed antenna

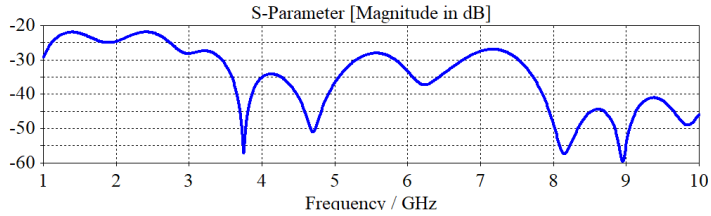

Fig. 3 Mutual coupling of proposed antenna

The antenna parameter VSWR is less than or equal to 2 at the dual–band of frequencies which is shown in Fig. 4. The directivity of the proposed system at dual-band of frequencies is more than 6 dBi which is indicated in Fig. 5. Fig. 6 shows the envelope correlation coefficient of the proposed system which is always less than 0.05. This value of ECC improves the diversity gain of the antenna in MIMO structure. The improvement in the ECC observes that there is a great suppression in the mutual coupling. The variations in the design observed that inserting the dumbbell structure greatly improvement in the antenna parameters.

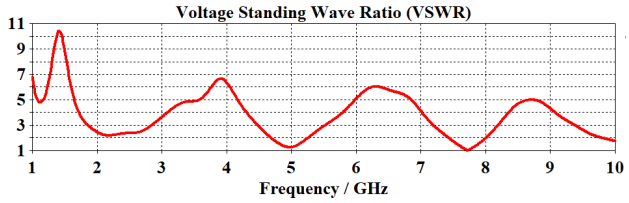

Fig. 4 VSWR of proposed antenna

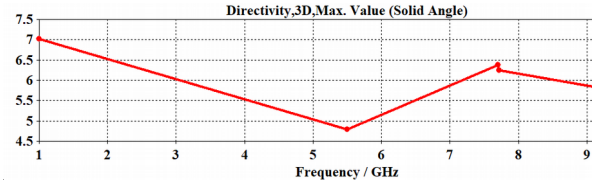

Fig. 5 Directivity of proposed antenna

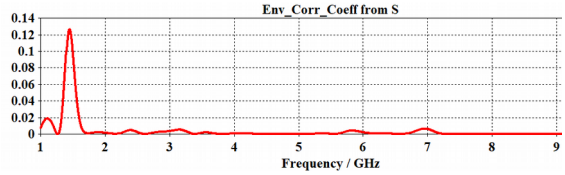

Fig. 6 Envelope correlation coefficient (ECC)

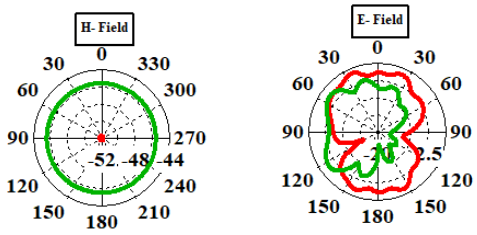

Fig. 7 Radiation Pattern at 4.969 GHz

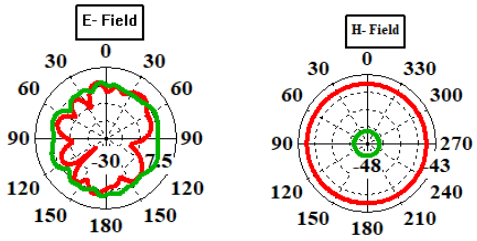

Fig .8 Radiation Pattern at 7.723 GHz

Fig. 7 & Fig. 8 shows the radiation patterns of dual-band MIMO structure with co & cross polarizations. Here these patterns are measured with one port is excited and other port is terminated with some characteristic impedances of 50 ohm transmission line. These shows that the design antenna observes that at dual-band operation the co-pol is always greater than cross-polarization which is observed here. Here E-field is measured at xz-plane and H-field is measured at yz-plane. This shoes that H-field pattern at the dual-band operations is looks like an omnidirectional nature and E-plane pattern is approximately doughnut shape is observed from the radiation patterns. At these resonant frequencies observed that the values is greater than -48 dB is identified. The improvement in the radiation patterns also with using the dumbbell structure and without dumbbell structure is observed. The dumbbell structure inserted between the patches improvement in the radiation patterns also.

4. CONCLUSION

This paper examines the design of the dumb-bell form of the MIMO antenna. The antenna is 60 mm x 60 mm in compact size. Simulated and measured results show that, with the exception of WLAN and IEEE INSAT / Super-Extended C-Band, the antenna being proposed has an impeder bandwidth of 2.9 to 10.8GHz and an isolation over operating band of more than 35dB. The ECC, DG, efficiency multiplexing, TARC and peak gain demonstrate an excellent diversity level. The antenna proposed is a good candidate for MIMO diversity applications.

REFERENCES:

1. J.A. Dupuy, C.C. Chiau, J.Yeap, S. B., X. Chen and C. C. G. Parini, IEE Proceedings Microwave antenna propagation, Vol., "Integrated diversity antenna for laptop and PDA terminals in the MIMO system." 152, Numbers 6, 495–504, 2005.
2. Ding, Y., Du, Ding, K., Gong, Z. Feng, "A four-element mobile telephone antenna system," IEEE and wireless letters, Vol. 6. Sixty-five–658, 2007.
3. K. M. Luk, K. Yang, S. L. S., H. Kishk, H. Lai, A. A. F. Lee, IEEE Magazine for Dual Polarized Antenna with Pattern Diversity, Vol. 50, Numbers 6, 71-79, 2008. Li, H., J. Xiong, and S. He, "A compact planar MIMO antenna system of four elements with similar radiation characteristics and isolation structure," IEEE Antennas and Wireless Propagation Letters, Vol. 8, 1107–1110, 2009.
4. Move, D. C., B. H., J. J. C. Liu, IET Microwaves Antennas and propagation, V. "Reconfigurable angular diversity antenna with quad-corner reflector arrays for 2.4 GHz applications," 3, Number 37, 522-528, 2009.
5. P. Zetterberg and S. Zhang, S. He is the "Printed four-piece MIMO antenna system, with large bandwidth and isolation," Vol. 46, 15, 1052–1053, 2010. 2010.

6. Progress in Electromagnetics Research Letters, Vol. Wang, S., "A new compact printed triple-band antenna," 67 to 72, 2016. 58.
7. H. Wang, T. Deng, R and Tang, M.-C. W.Ziolkowski: "Constantly tunable, independent band-notch compact planar,ultra wide-band antennas
8. H. Wang, T. Deng and R. Tang, M.-C. "W. Ziolkowski," IEEE Antennas and Propagation Transactions, "compact ultra-wideband flat band antennas with continuously tunable, independent, striped filters." August 2016, No. 64, No. 8, 32 92–3301. Electromagnetic progress Research C, Vol. Progress. 51 November 2019 G. Luo and G. Ke and K. Pan, S. Li, "a flat UWB antenna using a triple-mode step-impedance resonator with triple-band,"
9. M. M. N. Srifi, M. Elhabchi, R. Touahni, "A tri-band-shaped UWB planar antenna for the rejection of WIMAX / WLAN / X band using DGS and semi-arc-shaped slot," Progress In Electromagnetics Research Letters, Vol. 70, seventh–14th, 2017.
10. K. Kanaujia and S. Jaglan, N., S. D. GUPTA. Wireless Personal Communication, 1-27, Springer, May 2017, Srivastava, "Design and development of efficient EBG structures based on the UWB circular monopole antenna,"
11. Azerbaijan, N. And that's M. Microwave and Optical Technology Letter, Vol Ojaroudi, "small square monopoly antenna with variable rate bandnoch operation for UWB wireless communications." 54, 1994-1998. 12.
12. FCC, Federal Communications Commission First Report and Order, Washington, DC, 2002.
13. J. Xiong, Z. Ying, Hui, L., S. S. L. He,' Compact low-profile antenna structure co-locatedwith diversity of polarization and isolation of high-port,' Electronics Lett., Vol. 46, 110-10 October.
14. Liu, L., T. and S. Cheung. Yuk, "Compact MIMO antenna for UWB mobile devices," IEEE Trans. Propag., Vol. Antennas. 61, 4257–334, 2013. 2013.