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Research Article

DESIGN AND IMPLEMENTATION OF ROBUST ADAPTIVE CONTROL METHOD FOR ANTENNA ACQUISTION AND TRACKING

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ABSTRACT
The 3D characterization of radiating structures is a frequently encountered, and yet challenging, procedure. The theoretical sampling criterion often leads to prohibitive measurement duration, especially for antennas embedded on electrically large structures. However, the position of the antenna under test strongly influences the sampling requirements. By appropriately positioning the antenna with respect to the measurement system, it is possible to promote the low spatial frequency part of its spherical harmonic spectrum. We present a post-processing optimization algorithm enabling a systematic and accurate determination of the antenna best position from a given measurement dataset with no prior knowledge. This optimized position is exploited to improve the characterization of the antenna radiation pattern without resorting to any additional measurement sample. The proposed algorithm is validated for both near-field simulations and far-field measurements on various radiating structures, including an antenna embedded on a satellite model.

Keywords*: Antenna design, microstrip antennas, MIMO antennas, quad-port, co-located antenna, circular antennas*

INTRODUCTION
The 3D Charterization of radiation structure wireless framework denoted multiple input- multiple-output (MIMO) excessively increases the capacity of the system through spatially multiplexing as well as exploits the multiple path effect for providing the diversity, Therefore, the most common wireless communication systems such as LTE, WiMAX and WLAN standards have been enhanced thanks to the MIMO technology. The capacity and the diversity performance of the MIMO system depend upon the number of antenna elements to be used in the MIMO framework. However, it is very difficult to design multiple elements particularly for small systems. Because the elements are inevitably subjected of the mutual coupling among each other. In order to sufficiently isolate the communication channels, the mutual coupling should be alleviated. In general, the antennas are structurally modified to improve the isolation. The most efficient structural modifications are aligning the elements in orthogonal position, exploiting additional parasitic structures, utilizing neutralization-structure, using shorting and loading slots on the patch/ground , These modifications, on the other hand, require extraordinary endeavor with regard to the geometry and the position of the additional structures. Several quad-element MIMO antennas have been reported elsewhere In , a MIMO antenna structure composed of four semi-circular patch elements with a whole size of 55.0 x 55.0 mm2 was designed at 3.1-12.3 GHz. An antenna design with 75.19 x 75.19 mm2 size composed of triangular patches and structure of neutralization ring was conceived in for ultra wideband (UWB) applications. In ***4*** semi-disc monopoles which consist of a MIMO arrangement with 41.0 x 60.0 mm2 was modeled for operating at frequency band of 2.19-11.07 GHz. A UWB MIMO configuration with a total size of 45.0 x 45.0mm2 having 4 octagonal fractal was designed at 2.0-10.6 GHz, A MIMO antenna structure size of 39.8 x 50.0 mm2 composed of quad-monopole patches was reported in for 2.7-5.1 and 5.9-12.0 GHz operations. In a MIMO structure with a whole size of 50.0 x 50.0 mm2 comprising 4 quasi- self-complementary patches was designed for operating at the

frequency band of 3-12 GHz. A MIMO array with quad-port system, having a size of 152.0 x 152.0 mm2, consisting a few rings was formed in for triple frequency- band of - 2.5, 3.4-3.7 and 5.1-5.9 GHz. A MIMO arrangement with a size of 40.0 x 40.0 mm2 composed of quad-circularpatches was designed in to operate at the band of 3.1-11.0 GHz. While the literature is reviewed, the reported multi- port MIMO antenna structures are various in view of geometry, dimension, array, bandwidth and diversity for the polarization. I f the designs in are considered as small designs, those in are regarded as relatively big designs. The element sin is aligned in parallel, as that in are aligned in orthogonal. On the other hand, the antenna elements in are not printed on a common ground, resulting in a practical operation problem. The designs are designed as face-to-face array that causes interference among the patterns, Therefore, they could not radiate towards different way without interference. It is evident that the orthogonal arrangement enhances the Isolation level; yet the elements must be also located as opposition directions for efficiency diversity, as well. In this study, a low-profile quad-element circular MIMO antenna system is conceived for operating at the wide frequency band 3.0 - 5.0 GHz. The system consists of a 20 mm radius circular patch decomposed four co-located

Quadrant antenna elements each fed by 50 Ohm probe and 50 x 50 mm2 ground plane. The quadrant elements are isolated using two orthogonal shorting walls (SWs). The SW thus enhances the isolation level as well as improves theimpedance matching of the ports. Moreover, the open edge of each element is slot loaded with two circular slots to enhance the mutual coupling amongst the quadrant elements. The isolation performance of the SW is investigated through surface current and E-field distributions. The radiation and MIMO performance of the antenna is well examined in views of the radiation patterns, envelope correlation coefficient (ECC) and peak gain plot. The radiation pattern shows near Omni-direction. The ECC is below 0.5. The peak gain is over 1 dBi and maximum value of 8 dBiat 4.5 GHz.

II. DESIGN OF PROPOSED MIMO SYSTEM

The three-dimension (3D) antenna design with dimensions illustrated in. The antenna is designed by simulation via Hyper Lynx 3D EM platform. It is composed of a 20 mm radius circular patch and 50 x 50 mm2 ground plane beneathit. The design is constructed on a ceramic based dielectric substrate with 2.54 mm height, 6.15 dielectric constant and

0.002 tangent loss, corresponding to Rogers R03006™ material laminate. The circular patch is split into four quadrantsby two orthogonal SWs and thus four isolated antenna elements with regard to the mutual coupling among elements are achieved. Each quadrant is feed by 50 Ohm SMA probe.

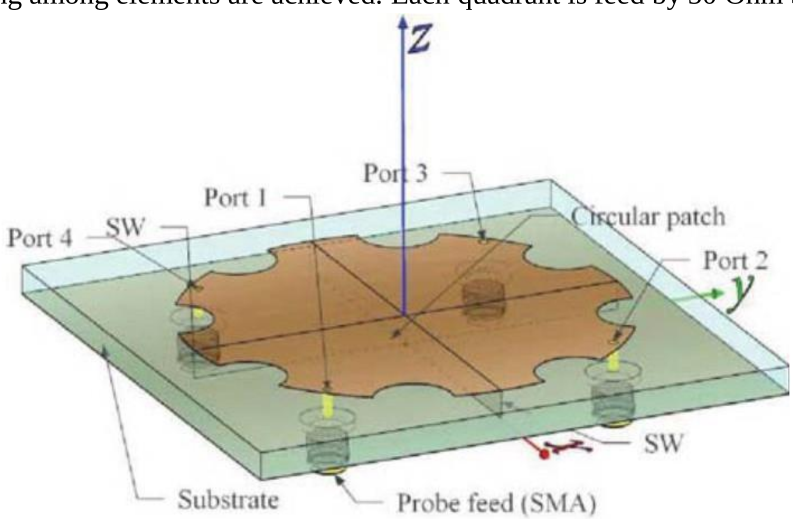

Fig.2.(a). MIMO Antenna 3D-view

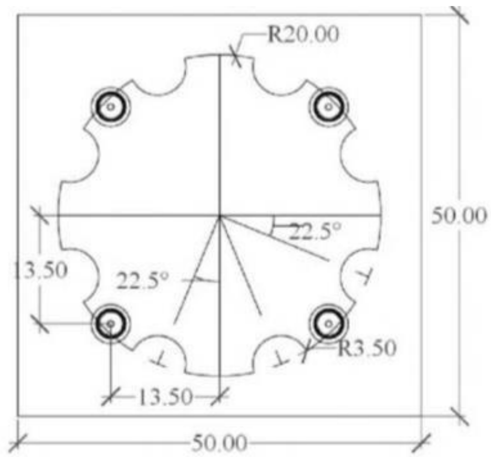

Fig.2.(b).MIMO Antenna 2D-view

Port 2and Port 1 - Port 3.Note that since Port 2 and Port **4** are also symmetrical with respect to Port 1, they are hencethe same and thus given together as one plot. From Fig. 2a, the resonant bandwidth is at the frequency range of 2-5 GHz for Sn= -10 dB with sufficient isolation levels. On the other hand, the impact of SW is investigated in to the SW, especially the Si3 is effectively reduced from approximately -3 dB to the operable level of -10 dB. At the same time, the S12 is enhanced via the SW. Therefore, the SW not only mitigate the mutual coupling, but also enhance the return loss.The simulated vector surface current distribution (SCD) of the MIMO antenna at 4.5 GHz in case Port 1 is activeis illustrated in Fig. 3. As seen from the figure, the surface current which would pass to the adjacent elements is blocked at the SWs. Therefore, the SWs ground the mutual coupling wave as well as the surface current.

An E-field distribution at the level of z = 1.27 mm and 4.5 GHz in case Port 1 is active is disclosed in Fig. **4.** As also seen from the figure, the SWs immure the field inside its own quadrant. The SWs hence mitigate the mutual couplingfrom each other.

III. THE IMPACT OF SHORTING WALLS

The S-parameters of the MIMO system with and without the SWs are revealed by simulation. Since the quadrant elements are in symmetrical form, S-parameters for merely one element is sufficient for examining the antenna. As Sn indicates the return loss for Port 1, Si2 and S33 respectively point out the mutual coupling Port 1 and Port 2.

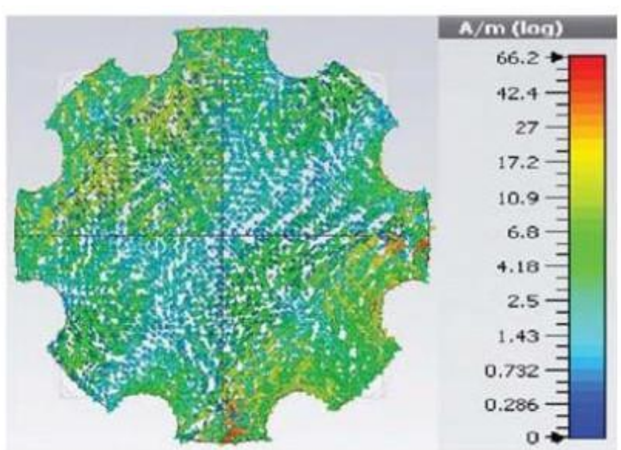

Fig.3(a).Vector SCD of MIMO Antenna at 4.5 GHZ.

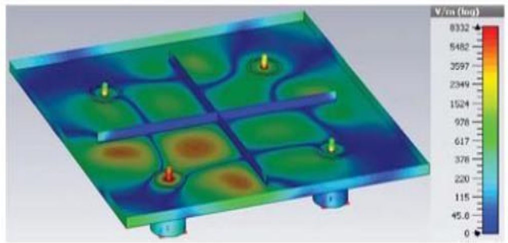

Fig.3(b). E-field at the level of z = 1.27 mm and 4.5 GHz

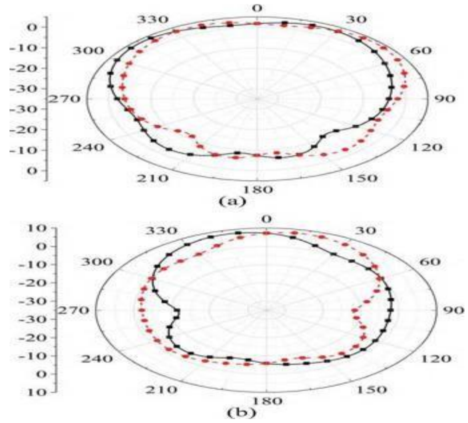

Fig.3(c). 2D radiation pattern in case Port 1 is active at a) 3.5GHz, b) 4.5 GHz. (The black-solid line with square symbol is on xz-plane, the red-dashed line with circle symbol is on yz-plane)

IV. RADIATION AND MIMO PROPOSED ANTENNA

The 3D radiation pattern of the proposed antenna in case Port 1 is active is demonstrated in Fig. 5. The antenna shows a quasi-omni-direction pattern which is convenient for the access points. For examining more elaborately the pattern, 2D radiation patterns at the frequency points of 3.5 GHz and 4.5 GHz are shown on xz-plane and yz-plane. It is also clearly seen that though the antenna radiates mostly towards z-direction, it radiates nearly omni-directional. It describes the 2D patterns in maximum (max.), minimum (min) and average (avg.) values.

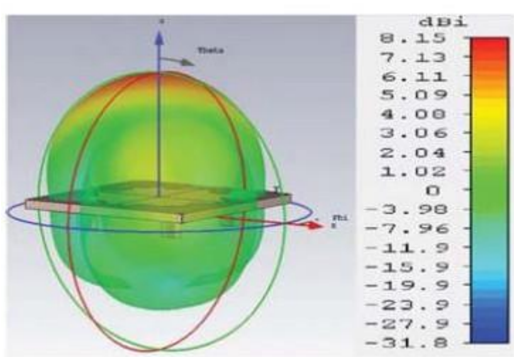

Fig.4(a).Radiation Pattern for 4.5 GHZ.

The isolation levels among the ports in terms of ECC and peak gain are measured in Fig. 7. The isolation level is below 0.5 ECC which is sufficient for the MIMO operation. The peak gain is higher than 1 dBi and it has maximum value of 8 dBi at 4.5 GHz.

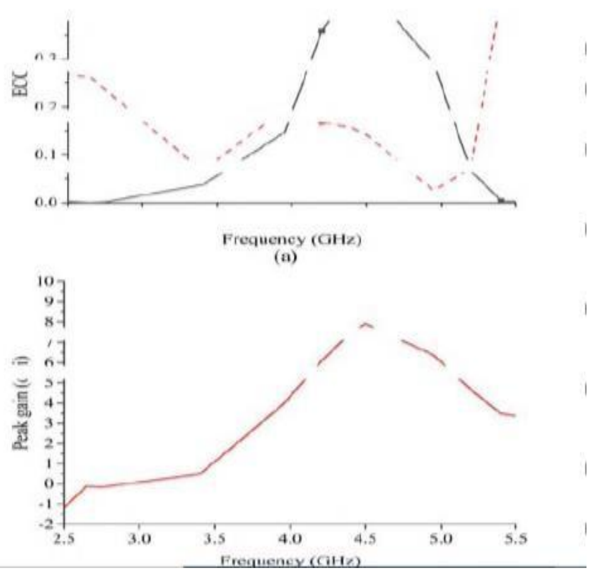

Fig.4(b).Variation of frequency(a)ECC (b)Peak gain

V. CONCLUSION

In this study, a compact 4-port circular MIMO antenna system, operating at a wide frequency range of 3.0-5.0 GHz,is presented. The antenna system consists o f a 20 mm radius patch disk which comprises four co-located elements anda 50 x 50 mm2 ground plane. The disk patch is decomposed four quadrants each fed by a 50 Ohm probe using two orthogonal SWs to minimize the mutual coupling amongst them. Two circular slots are also loaded on the outer edge of the quadrant elements to enhance the impedance matching. The impact of the SW on the mutual coupling is studied through surface current and E-field distributions. The radiation and MIMO performance of the proposed MIMO system is measured in terms of the radiation patterns, ECC and peak gain. Finally, from the results the proposed quadelement MIMO design is an eligible candidate for the access points since it is compact and versatile as well as has low ECC over a wide frequency band.

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