Design of a Dual-band MIMO Antenna for 5G Smartphone Application

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***Abstract*—A Dual-band MIMO antenna for the 5G communication is proposed in this paper. The proposed antenna consists of four antenna, it operating at 3300-3600 MHz and 4800-5000 MHz. The antenna designed in this letter are different from traditional 5G antennas, the antenna of this paper is perpendicular to the edge of the system circuit board, it can be applied to the popular full-screen mobile phone. According to the simulation results, reflection coefficient of the modulus is less than -6 dB, and the isolation is better than 12 dB over the band-frequency of 3300-3600 MHz and 4800-5000 MHz, it will met the needs of future 5G applications.**

Keywords—smartphone, 5G operation, MIMO antenna

I. INTRODUCTION

In order to meet the needs of modern 5G wireless communication system, study of the 5G smartphone antenna has great application value. 5G has become a hot spot in the field of mobile communications both at home and abroad. In early 2013, the EU launched the METIS (mobile and wireless communications enablers for the 2020 information society) project for 5G in the 7th framework plan[1], China and South Korea set up IMT-2020 (5G) Propulsion Team and 5G Technology respectively. At present, various countries in the world are conducting extensive discussions on the development vision, application requirements, key technical indicators and enabling technologies of 5G[2].

With the development of mobile 4G communication system, people's requirements for the speed of mobile communication are rapidly increasing. In order to meet these needs, the research and development of the fifth generation (5G) antenna has been carried out[3-5]. Miniaturization and multi-cell array antennas offer the possibility of high-speed data transmission, but pose challenges for cell phone antenna designs. Recently, the research of 5G mobile phone antenna is increasing day by day. In the future multi-mode 4G / 5G multi-antenna in smart phone applications, A multi-unit operate in the 3400-3600MHz single-band traditional 5G antenna was proposed[6]. An 8-element PIFA-based MIMO antenna system was proposed in [7], it only covers a single 3.5GHz band, And the minimum isolation between the various antenna elements only 7.4dB.

In this paper, a dual-band MIMO antenna which consist of four elements is proposed. The proposed antenna not only can operating in the dual frequency band of 3300-3600 MHz and 4800-5000 MHz. but also a 12 dB of isolation is obtained, the four antennas are disposed along two side edges of the smartphone, meet the requirements of a full screen smartphone antenna design, , in line with the current trend of full-screen smartphone.

II. DESIGN AND CHARACTERISTICS OF THE ANTENNA

The structure and dimensions of the proposed antenna array is shown in Fig.1. As is seen, the antenna system consisting of four bent lines and floor protruding branches as smartphones. The single antenna is designed and can be operated in the bands of 3300-3600 MHz and 4800-5000 MHz. The antennas are printed on the inner and outer surfaces of the side frame of the smartphone system circuit board. In order to meet the trend of modern ultra-thin smartphones, the height of the edge frame of the mobile phone is only 5 mm. The antenna elements have the same structure and dimensions. The side frames are orthogonal to the system ground plane, and the area of each antenna on the side frames is 3.9 mm ×17 mm.

The system circuit board is selected to have a size of 130mm×74mm, which is reasonable for the 5-in smartphone. Both the side-edge frame and the system circuit board are fabricated using 0.8-mm-thick FR4 substrate of relative permittivity 4.4 and loss tangent 0.02. The radiation part of the antenna can be divided into two parts: front radiation part is a bending line monopole, feed part as shown in Fig.1 (c) below; the back of the radiation part is a L-shaped short-circuit stub. The monopole adopts the bent line structure, and the coupling capacitance generated by the L-shaped branch behind helps to match the impedance of the low frequency band so that the low frequency can cover the frequency band of 3.5GHz better, the front feeder belt and monopole lengths resonate around 4900MHz and the coupling capacitors created by the back L-shaped branches and the front bend line contribute to high-frequency impedance matching.

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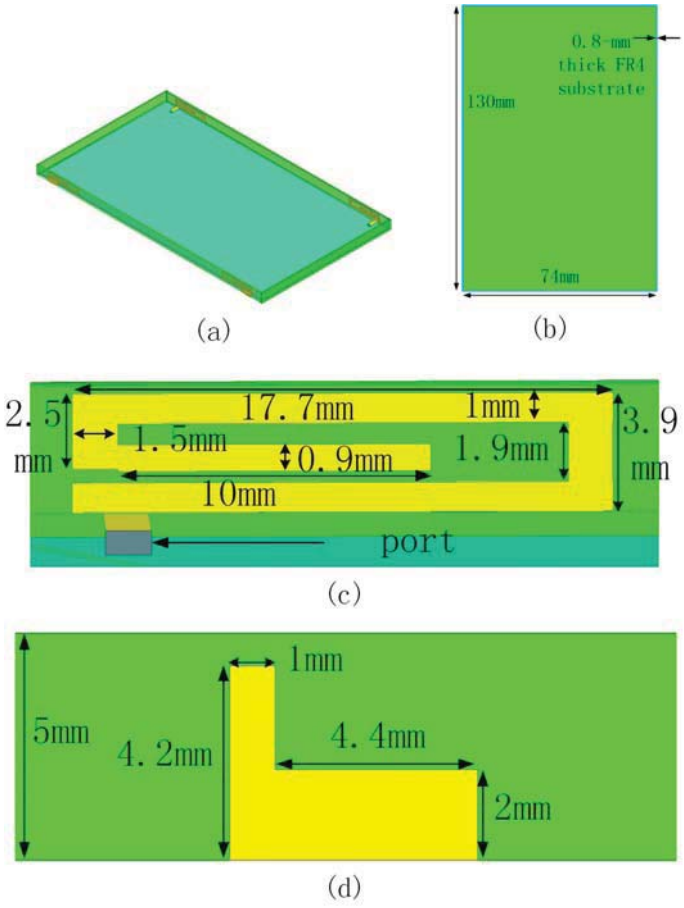

Fig. 1. The proposed antenna array structure. (a) Antenna 3D model. (b) Antenna model top view. (c) Antenna element model main view. (d) Antenna element model rear view.

III. SIMULATED RESULTS

The simulated results were performed by using ANSYS HFSS 15. Fig.2 shows the simulated S parameters for the proposed antenna array. As seen in Fig.2, the reflection coefficients (S11,S22,S33,S44) of four antennas are less than -6 dB (3:1 VSWR) in the desired frequency range of 3.3-3.6 GHz and 4.8-5.0 GHz , indicating that acceptable impedance matching is obtained. The transmission coefficient between antennas are presented in Fig.3, it shows a dip (about -15 dB) at about 3.5GHz and less than -12dB at about 4.9 GHz and is less than -10 dB for frequencies in the operating band., which is acceptable for smartphone applications. For the antenna efficiency shown in Fig.4, it is all above 50% in the operation band.

The obtained ECC of the four antennas is presented in the Fig.5. The obtained ECC is all much less than 0.1 in the operation band ,which is good for the MIMO operation. The result suggest that the proposed antenna array are suitable for practical MIMO operation and can be used as a building block in forming the MIMO array with eight or more antennas in the future smartphones.

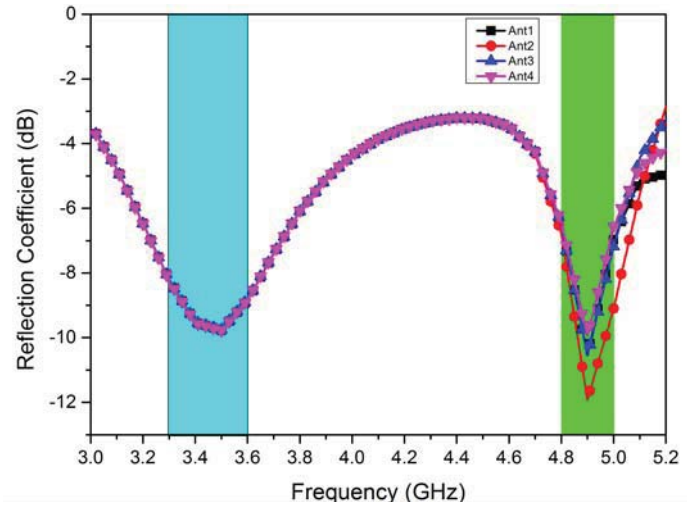

Fig. 2. Simulated Reflection Coefficient.

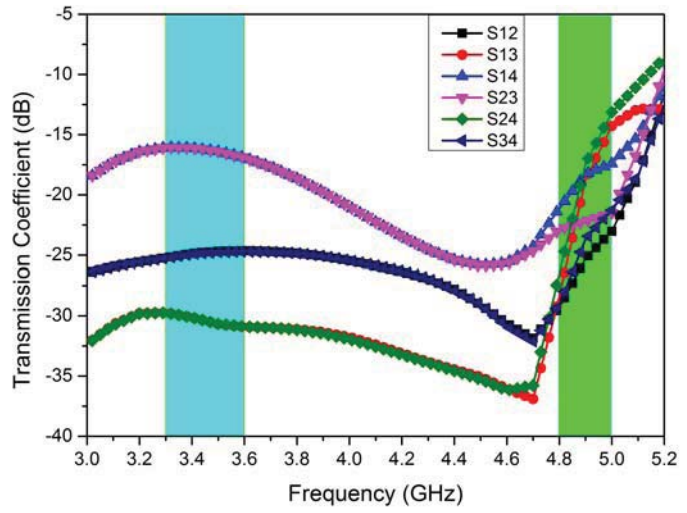

Fig. 3. Simulated Transmission Coefficient

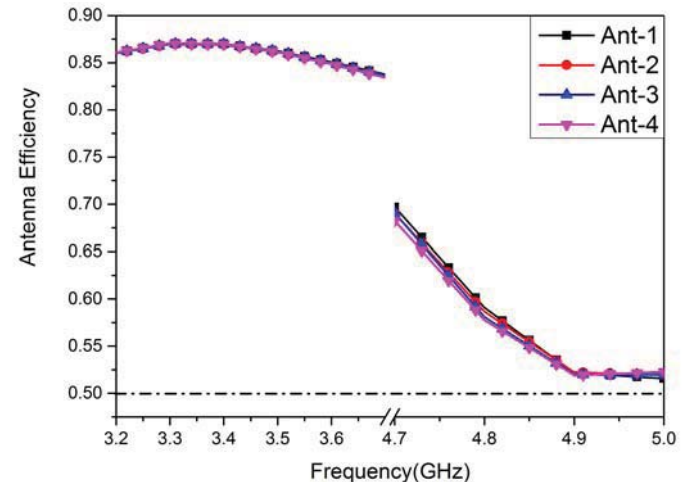

Fig. 4. Simulated Antenna Efficiency

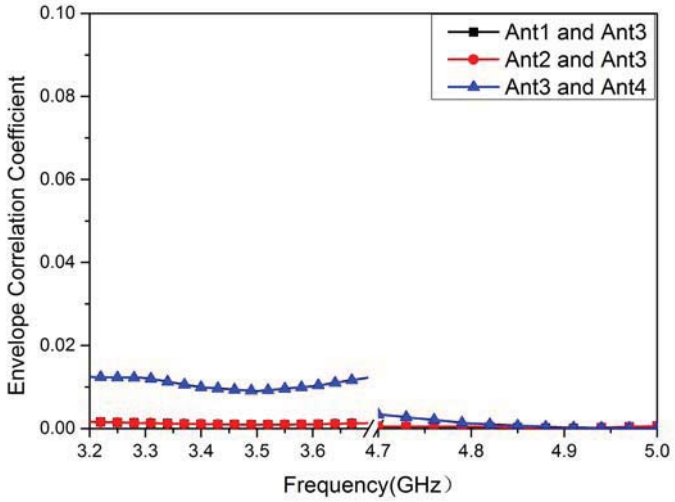

Fig. 5. Simulated ECC of the MIMO antenna

IV. CONCLUSION

A dual-band four-antenna MIMO array for 5G smartphone applications is proposed. The proposed antenna is located in the side frame, in line with the trend of a full screen smartphone antenna design, in the premise of the reflection coefficient to meet the requirements, to achieve a relatively high isolation, the antenna size is relatively small, ideal for today's ultra-thin smartphone communications.

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