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ARTICLE

Circular Ribbon Antenna Array Design For Imaging Application

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ABSTRACT

Our goal is to develop THz module on chip to visualize bone grinding at the early stage so that arthritis can be visualized and treated early. A critical component of such module is antenna. A compact 4 by 4 beamforming antenna array for biomedical application is presented in this paper. We are proposing a novel antenna which is in the form of a circular ribbon shape with a gold patch. Gold material for the patch is used to enhance its conductivity and to cut down backward radiation. Differential port pin used to increase the bandwidth. Au-posts are finally used for output connection. The proposed antenna operates over the frequency band from 201 GHz to more than 228 GHz. Directivity and gain of the proposed antenna are 13 dB and 7 dB respectively. This makes it applicable for imaging systems because of the frequency band for biomedical imaging. Index Terms—Beamforming antenna, antenna array, Advanced design system (ADS), Biomedical imaging.

1. Introduction

THz communications are one of the possibilities to meet the demand for ever-increasing data rates. In recent years, several publications have reported a 100 -300 GHz antenna design with a target for enhanced biomedical applications [1,2]. Microwave imaging from 100 to 300 GHz is an auspicious design for biomedical applications such as detecting the skin cancer. Reason is that it has good resolution and generation characteristics [3]. The process for skin cancer detection with the high-frequency module on chip containing antenna is initially a pulse that is transmitted from the antenna, which will penetrate through the various tissues of the body. At a particular time, the transmitted signal will be reflected from the small size. Particles which represent that skin cancer.

The same antenna can be used to collect the reflected signal for further measurements. For accurate results, the antenna should have high gain, directivity, resolution, dynamic range with compact size [4]. Also such technology is beneficial for the detection of Arthritic. Many antenna designs have been proposed for biomedical imaging applications [5,6], each has its advantages and drawbacks. Some published antennas have a structure of rectangular ribbon type, whereas others have a square structure. All the proposed structures are using only a single antenna for detecting the signal. As a result, weaker signals go undetected. In this paper, we are proposing a compact size 2.8*0.43 mm^2 circular ribbon-shaped beamforming identify applicable funding agency here. If none, delete this antenna array with high gain and directivity. In addition, we are also studying application of meta material elements for this application.

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2. Design Methodology

Traditionally, antennas are off-chip due to their size and because typical substrates are conductive [7,8]. The proposed circularly ribbon-shaped antenna is shown in Figure 1. To enhance its conductivity and to cut down backward radiation gold material was used for the patch. Differential port pin used to increase the bandwidth. Dimensions of the antenna are angle radius of the circle is 100 um with a thickness of 10 um and patch length 100 um with a thickness of 10 um.

Generally, antenna arrays are used to generate a high gain. One of the important parameters of array design is the setout of the distance between the adjacent elements of an array because this will lead to interference and distortion, not allowing further assessment of received signals [9]. Many mutual coupling contraction techniques [10-12] have been proposed to enhance the isolation performance between the antenna elements.

In this paper I am proposing a two-layer beamforming a 4x4 array antenna with high isolation between elements. I have used ADS to design the antenna. The top layer is a circular shape structure. For beamforming array, the distance between antenna elements is kept close to /4. Line length is adjusted to create a delay between adjacent elements for beamforming radiation patterns. GaN was used as a substrate while simulating antenna array. The configuration of our designed antenna array is shown in Figure 2.

3. Results

The Figure 3 depicts the S11 response of the proposed antenna. The simulated S11 graph has -10 dB return loss from 201.6GHz to 228.1 GHz, which means the bandwidth of the antenna is nearly 26.5 GHz. Peak S11 is noticed at 217.2 GHz with a value of -41.9 dB.

The Figure 4 shows gain and directivity plot of the proposed antenna has 7 dB gain and 13 dB directivity at 217 GHz frequency. The proposed antenna has maximum gain and directivity at 250 GHz frequency.

The Figure 5 and Figure 6 depict 3D radiation patterns in YZ and XZ directions respectively. The simulated results of the proposed antenna are mentioned in the Table 1.

Table 1. proposed antenna results

content	units	
Single antenna size (L*W)	um*um	500*615
Antenna array size (L*W)	um*um	2.8*0.43
Return Loss (S11)	dB	-41.8
Antenna Gain	dB	7
Directivity	dB	13
Antenna Bandwidth	GHz	28.5

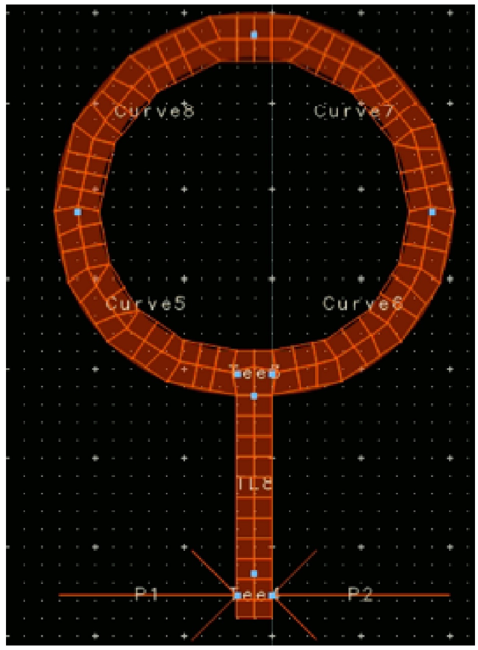

Figure 1. Proposed circular ribbon-shaped

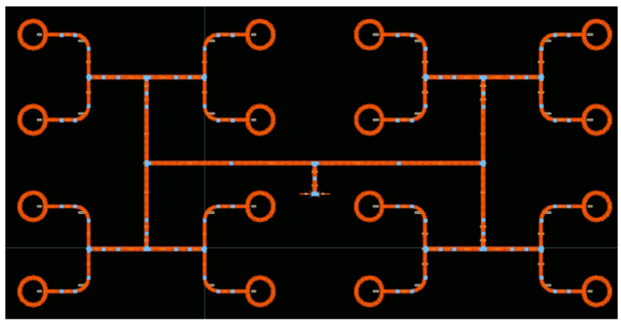

Figure 2. Proposed circular ribbon-shaped antenna array

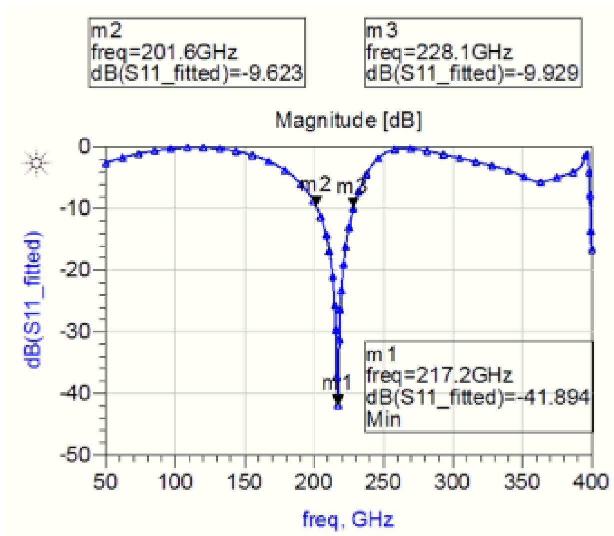

Figure 3. S11 response of proposed antenna design

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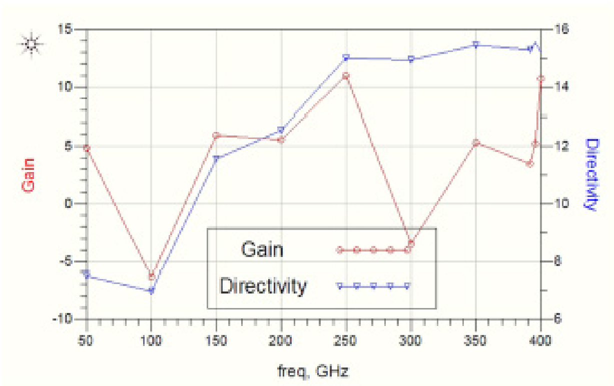

Figure 4. proposed antenna Gain and Directivity

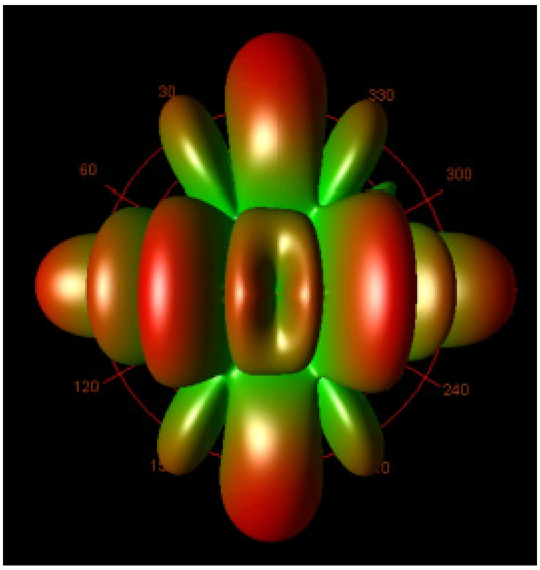

Figure 5. 3D radiation pattern in XY direction

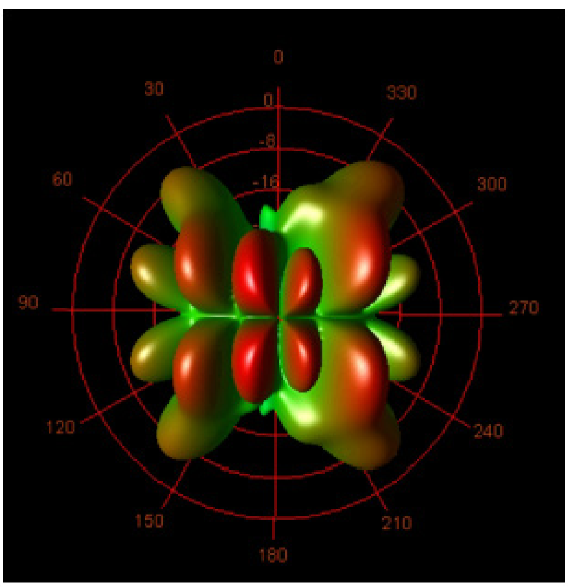

Figure 6. 3D radiation pattern in YZ direction

We would like thank NCTU for providing facilities for our research.

4. Conclusions

In this paper a compact 4 by 4 beamforming antenna array for biomedical application is presented. To enhance the conductivity gold material is used. The proposed antenna operates over the frequency band from 201 GHz to more than 228 GHz. Directivity and gain of the proposed antenna are 13 dB and 7 dB respectively. This makes it applicable for imaging systems because of the frequency band for biomedical imaging.

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