Steerable Roger Antenna for 5G Applications

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Abstract - *In this study, design of Antenna is modified for better bandwidth, cost effective and performance in the frequency range of proposed for 5G IOT applications. Antenna having three dielectric resonator antennas in which two of them are parasitic elements and one is driven element operates in two modes $TE_{(1,1)}$ & $TE_{(1,3)}$. The driven element excites the nearby parasitic elements through a principle called mutual coupling. The capacitors which are in the ground layers of parasitic elements are used to get steering which is in the range -32⁰ to +32⁰. The proposed design has gain >7dB and bandwidth of 1.47 GHz with operating frequency of 20.42GHz.*

***Key Words*: Beam steering, Dielectric resonator antenna, higher order mode, Parasitic elements,5G**

1. INTRODUCTION

Dielectric resonator antenna with parasitic elements of higher order mode was considered in HFSS version 13.In this the antenna design for required beam steering has been designed using HFSS. By switching the termination capacitor on the parasitic element beam steering was successfully achieved. Beam steering may be influenced by two factors. When switching conditions are varied then the change in the beam steering is more relevant to the required results when compared to the change in frequency. So here switching conditions of the capacitor take a major role. As a result, the beam steering of the antenna beam was -32⁰ to 32⁰ at 20.42GHz.

1.1. Literature Survey

A quick advancement in telecommunication has led an origin from 1G to 5G by increasing both the sharing of information and immense access to data. Internet of Things require these salient features for many applications. As a result, the increase of demand and the usage for the communication between the devices may cause interference particularly at higher frequencies in 5G.Since for a smart device can fix firmly with high gain antenna and bandwidth in order to control the increasing traffic and the interference. A directional antenna is necessary for the long distance communication. For 5G applications the spectrum above 6Ghz has provided a way for future networks.

The friis formula supports that path loss is based on the frequency. Since the loss will be increased at higher frequencies because of multiple antennas and also the decreased wavelength. In complex phased array design include power distribution in the network, phase shifter and bias component. Whereas the phase shifters are costly and require complex feeding networks which cause more losses at higher frequencies. Hence a new phased arrays are need to be developed for different techniques. In order to overcome this beam steering has been developed without the phase shifters which is known as Electronically Steerable Passive Array Radiator(ESPAR) antenna. It consists of driven and parasitic element. The steerable beam can be adjusted by controlling capacitor values.

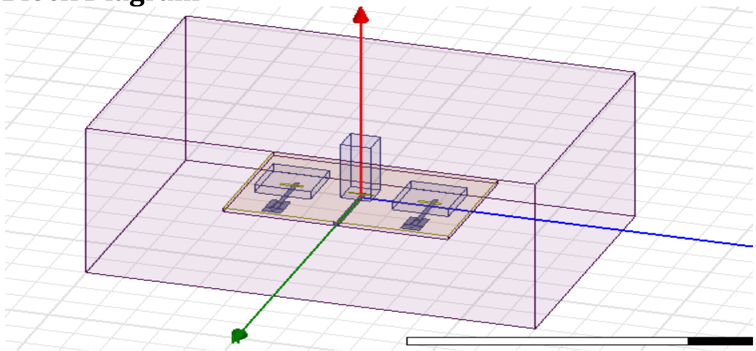
1.2 PROPSOED SYSTEM METHODOLOGY

We proposed a solution for arising technology 5G applications using a dielectric resonating antenna with parasitic elements. It is a cost effective design which is mainly used for industrial purpose. In this design of antenna it consists of six switches which effect the mutual coupling on the radiation pattern and the reflection coefficient. Here it consists of two DRA's in which each DRA is associated with three switches.

BEAM STEERING

By changing the phase of the signal on all radiating elements beam steering is achieved. Here beam steering is done using switching factors.

Block Diagram



DESIGN	MODE
Driven DR	Higher order mode $TE_{(1,3)}$
Parasitic DR I	Fundamental mode $TE_{(1,1)}$

Parasitic DR II	Fundamental mode $TE_{(1,1)}$

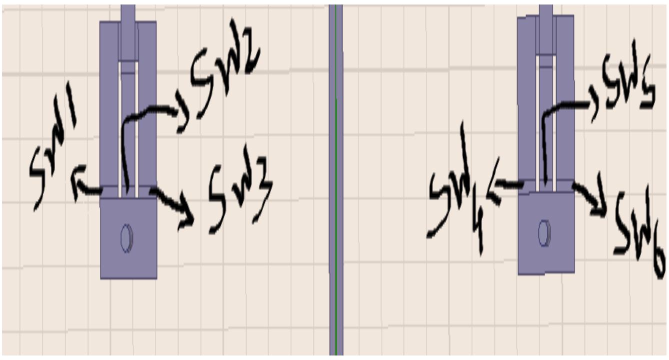
Working

In this the three resonator antennas where one act as driven element and other as parasitic elements .Here the feed is given to driven element which in turn drives and activates side by elements through a principle called mutual coupling. The capacitors which are in the ground layers of parasitic elements gets energized and switched in order to get beam steering. The principle used here is called mutual coupling.

- In this proposed system the main changes did on choosing different dielectric material used for substrate and DRA elements.
- This changes in dielectric material of DRA and substrate shows its effect on operating frequency, gain, bandwidth.
- Here we do switching of capacitors for different cases and observe beam steering, gain and bandwidth.
- Dielectric materials used are Rogers R04003(™) with relative permittivity as $\in_r = 3.55$ for DRA and Rogers RT/duroid 5880(™) with a relative permittivity as $\in_r = 2.2$.

Here for beam steering six switches and its cases has been taken for both the DRA's. The parasitic DR'S are excited in higher order and fundamental modes. In switching condition either of the three switches in one DRA one is in the ON condition and the remaining two switches are in the OFF condition.

Switching cases



			CS-I	CS-II	CS-III	CS-IV	CS-V
PARASITIC DRA 1	PARASITIC	SW I C_1 =0.01pF	ON	OFF	ON	OFF	ON
		SW II C_2=1pF	OFF	OFF	OFF	ON	OFF
		SW III C_3 =0.1pF	OFF	ON	OFF	OFF	OFF
PARASITIC DRA II	PARASITIC	SW IV C_4 =0.01pF	OFF	OFF	ON	OFF	OFF
		SW V C_5 =0.01pF	OFF	OFF	OFF	OFF	ON
		SW VI C_6 =0.01pF	ON	ON	OFF	ON	OFF

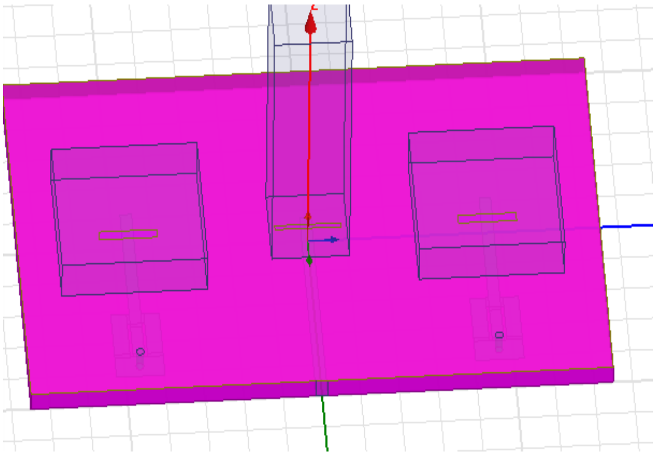
Software Requirements

- HFSS 13
- Windows 7/10
- Ram 4Gb (Min)

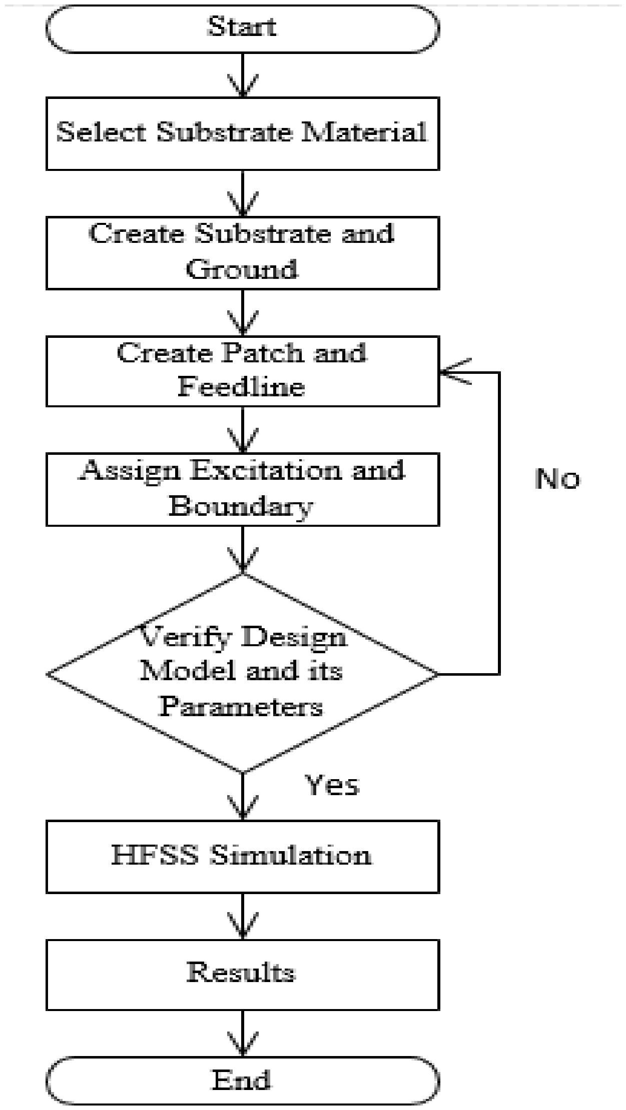
STEPS FOR DESIGN OF PROPOSED ANTENNA

1. First open the software and select file⍰ new⍰ HFSS design.
2. Select the solution type as driven model/ driven terminal/ transient.
3. Select the model's units of measurement.
4. Select the drawing plane as XY/ YZ/ ZX from the icons on top of the window.
5. Select the rectangles or circles or box symbols that are required for the design on the right corner of the window and draw the required number of them and set the positions and axis size for each rectangle/circle/box.
6. Now unite/subtract/add them as per the required design.
7. Assign the materials for the model.
8. Assign the boundaries for each plane.
9. Setup the analysis and add frequency sweep.
10. Save the project and analyze it.
11. Go to create reports to validate the results.

Design

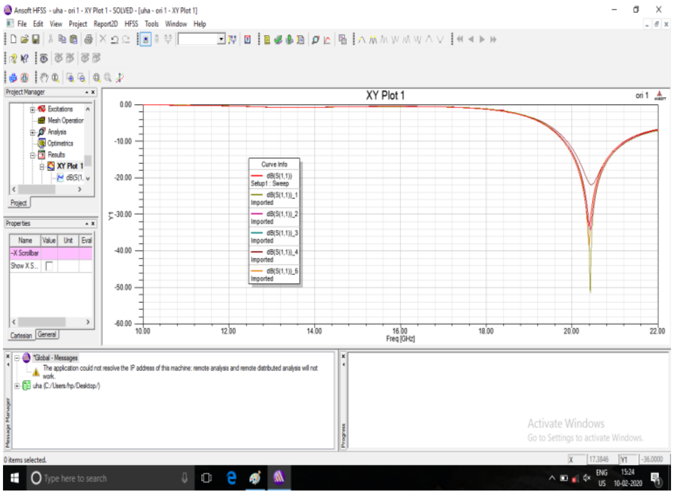


Flow Chart



Results

Overall Return loss plot



*Global - Messages

The application could not resolve the IP address of this machine: remote analysis and remote distributed analysis will not work.

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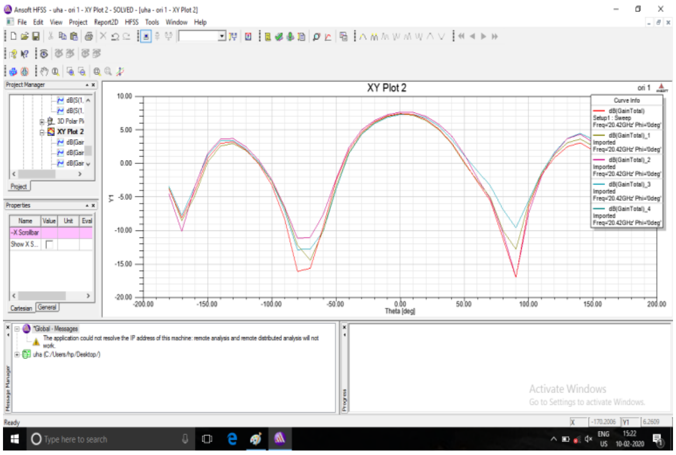
0 items selected.

Overall Gain Rectangular Plot



*Global - Messages

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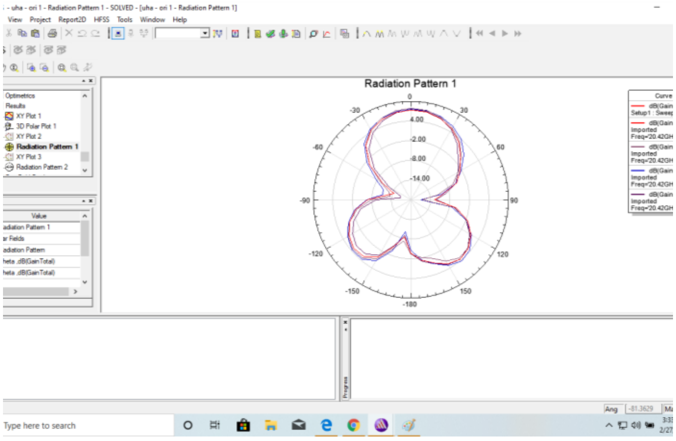
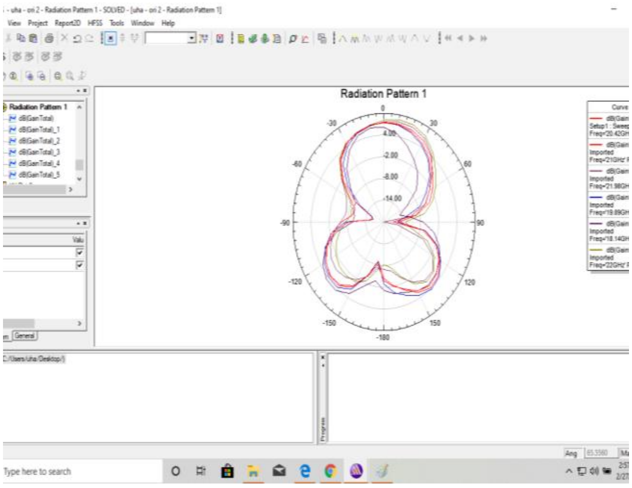
Ready

Overall Radiation Pattern By Switching



Overall Radiation Pattern By Changing Frequency



Conclusion

Beam steering is successfully achieved at -32° to 32° at high frequencies i.e more than 20GHz.As the frequency range increased the bandwidth is also more .Due to large bandwidth the area of transmission area has been increased with return loss less than -10dB.Due to the material change these factors are modified. Change in the material plays a major role in reducing the cost factor which plays a key role usage of antenna for industrial purpose.

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