SIMULATION AND ANALYSIS OF 5G MOBILE PHONES ANTENNA

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ABSTRACT

In this study, design of Array of Antennas is modified for better gain and performance in the frequency range of proposed for 5Gmobile applications. Three sub arrays of microstrip antenna identical in shape and design are used along the sides of Mobile phone to cover the broad area of space. The proposed design has gain >10dB.

Key words: *5G, Phased Array, Patch Antenna, mm-Wave, MIMO Antenna.*

1. INTRODUCTION

The early communication systems supported only analog voice and now provide wide range of different applications to large number of users. First generation of mobile system supported voice only. Within last few years we have seen gradual development of mobile communications by birth of 2G, 3G and 4G wireless networks respectively. Digital networking communication techniques like Modulations, Cellular frequency reuse, Packet switching and physical layer simulation etc have resulted in this change.

With the increasing demand of smart devices, now a day's IP based networks has become a necessity. Resultant, new multimedia applications for mobile users .Market is flooded with these applications and has open up new ventures for mobile user and service providers.

The future of mobile communications is likely to be very different to that which we are used to today. While demand for mobile broadband will continue to increase, largely driven by ultra high definition video and better screens, we are already seeing the growing impact of the human possibilities of technology as the things around us become ever more connected. The upcoming 5^{th} generation cellular network ("5G") is anticipated to exhibit a uniform Gbps data throughput experience across a vast range of user scenarios.

5G is more than just a new wireless radio technology. It is a door opener to new communications possibilities and use cases, many of which are still unknown. Enabled by 5G, a programmable world will transform our lives, economy and society. Data throughput will be enhanced by more than a hundred fold.

In this paper, design of multi-layer phased array antenna for millimeter-wave (mm-Wave) fifth generation (5G) mobile phone is designed and modified to achieve better performance, gain and directivity. The proposed linear phased array antenna is designed on *Nelco N9000* substrate to operate at 18-28 GHz which is under consideration for 5G wireless communications.

Key technique in 5G systems is the use of millimeter-wave bands along with directional phased array at both the mobile device and base station [11].

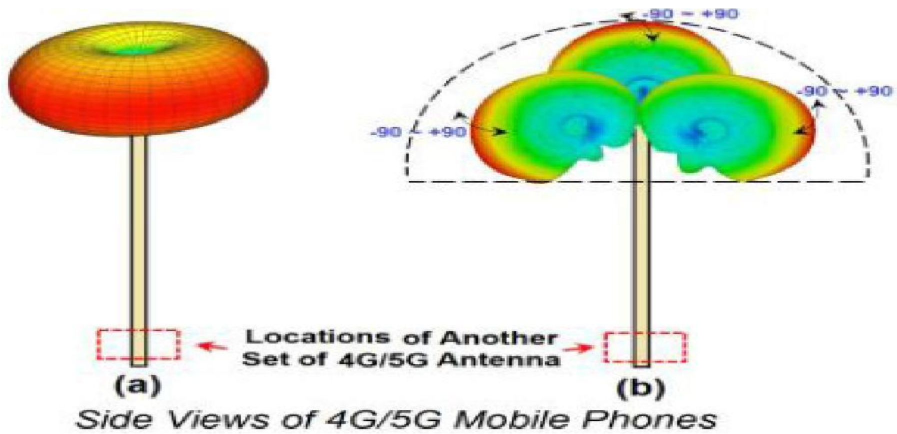

Figure1 Radiation patterns of mobile phone antennas, (a) typical 4G antenna, and (b) the proposed 5G antenna package.[6]

As shown in Figure 1 (a), typical 4G mobile phones use omni directional antennas with moderate radiation gain to achieve coverage in all directions [12]. For 5G mobile phones, to cover the space, beam steering is proposed. However the directional phased array can only cover part of the space. The coverage range for 5G mobile phones cannot be omni directional using one array antennas as for 4G .Thus it is proposed to use array of antennas at the edges of the mobile phone, in order to achieve the coverage by steering the beam.

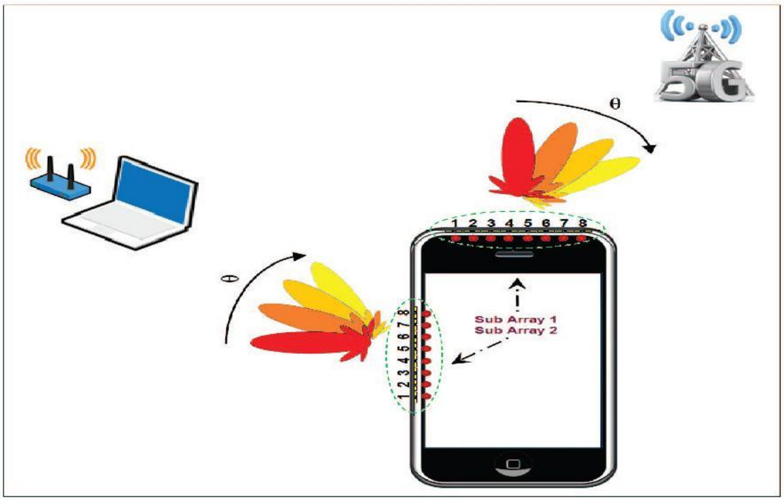

Figure 2 Architecture of the multi-user MIMO for 5G mobile communications.

As per Figure 2 it is proposed to place two identical sub arrays of patch antenna at different sides of the mobile-phone printed circuit board (PCB) to operate in diversity or multiple-input multiple-output (MIMO) modes [10].

2. DESIGN

The proposed antenna package operates in 18-22 GHz which is required for 5G communications. The proposed design consists of three sub arrays of patch antennas in different sides of the edge region in PCB.The proposed design has > 10 dB gain with good directivity and efficiency. Each of the sub arrays is steerable to the scanning range of -90 to +90 (Theta Plane).The three sub arrays are designed such that their radiation patterns partially overlap on each other but cover different parts of the space .The S-Parameters ,radiation pattern, efficiency and beam steering characteristics of the proposed design are investigated.

Eight patch antenna elements have been used for each of the sub arrays. The center to center distance between the elements is approximately $\lambda/2$, For beam forming array, the distance between antenna elements (d1+W/2) is calculated close to $\lambda/2$. The antenna is designed on a Nelco N9000 substrate with thickness (h_{sub}) of .787 mm, dielectric constant permittivity (ε_r) of 2.2, and loss tangent (δ) of 0.0009.The software used for simulation is IE3D.

3. DESIGN OF SINGLE ELEMENT PATCH ANTENNA

To design an array of antenna the first step is to design a Single Microstrip Patch Antenna. Microstrip Patch Antennas (or simply patch antenna) is chosen because the antenna is printed directly onto a circuit board.

Additional benefits of patch antenna is that they are easily fabricated making them cost effective. Their low profile design, often square or rectangular, allows them to be mounted to flat surfaces. The main challenge here in the design is to cover at least half of the space for 5G mobile phones with high-gain radiation beams. In order to achieve this property, three linear sub arrays of patch antennas have used at different sides of the PCB.

We have designed a single rectangular Patch Antenna with dimensions W=2mm, L=4.32mm H =.787 mm. A slot of.75mm is given at .625mm and .7mm.Array of eight identical rectangular patch antennas is designed; distance in between the single antennas is 6.5mm for better gain and directivity.

4. RESULTS

Microstrip patch antennas are fed by using coaxial probe technique. The inner conductor of the coaxial probe feed extends from ground plane through the PCB substrate to reach the radiating element[6].The coaxial feed is given at x=1mm and y=.5mm .The proposed antenna package could also be used in the bottom portion of the mobile phone PCB to cover another half of the space.

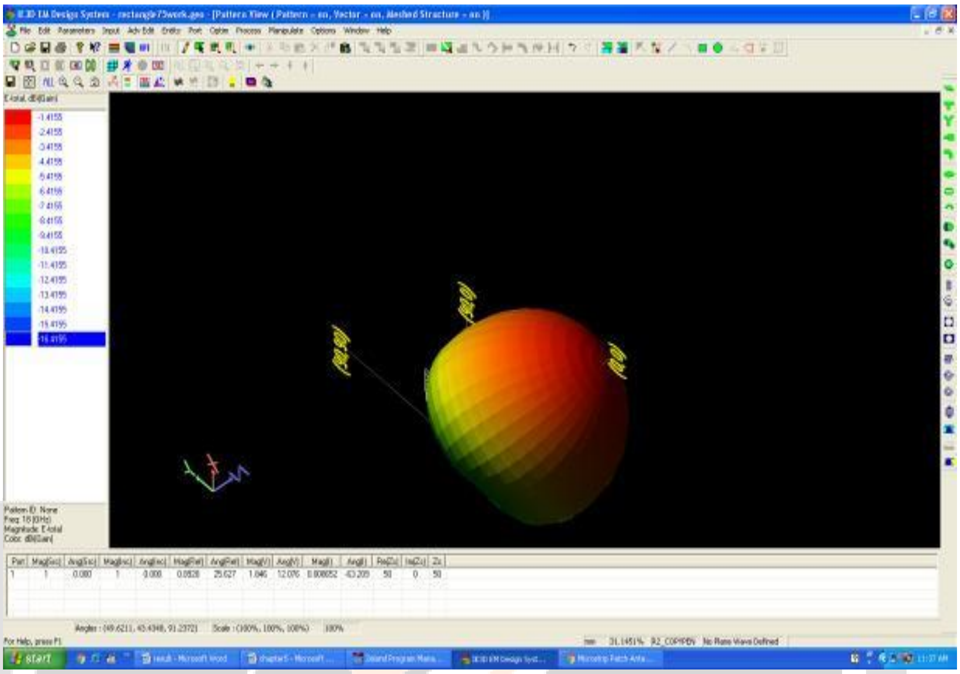

Figure 3 Simulated Radiation Pattern for Single Antenna

The antenna show good radiation pattern in frequency range 21 to 28 GHz for single element.

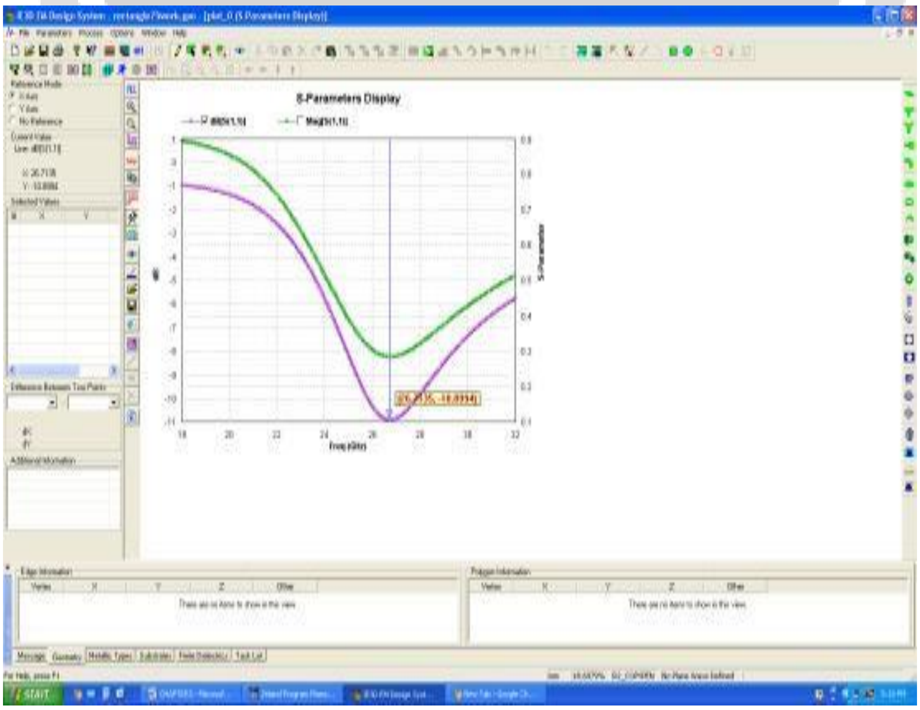

Figure 4 S11 for Single Patch Antenna

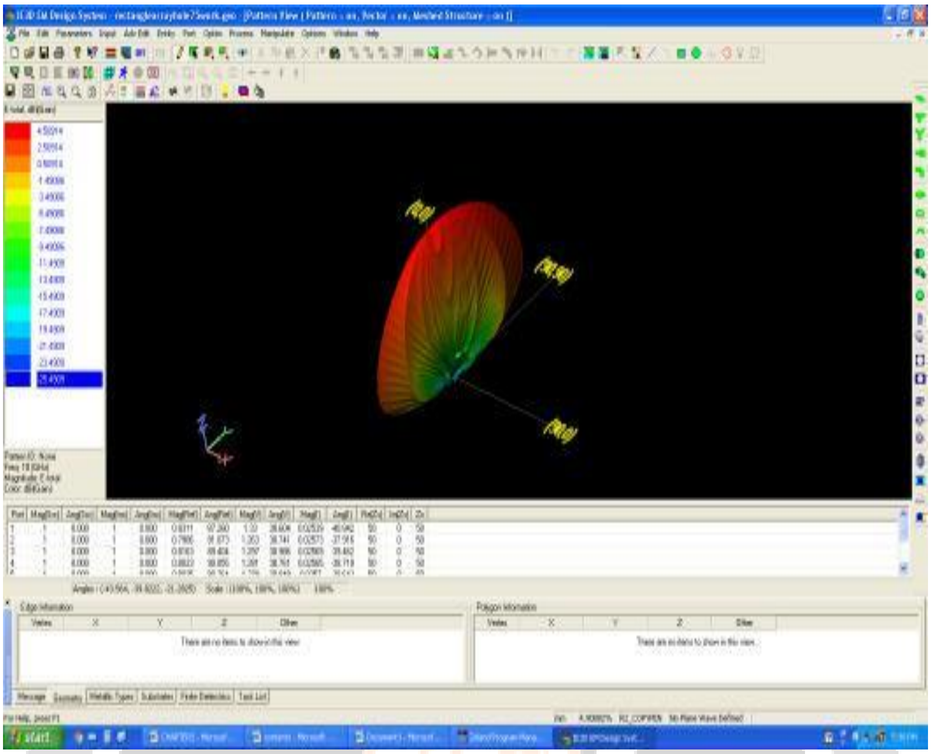

Figure 5 Radiation Pattern for Array of Eight Antennas

The radiation pattern shows narrow beam and good directivity. The antenna shows good radiation patterns at 21.75 GHz for sub arrays.

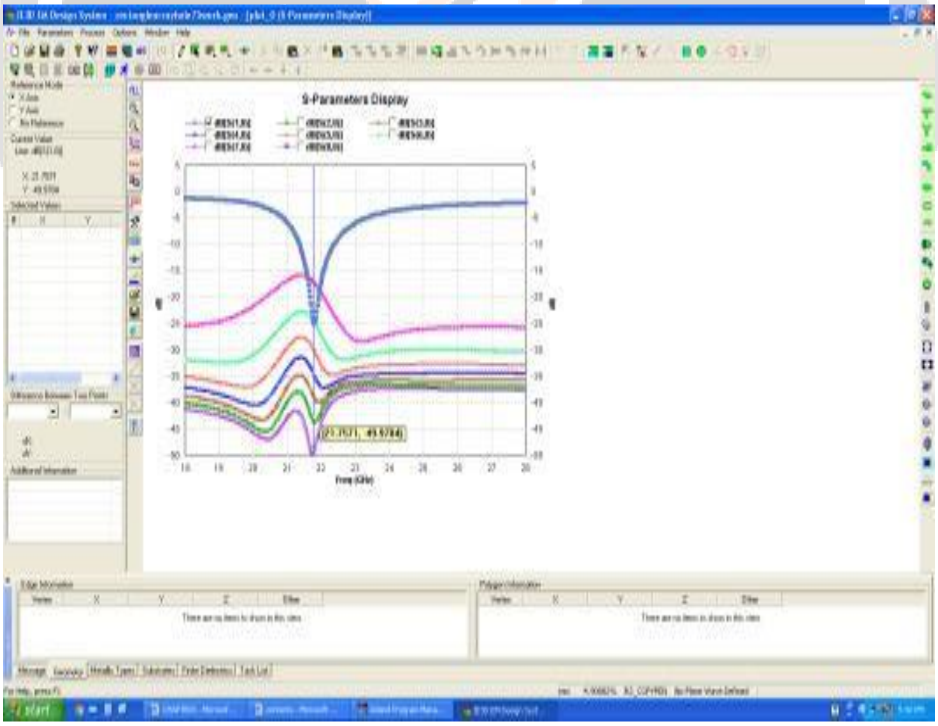

Figure 6 S Parameters Result for Array of Eight Antennas

The S parameters result for array of eight antennas is shown in Figure. 6.The simulated S-Parameters shows good results. The antenna obtains a gain of more than 13 dB at a frequency of 21.7

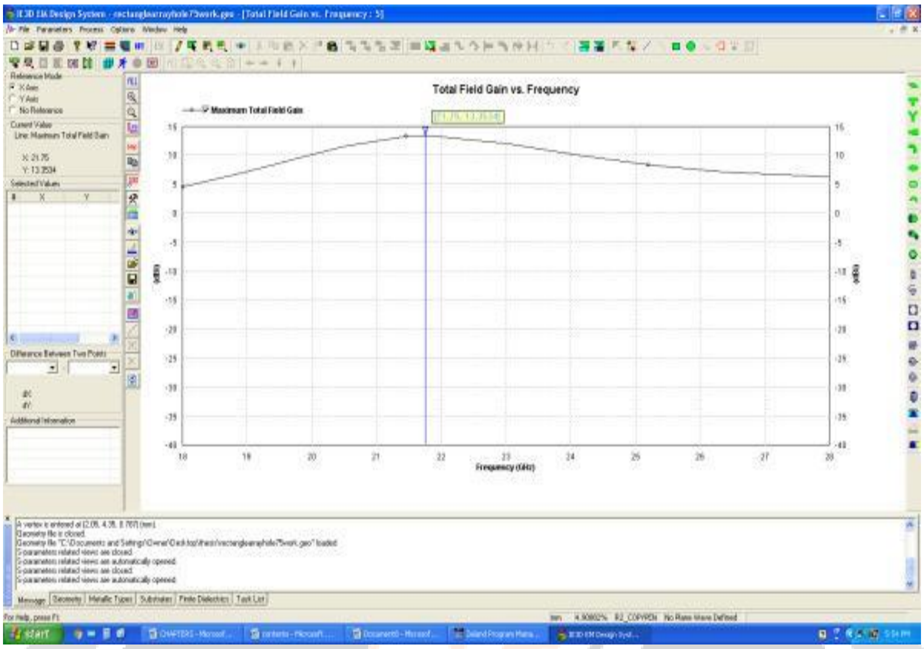

Figure 7 Gain Vs Frequency Graph

5. CONCLUSION

The design of a phased array antenna package for 5G communications has been presented. The antenna consists of three sub arrays and each sub-array covers part of the scanning space.

It is seen that gain of > 13dB is achieved for each array. The whole design has been validated by simulation.

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