SMALL 4-ELEMENT BEAM-STEERABLE ADAPTIVE ARRAY ANTENNA FOR 5G APPLICATIONS

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Abstract— Mobile data traffic is expanding at a never-before-seen rate as a result of the popularity and use of smart phones. Along with acceptable cost and low power system requirements, high data rates for HD video streaming are becoming more and more in demand. Nearly all of the 4G LTE (Long Term Evolution) spectrum has been used up to meet the needs for future, rapid communication. Therefore, in order to implement 5G communication networks, technology must rapidly advance. For the expansion of high-speed media, 5G demands an antenna system with high efficiency and wide bandwidth. Broad radiation pattern antennas, which are commonly employed, are not ideal for achieving high gain and efficiency. To build an assembly of radiating parts in order to attain high gain and efficiency, forming an assembly of radiating parts in an electrical and geometric layout is a straightforward technique to obtain high gain and efficiency. The term "antenna array" is used to describe these groups of radiating devices. Additionally, antenna beam steering, which was previously only thought of for radar and satellite systems, is now required for consumer devices. The ANSYS HFSS (High-Frequency Structure Simulator) programme was used to design, analyze, and verify this compact 4-element beam steerable adaptive array antenna.

Keywords: Micro strip, Beam Steering, Resonant Frequency, Antenna Array.

I. INTRODUCTION:

Consumers are stuck in a rut as a result of their present 4G usage. Because the 4G spectrum is being oversaturated, people are experiencing low data and poor wireless connection signals. This will also soon be true for the incoming 5G spectrum. However, the 5G spectrum won't last as long as the 4G spectrum did due to the rise in societal demands over how they use the spectrum. It will actually reach saturation faster than the 4G spectrum. We've developed the idea of "beam steering" in order to prevent this scenario from happening. It is a concept that is exclusively applied in military-grade research. Due to its ability to prevent the 5G spectrum from becoming oversaturated, we made it accessible to regular customers. Simply put, this is the best configuration of a number of radiating patches so that each patch emits radiation as a single major lobe with the fewest number of side lobes.

A. Inspiration The effectiveness of the spectrum has diminished due to everything being remote these days, from shopping to telemedicine, making wireless communication more crucial than ever. The objective of this project is to get the system back into the saturation region by restoring the efficiency that formerly made a good wireless communication system effective. Consequently, this initiative was created.

Problem Definition:

This project mainly depicts the problem faced by a common wireless device user, say Smartphone, who faces mobile data traffic issues and less data transmission speeds due to the oversaturation of the current running 4G spectrum, and to avoid the upcoming 5Gspectrum from facing the same fate, we have developed this Compact 4-Element Beam Steerable Adaptive Array Antenna for 5G

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application.

Objective:

The goal of this project is to develop a small, compressed, or simply compact, microstrip patch antenna that is capable of adapting to various radiating conditions and is powerful enough to function in the frequencies of the 5G spectrum, which are generally between 28 and 50 GHz. This is easily accomplished using the idea of "beam steering," in which several patch antennas work together on the same ground plane or substrate to radiate at the same frequency of 38 GHz. has a strong (5dB) gain. The high-frequency structure simulator (High-FrequencyStructureSimulator) programme will be used to research, design, and model this project.

II. LITERATURESURVEY:

There have been numerous previous attempts to create an effectively functioning antenna system using rectangular, triangular, and other shaped micro strip patches in the antenna, but they all had drawbacks of their own. We created an antenna with the fewest restrictions compared to its predecessors after consulting all of the prior base papers and keeping their limits in mind. Beam steering, which is being used in the household sector, is the principle that sets our antenna apart from its forerunners. Prior to now, it had only been employed in military-grade applications, but we'd like to introduce it to the commercial sector for its advantages.

III. Existing System:

The frequency at which antennas are now and continuously operated is insufficient for users of wireless communication to benefit fully from them. As we indicated before in this study, the 4G spectrum became saturated as it was used by an increasing number of individuals every day, resulting in little-to-no data being received by all users. They're doing operated between 2 and 20 GHz with a gain of 2 dB, which is obviously insufficient for this generation. Considering the size of the antennas it is definitely small, but more size reduction is required to fit more antennas or radiating elements into a single device while still achieving superior performance. In the next figures, we've also modeled the outcomes of the patch antenna in use.

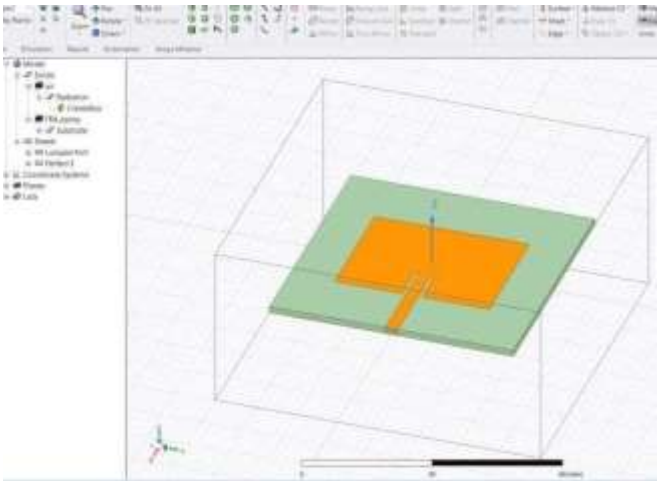

Fig.1.Existing Rectangular Micro strip Patch Antenna.

We propose a Compact4-ElementBeam Steerable Adaptive Array Antenna, capable of operating at a frequency of 38 GHz, which is deemed as optimum for wireless 5GApplications.The concept that is a game-change in our proposed system is “BeamSteering” which simply means the ability

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to steer the major lobe of the radiation to an intended direction.

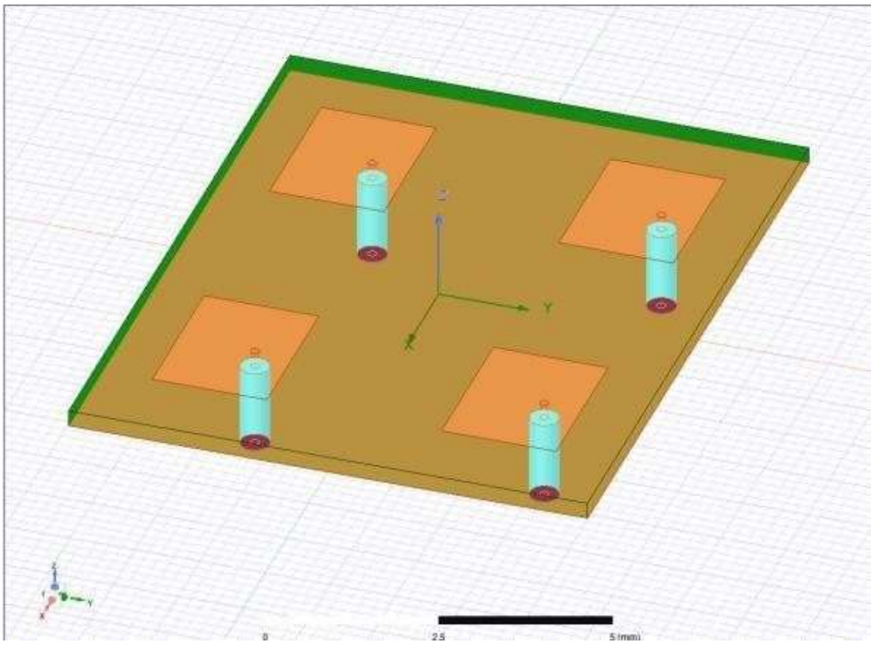
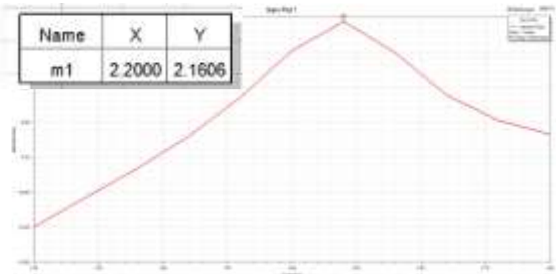


Fig.2.Proposed System Patch Configuration.

Simply placing numerous radiating parts or patches in a configuration and providing them with excitations that cause them to perform fully can accomplish this. In this project, we used co-axial probes rather than micro strip patch feed lines because they are more effective at transmitting antenna data. We applied them to each of the radiating rectangular patches.



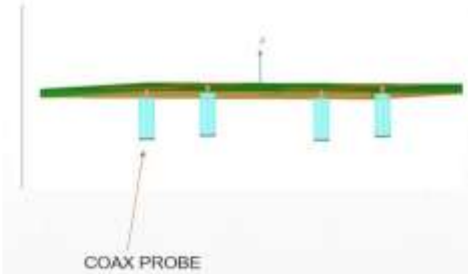


Fig. 3 Existing Rectangular Micro strip Patch Antenna's Frequncyv/s Gain Plot. Resonatingat2.2GHz with again of2.1606dB.

IV. Drawbacks:

Following are a few shortcomings found in the current system and their definitions:

• Less operating frequency.
• Size is comparatively large.
• Over saturated spectrum.

The suggested system has a lot of features, not only different approaches to avoid the problems. The created prototype is a scaled-down version of the solution. Now, if we compare the newly proposed prototype to the original existing model, there will undoubtedly be certain improvements. These improvements are listed below:

• Increased operating frequency.
• Size is relatively modest.
• Prevents overuse of the 5 GHz band.

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TABLEI.COMPARISIONBETWEENEXISTINGANDPROPOSEDSYSTEMS

Sl.No.	Comparison		
	Characteristic	*Existing System*	*Proposed System*
1.	Small in size	No	Yes
2.	Performs Beam Steering	No	Yes
3.	Higher operating frequency	No	Yes
4.	Reliable	No	Yes
5.	Over saturated Spectrum	Yes	No

PARAMETER	VALUE (mm)
Substrate Height	0.254
Substrate Length	10.208
Substrate Width	7.969
Patch Length	2.4
Patch Width	1.76
Coax Inner Radius	0.066
Feed length	1.31
Coax Outer Radius	0.224

Fig.4: Proposed System Specifications.

A. Software Requirements

The software requirements to run ANSYSHFSS (High-Frequency Structure System)

• 64-bitIntel or AMD system, running Windows10.

• 8GB RAM.

• A dedicated graphics card with the most recent drivers, at least 1 GB of video RAM, and the ability to support DirectX 11 or higher.

• 10GB of disc space.

B. Design

To start, we created and tested a single patch with a resonant frequency of 2.4 GHz. The substrate was made of FR4 Epoxy, which had a dielectric constant of 2.2. According to Fig. 2, the outcomes have been developed to be favorable for the aforementioned parameters.

PARAMETER	VALUE (mm)
Substrate Height	0.254
Substrate Length	4.00
Substrate Width	4.20
Patch Length	2.50
Patch Width	2.65
Feed length	2.00

Fig.5.Single patch specifications.

Later, we have employed the process of trial and error to arrive at the best configuration for a set of 4 radiating elements so that beam steering is possible. After carefully examining the patch placement, we developed the 2x2 layout shown in Fig. 3. Additionally, the distance between each additional patch is smaller than /2. The ground plane is constructed from the same inexpensive material, FR4 Epoxy, as the present system. We have individually provided each of the macro-axial probes with excitations following the determination of the patches' ideal positions. Finally, we have begun the simulation and have seen a variety of outcomes for the revised antenna system requirements that follow.

There is no other way to clearly see how the antenna system is operating with ANSYSHFSS Software because the results speak for themselves. The simulation is performed for various tests, including E-Field Vector, H-Field Vector, Radiation Pattern, Return Loss, and Frequency v/s Gain Plot, with the radiation set up as "air" around the antenna. The "Project Manager" pane on the left-hand side of the ANSYSHFSS window is where the results can be seen.

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V.RESULTS AND DISCUSSON:

Output

The simulation was run for various tests such as return loss plot, rE 3-DimensionalPlot (i.e., the major lobe direction of the antenna's radiation), radiation pattern for E- Field, radiation pattern for H-Field and Frequency vs. Gain Plot as stated above and the results are as follows.

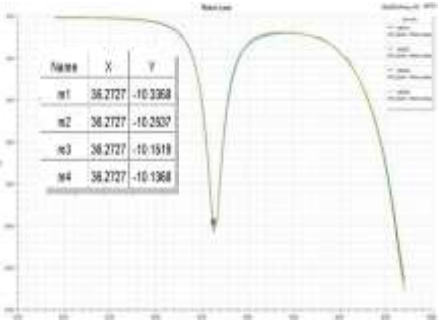

Fig.6. Return Loss of 10dB.

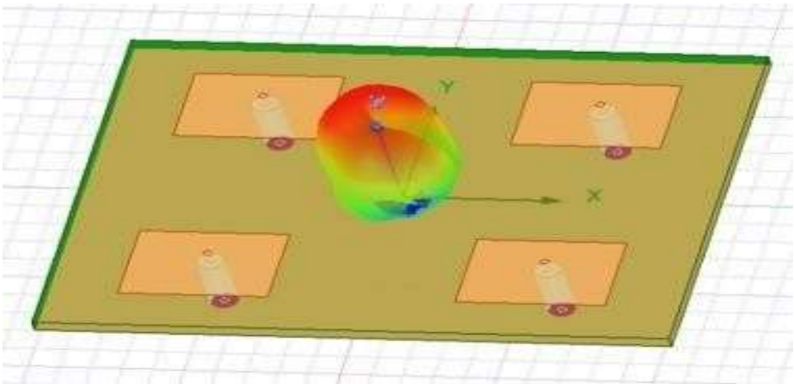

Fig.7. Major Lobe in One single Direction with no minor Lobes

Fig.8. Radiation Pattern for E-Plane.

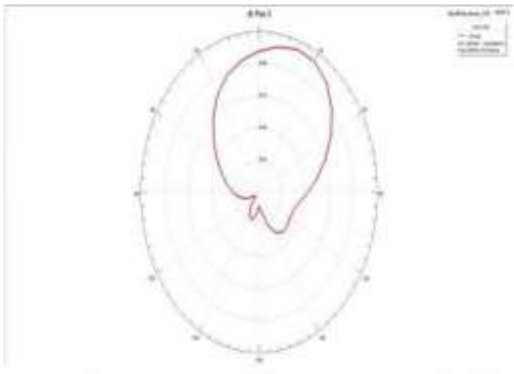

Fig.9.Radiation Pattern for H-Plane

Frequencyv/sGain Plot:

The below given frequency v/s gain graph shows the final result of the antenna system. The resonating frequency is at 38 GHz sharp with a gain of 5.1576 dB which is an optimum result for this an tennato function in the 5G spectrum efficiently.

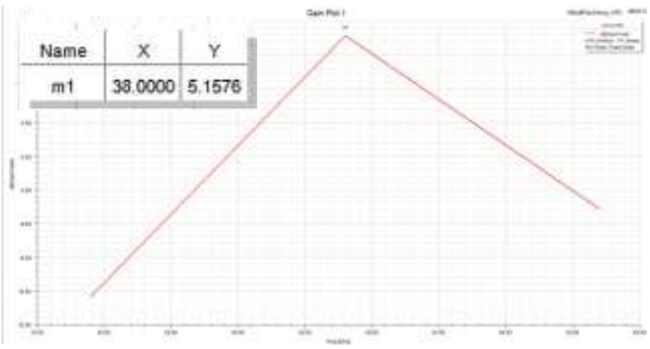

Fig.10.Frequency38GHzwithagainof5.1576dB.CONCLUSION

In this study, a Compact 4-Element Beam Steerable Adaptive Array Antenna for Wireless 5G Applications has been constructed, researched, and simulated to withstand the forthcoming demands of the everyday users. The idea of "Beam Steering" was previously only used in military-grade applications, but by bringing it into domestic or commercial usage areas, the 5G spectrum can now benefit from it in order to avoid becoming oversaturated like the 4G spectrum and to run smoothly for every user while satisfying their demands on a daily basis. The outcomes displayed above demonstrate its effectiveness and potency under diverse circumstances.

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