Design and Implementation of Microstrip Patch Antenna using 5G Resonant Frequency

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ABSTRACT

The COVID-19 pandemic has pressured the sector to have interaction in the ubiquitous use of virtual studying. And while on-line and distance studying has been used before to preserve continuity in training. there's a need for high-quality video streaming online around the sector particularly in developing countries like India in which it requires a high data rate and high bandwidth. Therefore, in this research paper, the authors have designed a microstrip patch antenna for high-quality video transmission and other 5G applications using 5G millimeter-wave bands at the resonant frequency of 26 GHz. In this proposed method, the authors used a rectangular patch having a dielectric constant of 2.2 and a dielectric loss tangent of 0.0010. The design is simulated and analyzed using HFSS software. Thus, after simulation authors have found a good return loss of -12.7 dB, good bandwidth of 3.56 GHz, VSWR of1.1, high gain of 7 dB. This proposed design has great use during the ongoing lockdown.

Keywords— dielectric substrate, microstrip antenna, bandwidth, feed line, microstrip patch, 5G, millimeter wave bands.

INTRODUCTION

India is one of the developing nations of the world where people are mostly are on the whole illiterate or much less educated and poor. They can't have enough money for better higher education. Also, students of low-class families cannot afford higher education. Hence, online education or e-learning is the approach to offer them better education and increase the literacy rate. Online education has improved during a pandemic. 5G communication system is used at this place. during pandemics, it is important to upgrade higher education by opening online courses. Also, for engineering students to not hold their education by giving practical education with remote and virtual labs this application is used. All this online education could be useful especially during the currently ongoing lockdown situation due to COVID-19 with proper video transmission. However, for all the above online education processes, you need a high-speed data rate and large bandwidth for high-quality video transmission for education. 4G cannot handle the bandwidth for the high-quality video transmission. therefore, we need better technology than 4G. Therefore, thinking of the above situation we have designed a microstrip patch antenna of rectangular shape which offers good bandwidth, high gain and good reflection coefficient using 5G applications at the resonant frequency of 26GHz. . In India, 5G Radio Frequency spectrum specs for millimeter-wave bands starting from 24.5-29.5 GHz[6].

Microstrip patch antenna has an important role within field of wireless communication. It has a dielectric substrate, groundplane, and a thin metallic patch made up of copper or gold. The patch and the ground plane are separated from the dielectric substrate. There are different types of patch antennas considering the shape of the patch such as circular, rectangular, square, elliptical, triangular, and dipole[7]. The most generally used Microstrip antennas are in circular and rectangular shapes. These two patch antennas have most of the applications particularly in the field of 5G field. The proposed work has good bandwidth of 4.7 GHz and returns a loss of -12 dB at 26 GHz resonant frequency[8].

In this method, authors have used Roger RT/Duroid 5880 substrate having a dielectric constant of 2.2 and tangent 1.10. Low dielectric substrate gives high efficiency and better bandwidth. Further, the fringing field has increased with a substrate having a less dielectric constant. Therefore, this research focuses on providing high speed and high bandwidth with less amount of return loss for uninterrupted high-quality video transmission.

LITERATE SURVEY

Resonance characteristics of microstrip antenna as a function of substrate thickness RitikaTandon1, Alpana Singh2, Saurabh Khanna3, states that A slight variation in resonance frequency is also noticed which can be neglected for wideband application by using different substrate thicknesses.

Effect of Substrate dielectric constant on Bandwidth characteristics of Line feed on Patch Antenna Amita Thakur, Manoj Chauhan, Mithilesh Kumar, states that, when we increase the substratedielectric constant in antenna design The performance characteristics of antenna-like antenna bandwidth, gain and S11(Return loss) parameter are reduced.

Investigation on the effect of Substrate on the performance of Microstrip antenna Sant SharanShukla, Rahul Kumar Verma, Gurpreet Singh Gohir, states that, As we change the value of relative permittivity with the substrate material, we get a better result on patch antenna.

Effect of Dimension, Spacing, and Shape on Resonant Frequency and Bandwidth of 2 × 2 Antenna Array Nayana Chaskar, Sneha Dalvi, Sandip Rathod, Anjali A. Chaudhari, and Rajiv K. Gupta, states that the dimensions of the antenna can change the performance of the antenna.

Effect of the dimension of feed line on enhanchment of bandwidth and square microstrip antenna R.K Chausaria, Ranjan Mishra, states that, broadband is obtained by increasing the width of feeding line.

EXISTING METHOD

Parameters Symbols	Details of Parameters	Value(mm)
W_s	Width of Substrate	6.0
L_S	Length of Substrate	6.0
W	Width of Patch	4.5
L	Length of Patch	3.4
W_F	Width of Microstrip line feed	0.6
L_F	Length of Microstrip line feed	2.0
h	Height of Substrate	0.65

The rectangular microstrip patch antenna has the configuration and choosing the electric substrate with dielectric constant 2.2, they have used Rogers RT/Duroid substrate materials with substrate height of 0.65 mm with dielectric loss tangent of 0.0010. Next, we found out the length and width of the patchfrom the equation and lastly selecting the best resonance frequency from the millimeter-waveband and authorshave selected 26 GHz. The parameters used to design the microstrip patch antenna are shown.

PROBLEM IDENTIFICATION

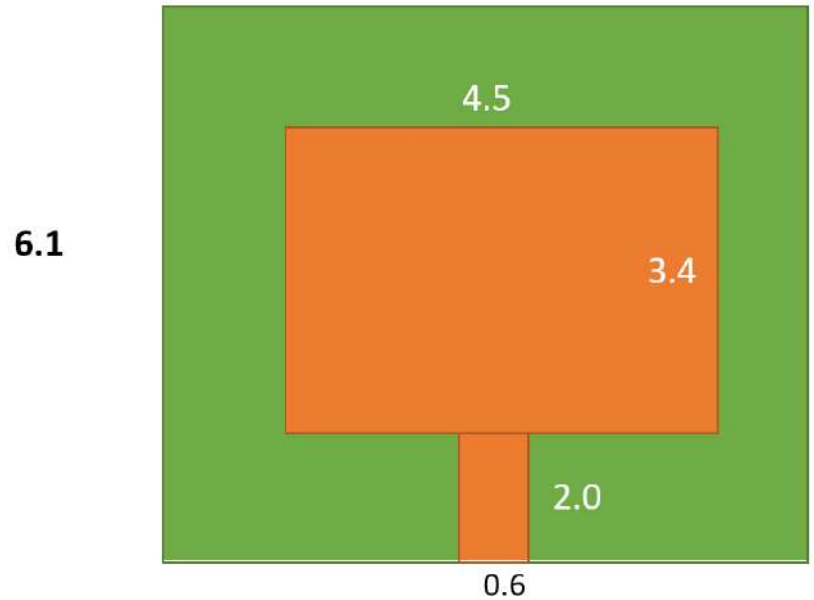
The reflection coefficient is also called return loss and is denoted by (S11). The performance of the antenna generally depends upon a good reflection coefficient or return loss of at least -10 dB or greater than -15 dB because return loss in the antenna is a ratio of incident power to that of reflected power. Consider that the reflection coefficient is 0 dB then nothing has radiated as all the power have reflected from the antenna

PROPOSED METHOD

The proposed method has dimensions of the antenna changed so that the return loss of the antennais reduced. Along with the return loss, the VSWR is also reduced. The VSWR should not be 0 it shouldbe in the range of -10 to 10 but not 0.

The new dimensions of the antenna is:

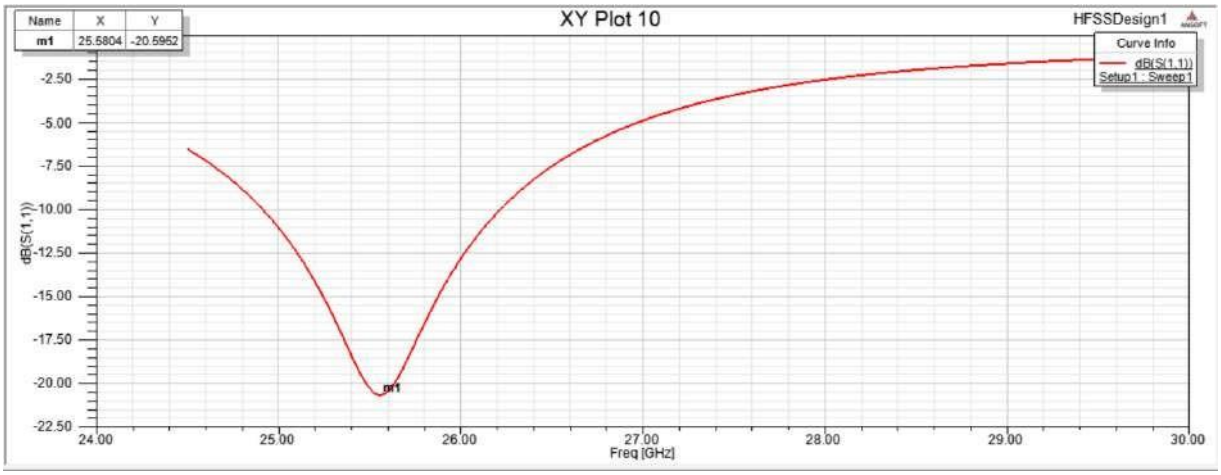
parameters	Details of parameter	value
Ws	Width of substrate	6.1
Ls	Length of substrate	6.1
W	Width of patch	4.5
L	Length of patch	3.4
Wf	width of microstrip feed line	0.6
Lf	Length of microstrip feed line	2.0
h	Height of substrate	0.66



RESULTS

Reflection coefficient

Return loss is a function of the reflection coefficient. It is denoted by s(1,1). The performance of the antenna depends on a good reflection coefficient or return loss because return loss in the antenna is a ratio of incident power to that of reflected power. If the reflection coefficient is 0 dB then nothing has radiated as all the power has been reflected from the antenna. The return loss is -12.7 dB and bandwidth is 3.56 GHz and analyzed that with this high bandwidth and good return loss one can stream ultra-quality of data such as videos without any interruption.



Return loss S(1,1)

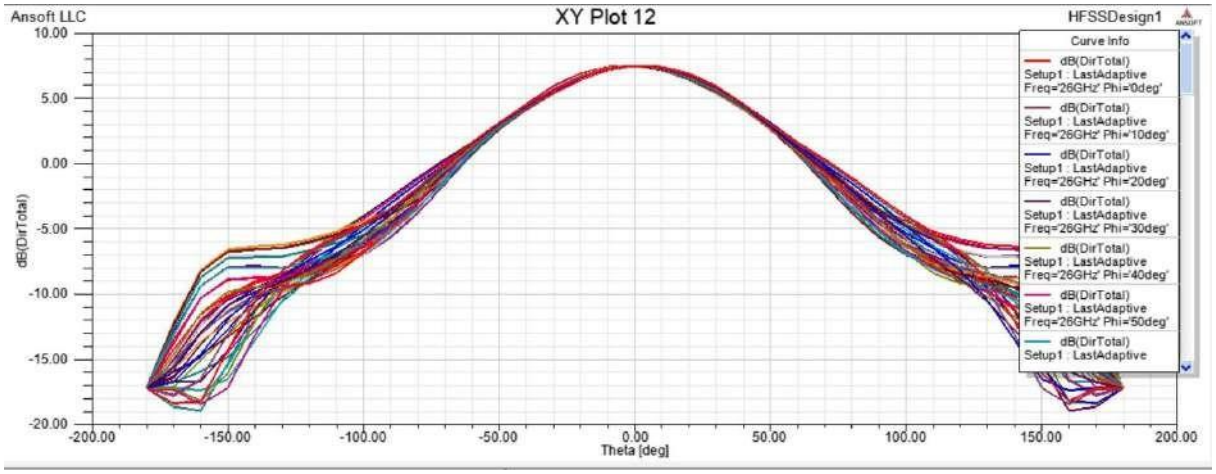
Voltage Standing Wave Ratio

The voltage standing wave ratio is also called as standing wave ratio. For microstrip patch antenna design to be used for video streaming in 5G, this ratio should be in the range of $1 \leqslant VSWR \leqslant 2$. This ratio is always will be a real and positive real number. Higher the value of VSWR means there is a greater mismatch. Therefore, the authors proposed a microstrip rectangular patch antenna that has a value of 1.11 at 26 GHz.

VSWR

Directivity

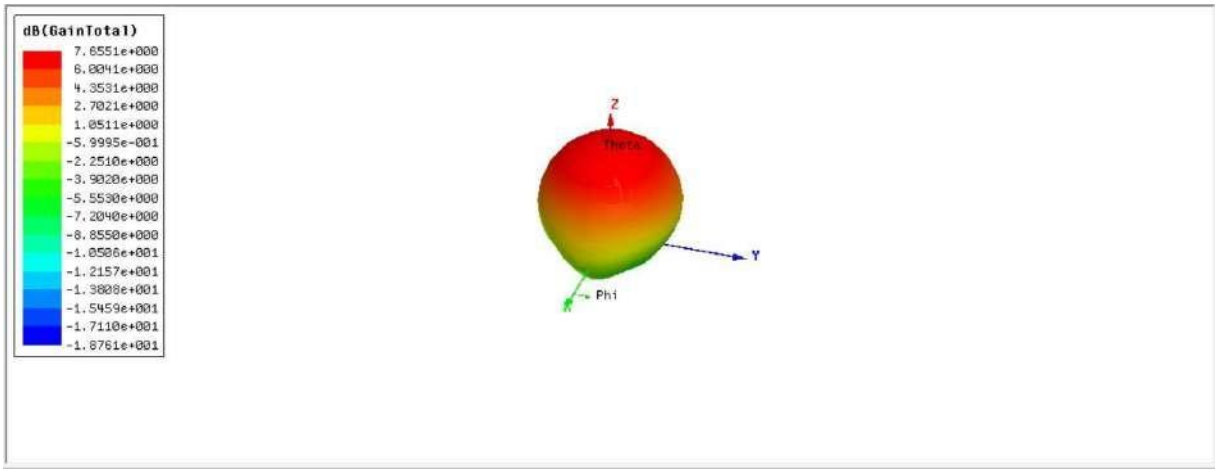
The directivity of the antenna we obtained is 7db. The higher the directivity the more concentrated the wave radiates. Higher directivity means the signal travels far distances. This can be used for data transmission.

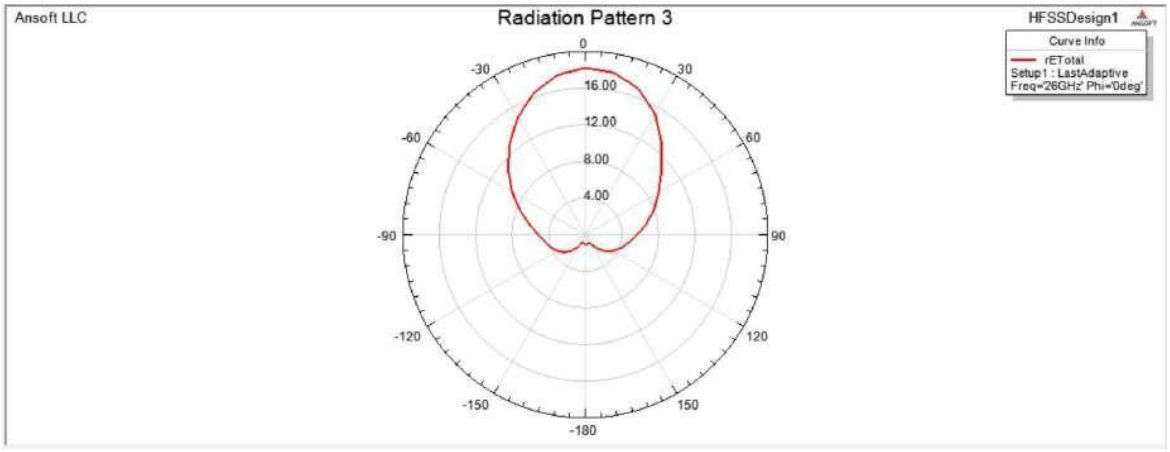


Directivity

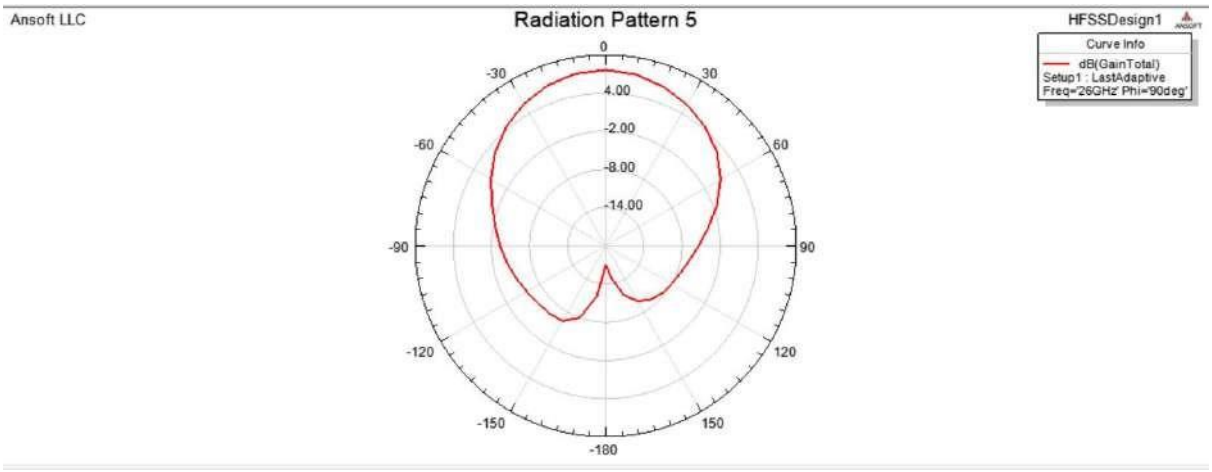
Radiation Pattern

The below figures shows the 3D and 2D radiation pattern of the microstrip patch antenna of gain 7db at 26GHz. This can be used for wireless transfer.

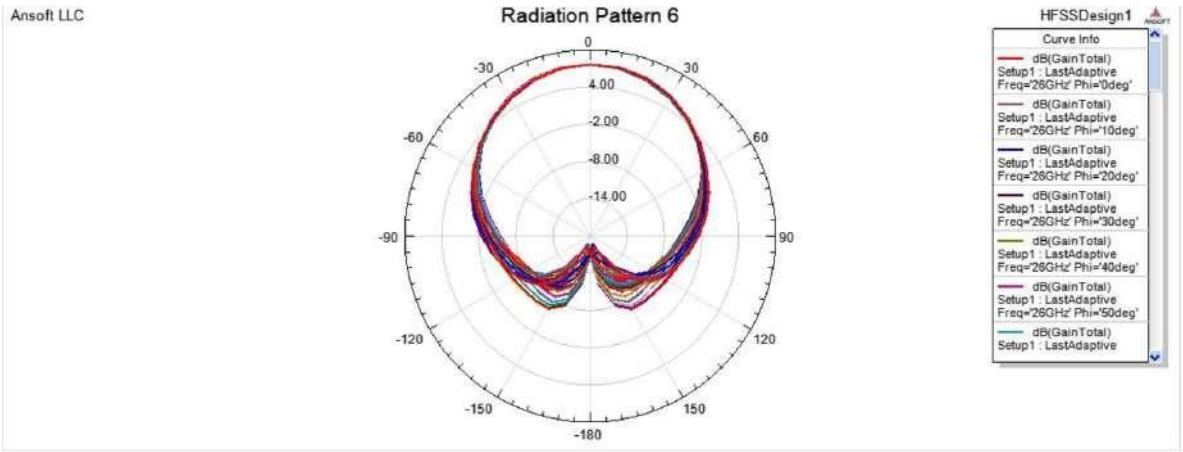




Radiation pattern at 0˚



Radiation Pattern at 90˚



Radiation pattern at all angles

CONCLUSION

Our proposed microstrip rectangular patch antenna is designed and successfully implemented at the resonance frequencyof 26 GHz using HFSS software which is more reliable to design and view high-quality results especially 3D radiation patterns than other antenna design software. As shown above, from our simulation results and comparison table, the proposeddesign of Microstrip patch antenna has a higher gain of 10 dB forgood signal strength, increased bandwidth of 3.56 GHz for high-quality video transmission using 5G applications. We achieved a better and good return loss of –12.7 dB, voltage standing wave ratio of 1.11. However, the shortcoming of this proposed antenna is that efficiency and bandwidth are slightly less.

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