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Group 10 Project
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Design of a Novel High Power Applications Radar Jammer

Aim

Design and Simulate a Novel Wideband Leaf-Shaped Printed Dipole Array Antenna Using a Parasitic Loop for High-Power Jamming Applications using CST Simulation software.

Apparatus Required

1. CST Software

Theory

CST Studio Suite is a high-performance 3D EM analysis software package for designing, analyzing and optimizing electromagnetic (EM) components and systems

Radar systems are used extensively in defense operations from area surveillance and early warning to target tracking and fire control. Radar plays a critical role as the eyes for countless defense systems now if we're talking about defense that implies we have an adversary and if we're using radar to conduct military operations our adversary might want to prevent us from being able to use that radar.

Radar jamming is a form of electronic countermeasures or electronic attack to interfere with the operation of radar, it involves sending intentionally disruptive radio waves towards that target radar which might oversaturate its receiver so it can't detect anything or perhaps deceive it into interpreting false information, either way, we're preventing that radar from being able to do its job. There are several different approaches to jamming radar.

<u>Types of Radar Jammer</u>

1. <u>Mechanical Jamming</u>
    a. <u>Chaff</u> : Chaff is made of different length metallic strips, which reflect different frequencies, to create a large area of false returns in which a real contact would be difficult to detect. Modern chaff is usually aluminum-coated glass fibers of various lengths. Their extremely low weight and small size allow them to form a dense, long-lasting cloud of interference.

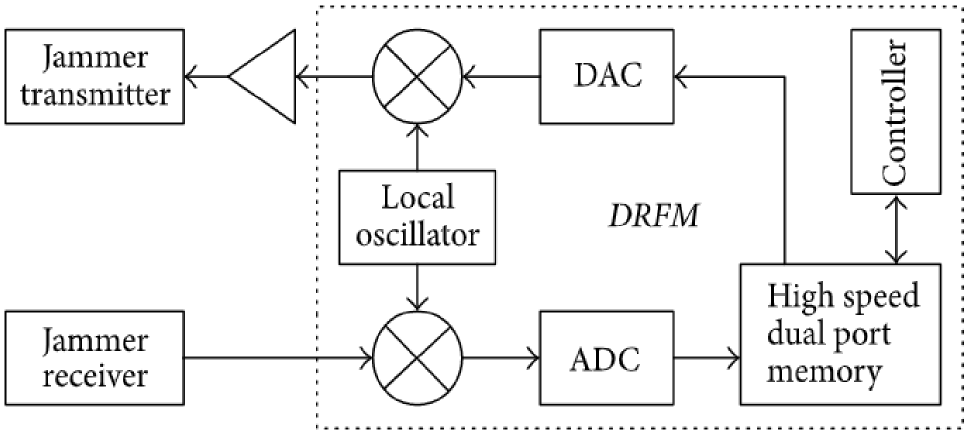
    b. <u>Decoy</u>: Decoys are maneuverable flying objects that are intended to deceive a radar operator into believing that they are actually aircraft. They are especially dangerous because they can clutter up a radar with false targets making it easier for an attacker to get within weapons range and neutralize the radar.

2. <u>Electronic Jamming</u>
    a. <u>Noise Jamming</u> : Noise jamming is produced by modulating a RF carrier wave with noise, or random amplitude changes, and transmitting that wave at the victim's radar frequency. It relies on high power levels to saturate the radar receiver and deny range

and, occasionally, azimuth and elevation information to the victim radar. Noise jamming takes advantage of the extreme sensitivity of the radar receiver and the transmission pattern of the radar antenna to deny critical information to the victim radar.

b. Deceptive Jamming: A deception jammer receives the signal from the victim radar and alters the signal to provide false range, or velocity information. The altered signal is then retransmitted. The victim radar processes this signal, which disrupts the victim radar and confuses the radar operator.

Block Diagram of Radar Jammer



The local oscillator shown is used to convert an incoming frequency to another frequency and is sometimes used in a system to convert from one internal frequency to another.
A DRFM, or digital radio frequency memory, is a system that performs real-time processing of received signals, typically radar.
The high speed dual port memory is used to store and read the waveform on-site, which is important when we have to make changes to the radar waveform from the enemy, and then transmit it back towards the enemy.
By digitizing, processing and transmitting enemy's radar pulses, a DRFM can deceive the radar system, which is especially critical to protect ourselves against radar-guided missiles.

Research Paper Antenna Features

1. Dipole Antenna: A dipole antenna is the simplest type of radio antenna, consisting of a conductive wire rod that is half the length of the maximum wavelength the antenna is to generate

2. Wideband Antenna: A wideband antenna is one with approximately or exactly the same operating characteristics over a very wide Passband.

3. Parasitic element: A passive radiator or parasitic element is a conductive element, typically a metal rod, which is not electrically connected to anything else.

Procedure

1. The CST software was opened and after opening of the window 'New Template' button was clicked.
2. Then Microwave and RF Optical was selected and then Antennas option was selected later.
3. After that Planar (Patch, Slot, etc) was chosen.
4. Now Time Domain was selected, Next was pressed and then Finish was pressed to proceed further.
5. The Frequency Rage was selected between 2.5 GHz to 5 GHz.
6. For Parameter the Research Paper was referred for more clearer picture of antenna
7. For modelling of Exponential Curve, Analytical Curve was created, with curve equation of form

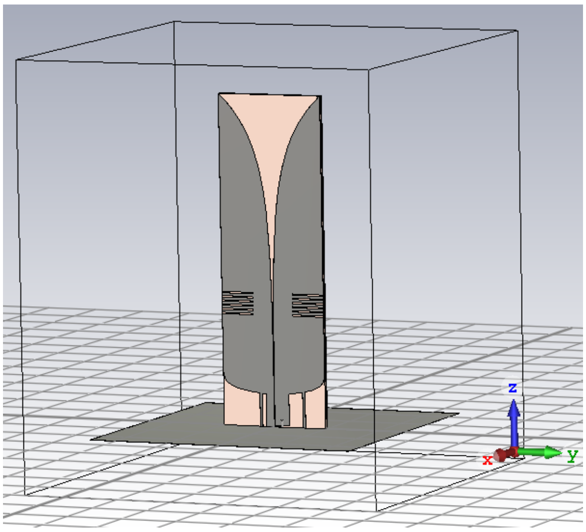
$$f_1(z) = c_1 e^{r_i(z-(h_1-h_1))} + c_2,$$

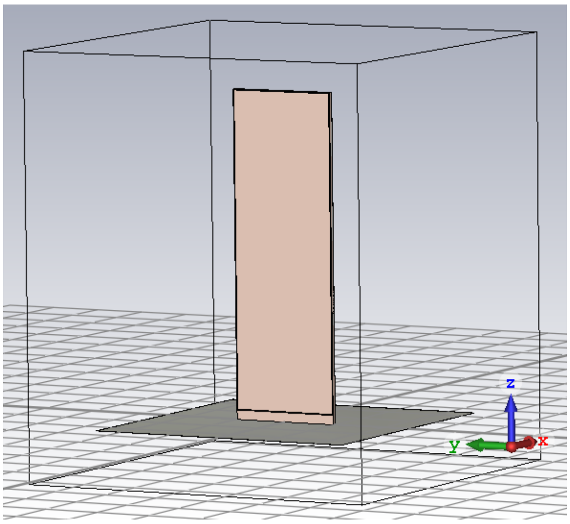
$$f_2(z) = c_3 e^{r_o(z-(h_1-h_2))} + c_4,$$

Variables	Value
c1	-0.025
ri	0.056
c2	-39.5

Variables	Value
c3	-56000
r0	-0.6
c4	-15.9

8. For making a continuous attached shape, Sweep Action was performed, along the curve with reflector chosen as PEC material
9. Rectangular Slots and Matching Points were added accordingly
10. Later the Dielectric of TLY-5 and Parasitic Loop were added and with feeding point too
11. This is how it appeared after modelling

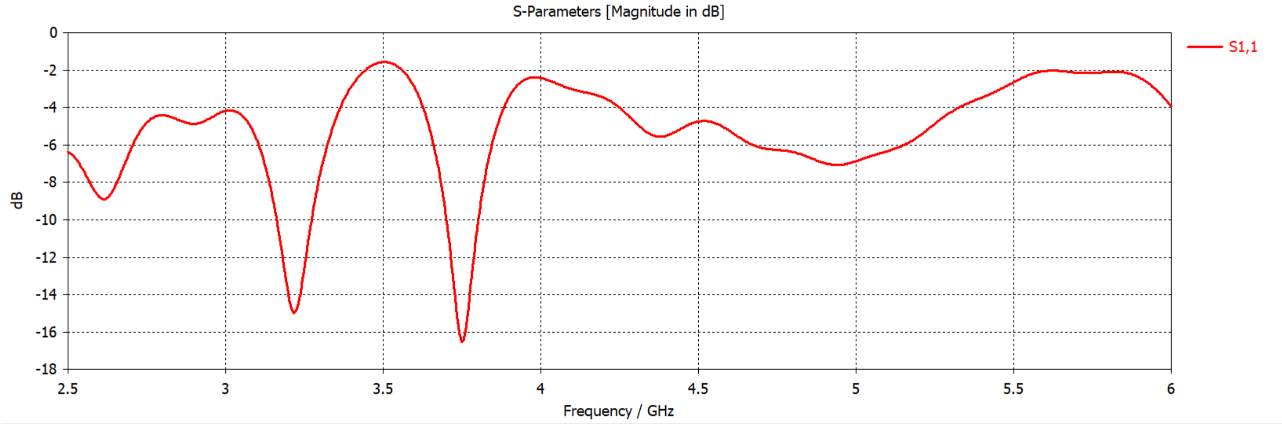




12. After the modelling, the simulation was started and observations were recorded
13. Later the file was saved and closed

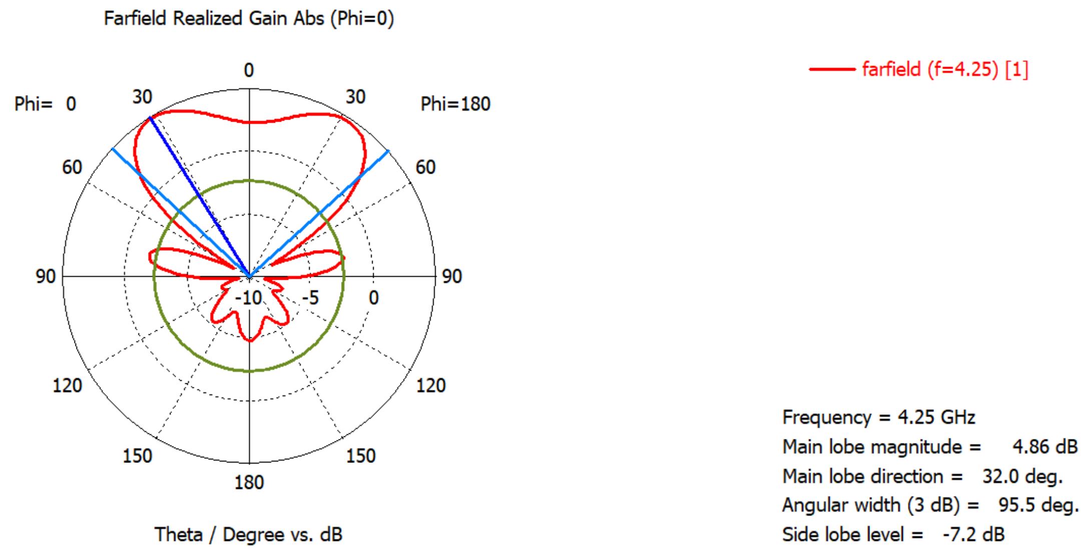
Observation

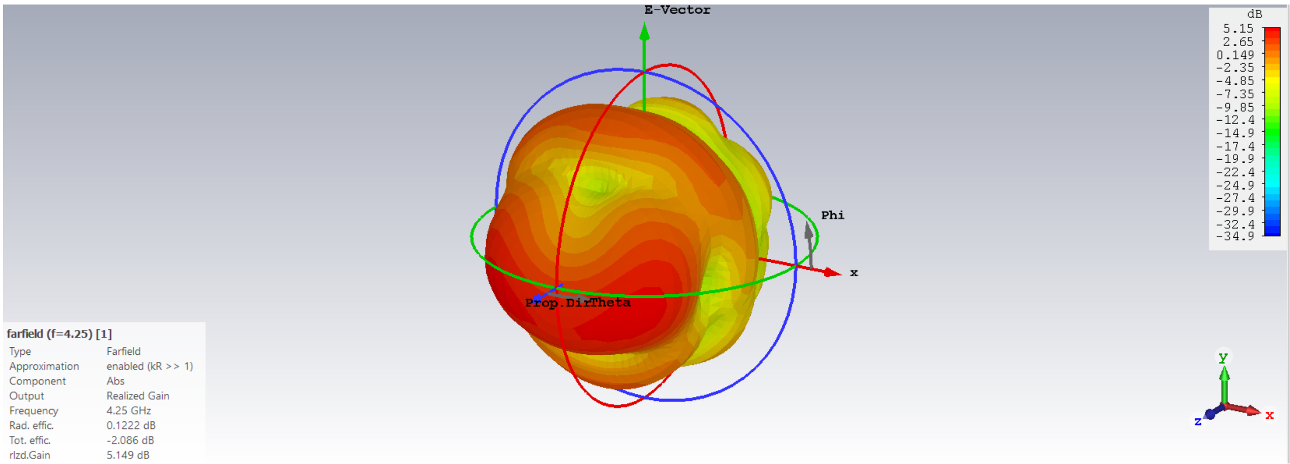
Reflection Coefficient S11 Parameter



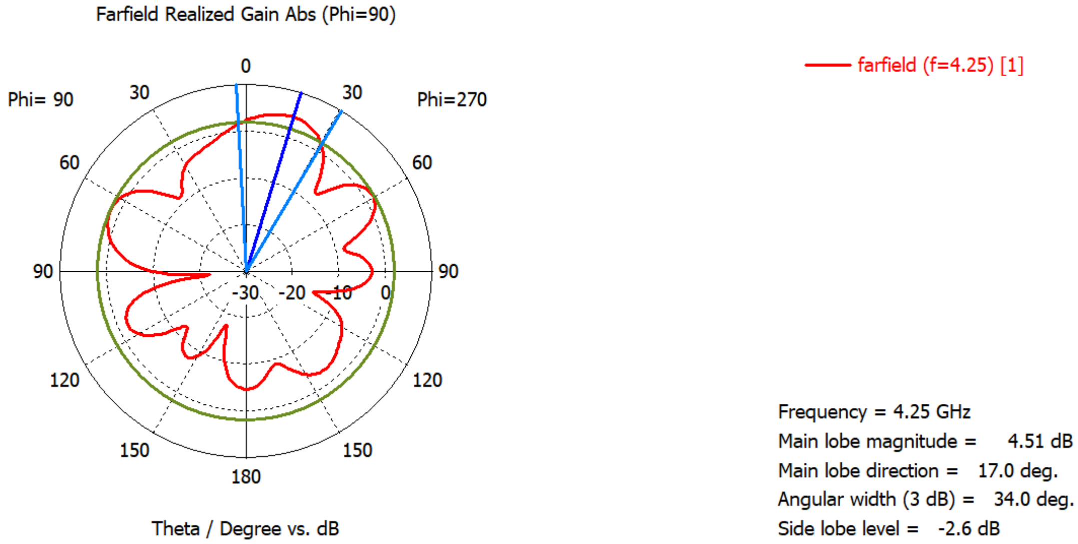
The significant decrease in S11 parameter is enhanced by the parasitic loop attached at the back side of antenna, It can be further enhanced by 11X1 Array Antenna

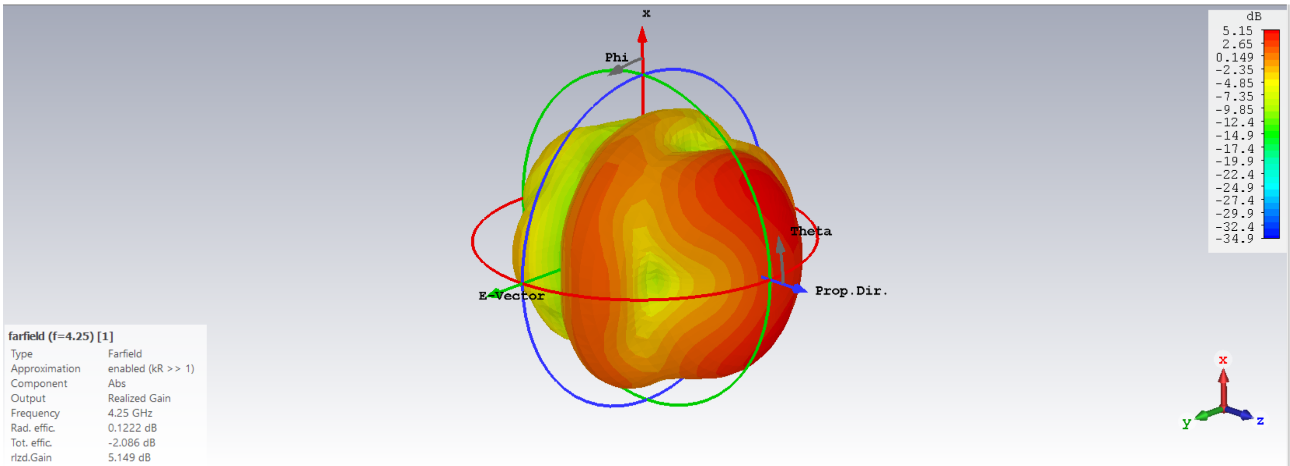
Farfield plot of antenna in xz plane at f=4.25 GHz





Farfield plot of antenna in yz plane at f=4.25 GHz

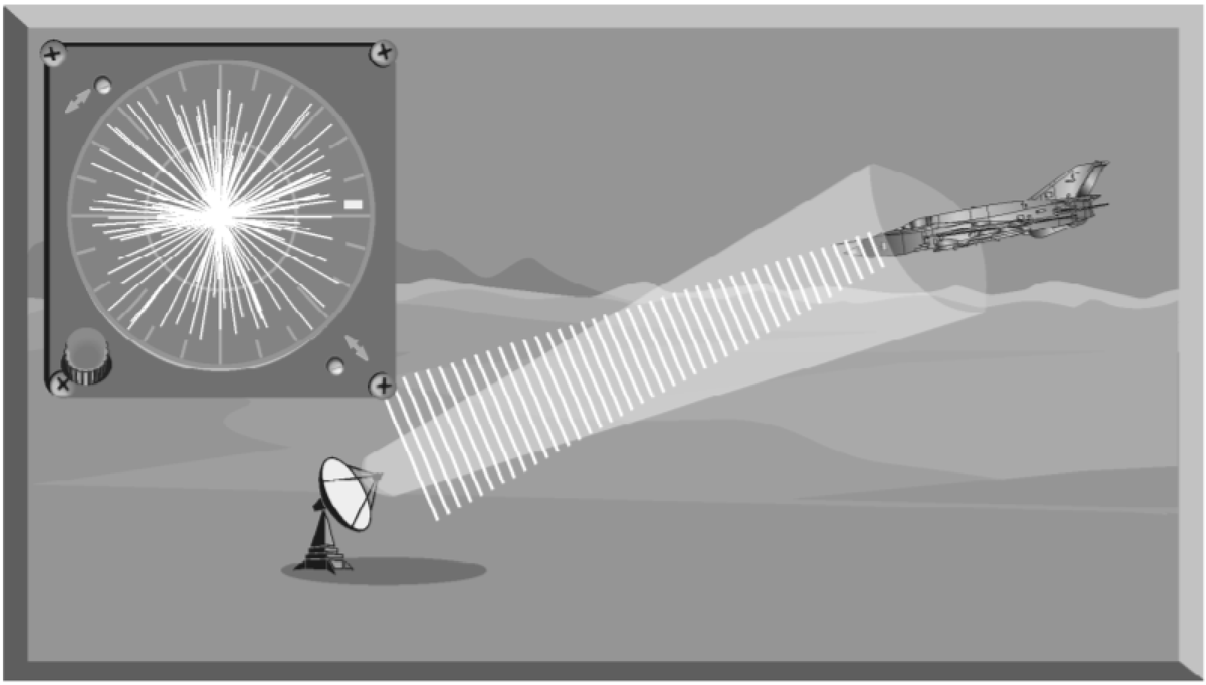




This Far Field Pattern of Antenna appears to have High directivity which is achieved with the exponential curve of leaf structure.

Conclusion

From the above project we can see that the size of radar jammers have reduced from a truck mounted system to a missile launched system which shows that the need of the hour is to reduce the size of radar jammers and at the same time increase the jamming power so that it has greater use during electronic warfare.
Hence we are able to simulate the Novel Wideband Leaf-Shaped Printed Dipole Array Antenna Using a Parasitic Loop for High-Power Jamming Applications



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