Design of Metamaterials: Flexible Antennas

▶ STUDENTS / UNIVERSITIES

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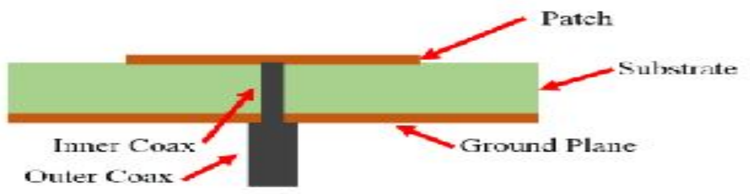
Güllü Kızıltaş Şendur

Abstract

Our goal in this project is combining metamaterials and patch antennas to improve it's bandwidth performance with the help of topology optimization and certain softwares.



Introduction & Background

Antenna is a device which transmits or receives signals in the form of electromagnetic radiation used in telecommunication industry. There are different types of antennas. In this project our focus is on the design of a patch antenna. Patch antennas simply consist of two conductive metallic plates and a dielectric material sandwiched between them. We use the concept of artificial dielectrics varying in 3D, known to form metamaterials. Metamaterials are artificially designed materials which exhibit unique interaction with the electromagnetic radiation and produce 'unusual' performance.Topology optimization is a very effective tool for finding best material distribution and with the help of this tool we end up with improved/larger bandwidth and reduced mismatch losses values.

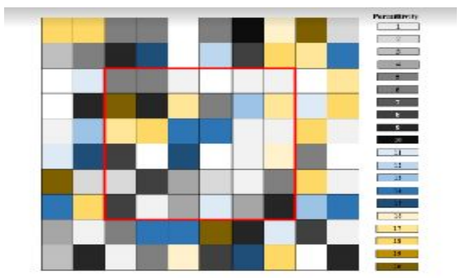
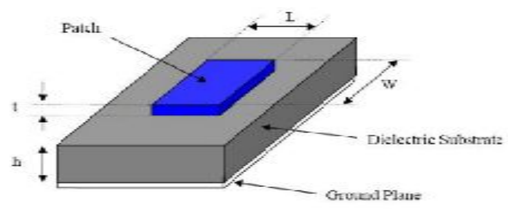


Figure 4.31 Dielectric material topology.



Objectives

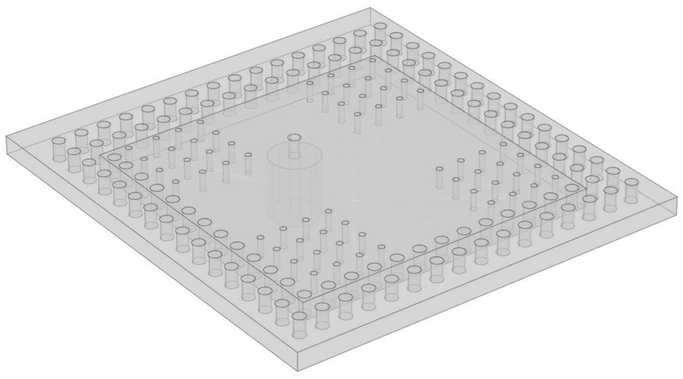
CURRENT: Design an antenna with desired specifications such as:

- High efficiency & low signal loss
- Greater working bandwidth
- Low cost and manufacturability
- Smaller size

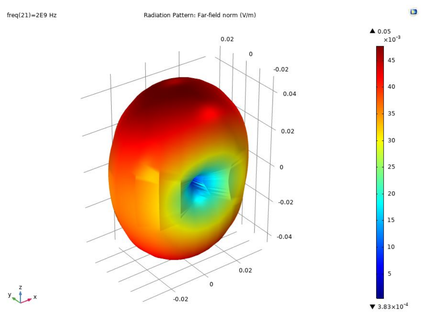
FUTURE: To use flexible/conformal antennas in continuous health monitoring applications

Manufactured antenna

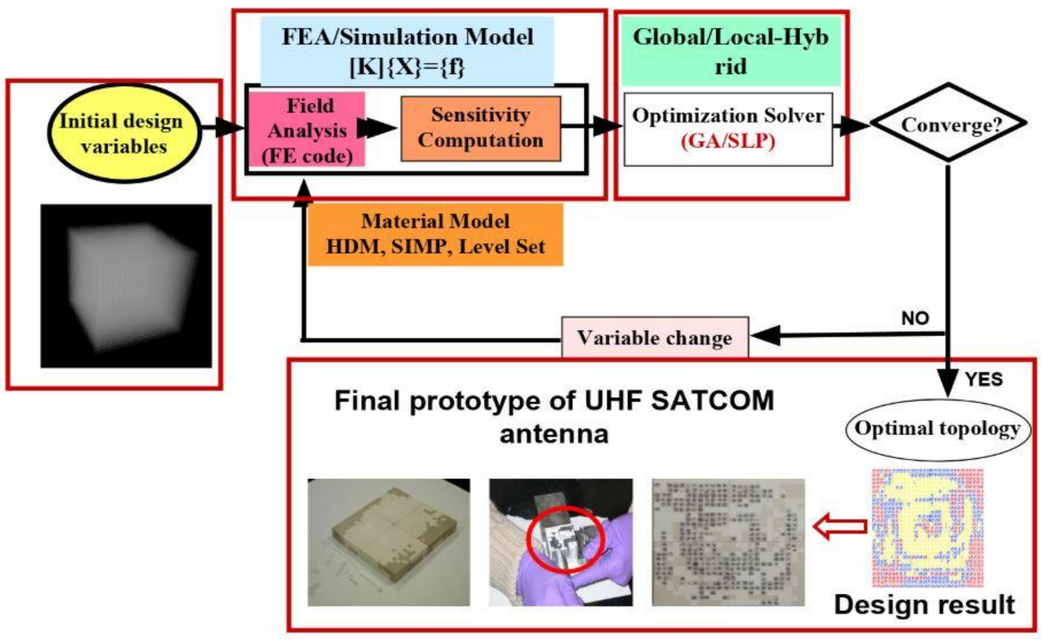
Simulation Model



Radiation pattern of antenna



Design Methodology: Topology Optimization[1,2]



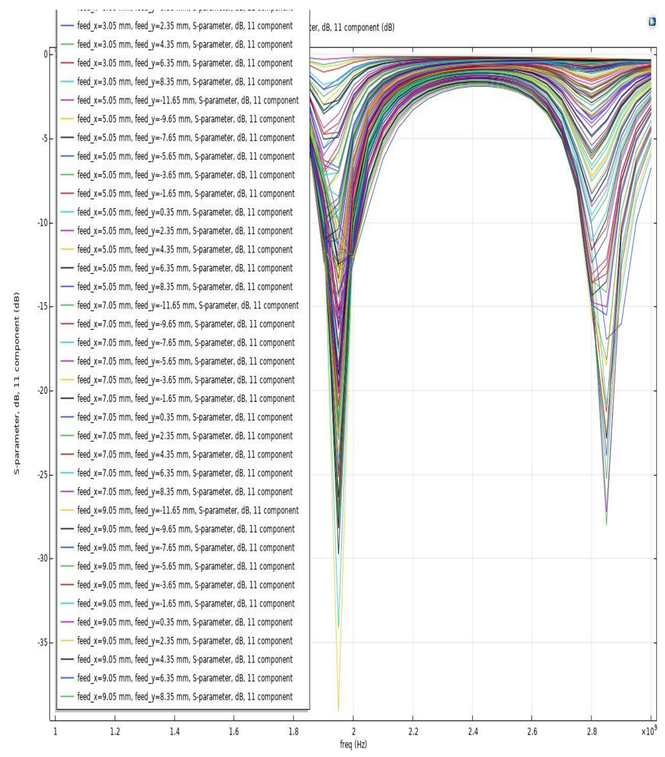
Simulation Tools

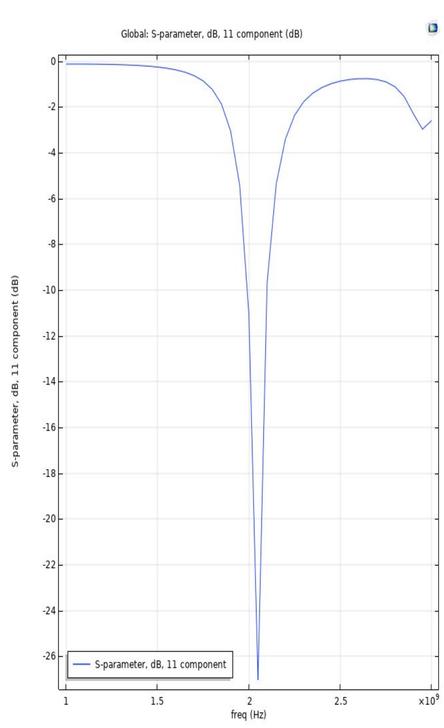
Comsol 5.4 Multiphysics Software is used in this project to achieve:

- Exploration of simulation versus measurement discrepancy of flexible mosaic substrate antennas.
  - Remaking of feed
  - Remeasurement
  - Resimulation using material dielectric permittivity and loss, feed location, conductor size and shape perturbation effects
- Redesign of various miniaturized broadband patch antenna configurations on artificial metamaterial substrates
  - Single and double patch configurations with optimized conductor topologies
  - Multilayer optimized dielectric and magnetic material topologies
  - Combined optimized conductor and multilayer material topologies
- Design of optimized antennas embedded in flexible fabric for health monitoring.

Results

We performed parametric sweep in Comsol so that we found feed location's impact on the signal and from that we acquired S11 versus frequency graph corresponding to measurement results.



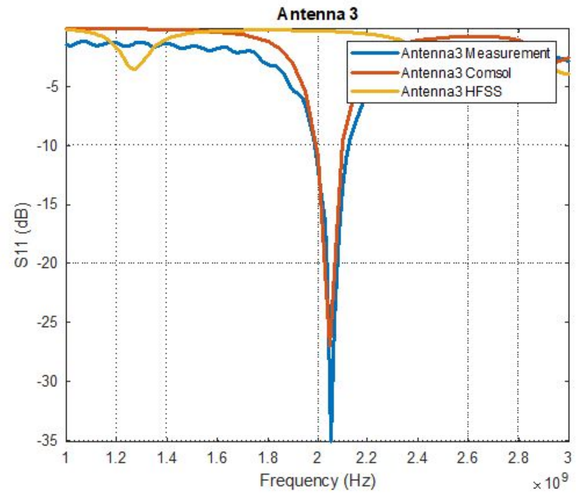


Conclusions

Patch antennas are widely used because of their low cost and lightweight structure. We worked on:

- Decreasing the differences between measurements and simulation results
- Conducting parametric studies by changing the composition of substrate
- Researching the effect of the placement of antenna elements.

Determining the characteristics of the patch antenna was easier thanks to computer modeling, consequently preparing one which matches specific needs.



References

1. Saygıner, O 2018,Integrated Topology Optimization of Volumetric Antenna Substrates and Conductor Surfaces for Broadband Microstrip Patch Antennas, Sabancı University, Istanbul.
2. Sigmund, O., & Maute, K. (2013). Topology optimization approaches. *Structural and Multidisciplinary Optimization,* 48(6), 1031-1055.