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The Silver Lining: A Novel, Inkjet-Printed Mesh Coplanar-Slot Antenna for the UHF Band

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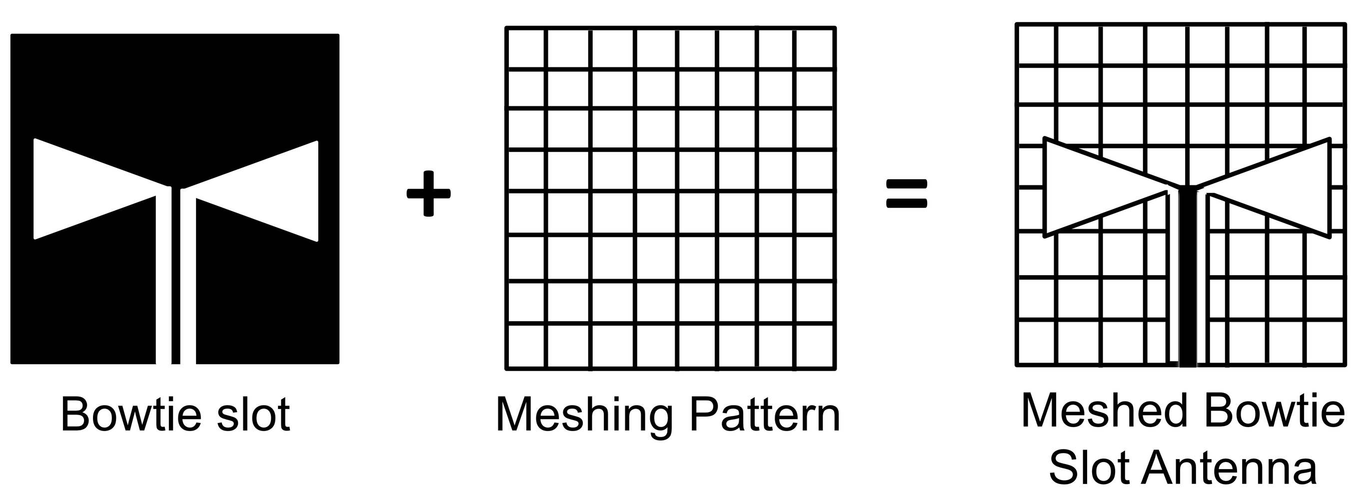
Mentor: Ryan Green

Introduction

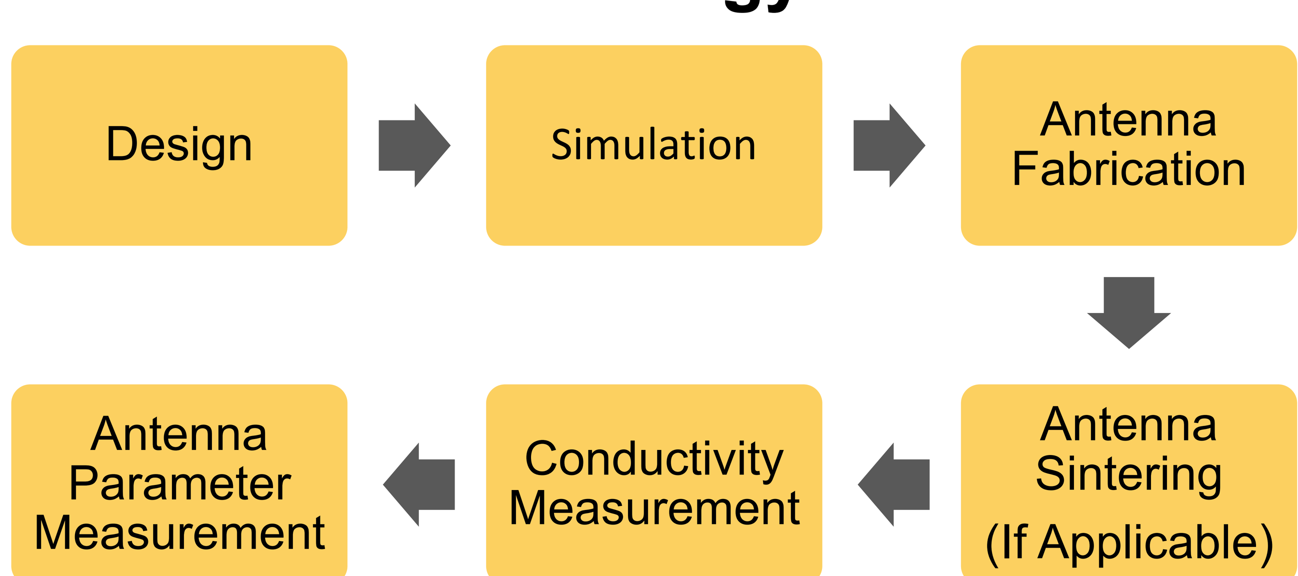
Conventional antennas are fabricated using subtractive manufacturing techniques, such as the milling machine or photolithography; such manufacturing processes suffer from a high degree of material wastage and high cost [1]. In addition, typical subtractive flex substrate fabrication for the production of conformal devices takes place in a clean room and requires the use of hazardous chemicals [2]. Inkjet-printing using silver nanoparticle (SNP) inks is a promising alternative to these methods and can be used to fabricate UHF antennas [1], [3]-[7].

Hypothesis

The design and fabrication costs of antennas for the UHF frequency band can be reduced by 1) meshing traditional antenna topologies and 2) utilizing inkjet printers ($100). This reduces the start up costs to fabricate. The meshing of the antenna topology reduces the amount of material used in the fabrication, thus reducing cost [8].



General Methodology

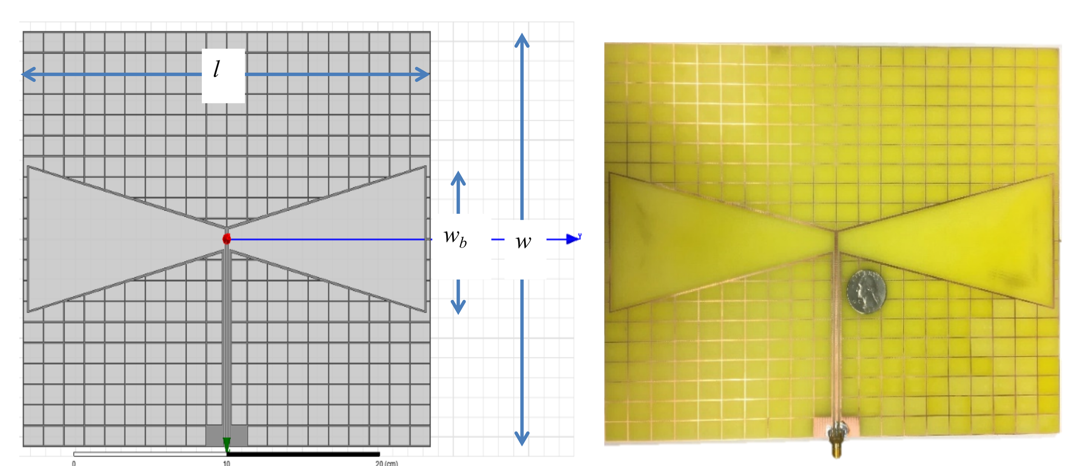


Design

The design investigated in this study was the bowtie slot antenna. This topology was chosen due to its wide band properties and balunless design. It was meshed and simulated on HFSS to operate between 400 MHz and 700 MHz. Two antenna types were designed to fit on a 210 mm by 227 mm footprint and the following cases were investigated:

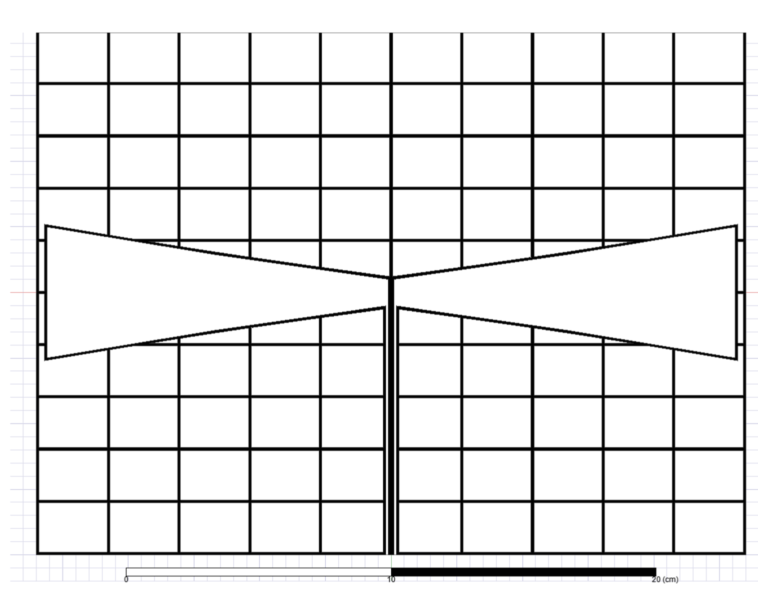
Case 1: Milled Copper Antenna on FR-4 Substrate

This antenna was fabricated on one sided copper-clad FR-4 utilizing the an LPKF S103 . This antenna is considered to be a test bench antenna to verify the efficacy of the meshed bowtie-slot topology.



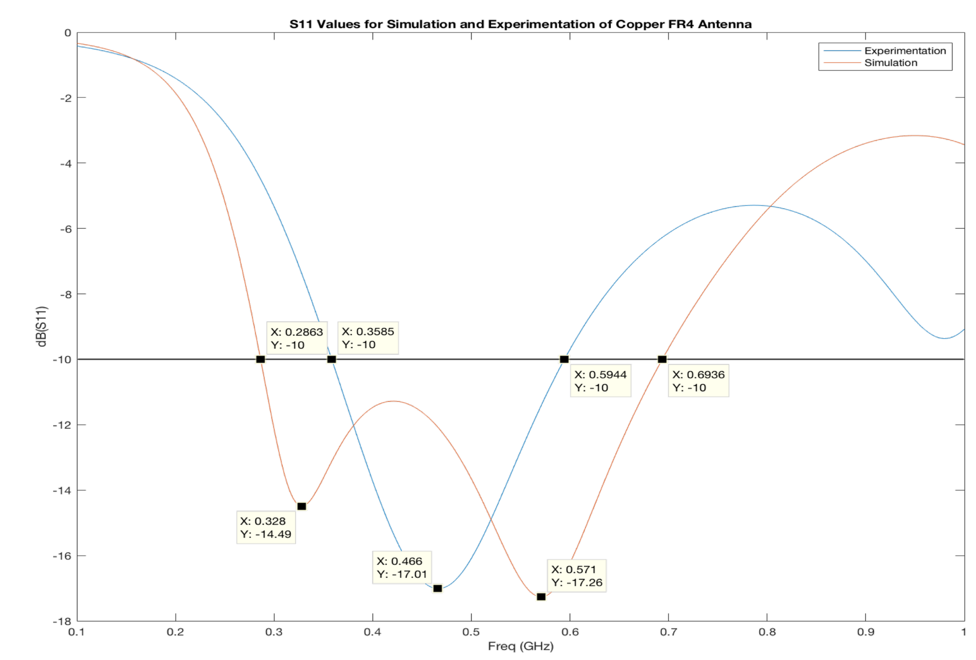
Case 2: Printed Antenna on Transparent Substrate

This antenna was simulated according to the properties of silver and the properties of Kodak photopaper reported in [9].



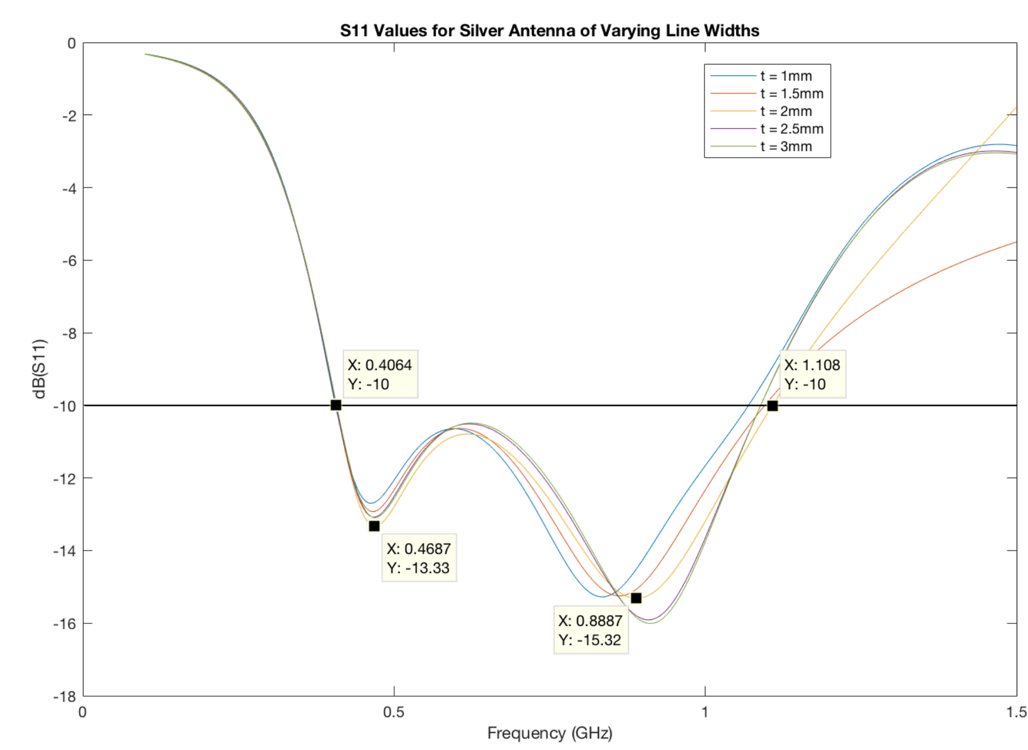
Simulation and Results

The simulated and measured data focuses on the Return Loss measurements. The antenna operates properly when the return loss is below -10 dB.



Graph 1: S11 – good agreement between simulation and experimentation results for Case 1. S11<-10dB, showing adequate antenna performance.

The topology was iteratively altered in HFSS to achieve the desired bandwidth for Case 2. For Case 2, a range of different line widths (1mm to 3mm) was investigated so that we could determine a topology that is as inexpensive as possible.



Graph 2: S11 comparison for different line widths for Case 2.

Conclusions

The results of the simulation and experimentation support the hypothesis that meshing can be merged with the coplanar-slot topology to reduce the amount of ink used in the fabrication process, and thus reduce the cost of the device. This fabrication technique shows promise in order to mass produce electromagnetic devices and antennas at lower prices.

The Federal Communications Commission is opening frequencies in the television band (470MHz – 700MHz), which lies in the UHF band (300MHz – 3GHz). The opening of VHF and UHF frequencies is envisioned to be used in the emerging Cognitive Radio Network communication technology as well as Machine-to-Machine communication applications. One such application of Machine-to-Machine communication is the Self Driving car currently being researched. Inexpensive antennas operating at current television bands would allow car to car communication at much higher broadcast distances.

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