Investigation of Ultra-Wide Band (UWB) Microstrip Antenna for Time and Frequency Domain Characteristics

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Guide

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Outline

- Introduction and Motivation
- Microstrip Wideband Patch Antenna
- Frequency and Time Domain Characteristics
- Mutual coupling in array
- Conclusion and Future Work

Introduction and Motivation

- Ultra-Wideband (UWB) communications has several advantages over narrowband communications

- ✓ **Communications** –Ability of UWB to share frequency spectrum, low power, low cost, large channel capacity makes UWB useful in Wireless Personal Area Network ,military, civil and commercial sectors.

- ✓ **Radar** –UWB signals have superior penetration properties which can be applied in Ground penetrating radar and Through-wall radar applications.

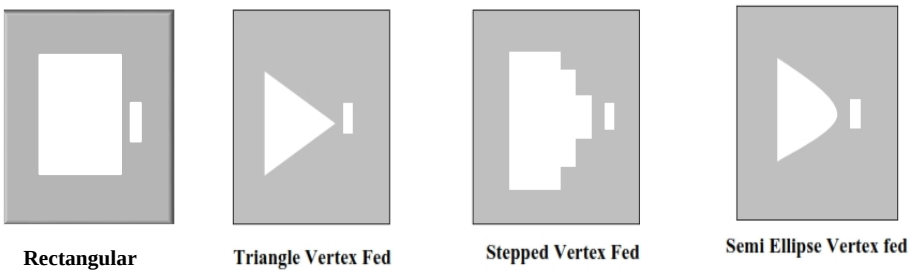
- ✓ **Intelligence Sensors** –These frequencies are sufficiently high, with short enough wavelengths, and wide enough bandwidth, to provide high ranging resolution, sufficient to detect heartbeat and respiration. Hence can be used in Surveillances, Intelligent transport system /location.

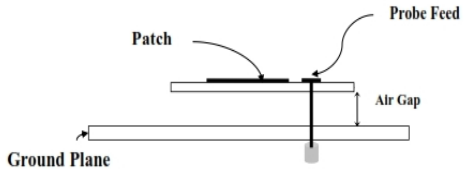
- ✓ **Microwave Imaging-** Early detection of cancerous tissues is possible using UWB antenna array and the location of tissue can also be detected.

Microstrip Wideband Patch Antenna

- According to FCC* in 2002, any wideband antenna which has more than 20% bandwidth or greater than 500 MHz fractional bandwidth can be stated as UWB antenna.
- Range of frequency for UWB is from 3.1 GHz to 10.6 GHz.
- Antenna designed has a bandwidth of 1GHz from 3.1 GHz to 4.1 GHz [1]
- Suspended and capacitive probe feed results in wideband nature.[2]

➢Different radiating patch shapes like Triangle Vertex and Edge-fed, Rectangular, Stepped, Semi ellipse Vertex and Edge-fed are investigated by time and frequency analyses.

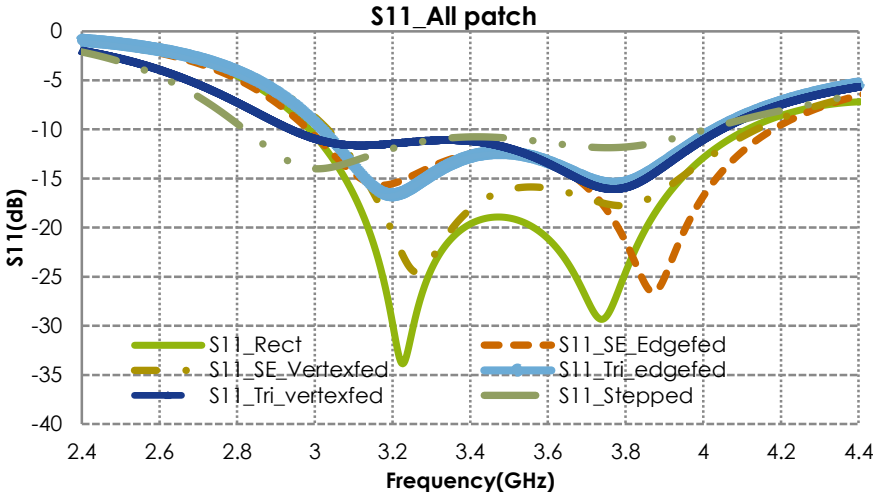


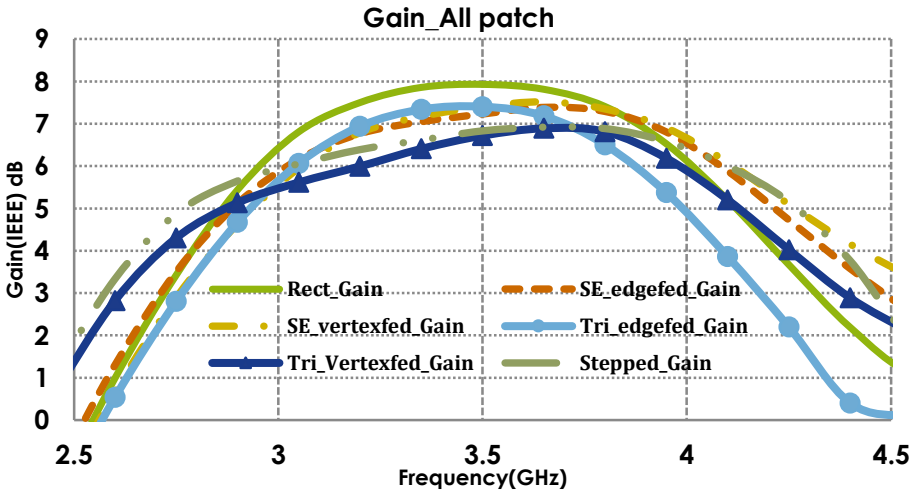


*Federal Communications Commission

Frequency Domain Antenna Characteristics

- Frequency Characterization
  - **Scattering parameter-** S11<-10 dB frequency bandwidth~ 3.1 GHz to 4.2 GHz
  - **Gain Flatness**-Flat gain results in nearly constant group delay which in turn reduces distortion
  - **Efficiency** – More than 97%, hence good radiator.
  - **Radiation Pattern**- Uni-directional linear polarized pattern not typically like Omni directional UWB monopole antennas
  - **Phase Center**- Nearly constant phase center over the band of interest.





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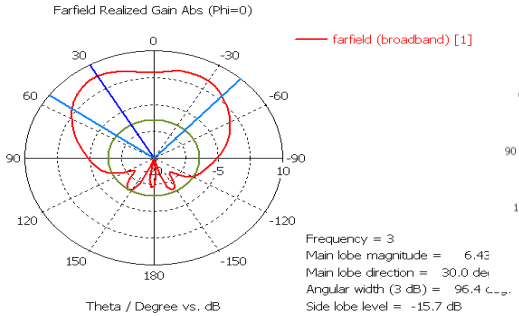
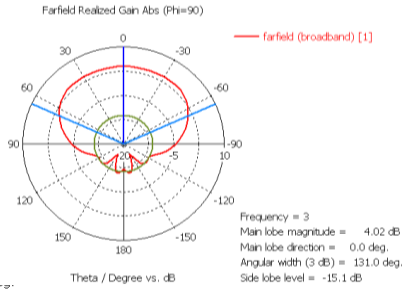
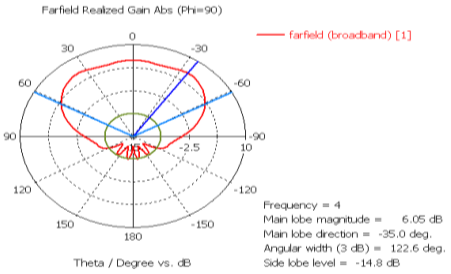
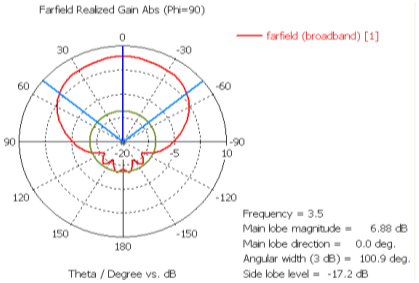
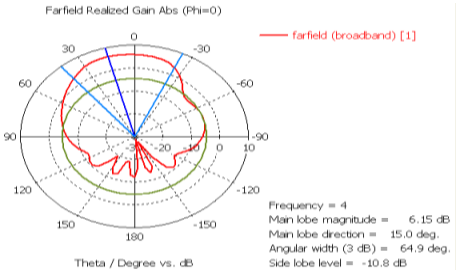
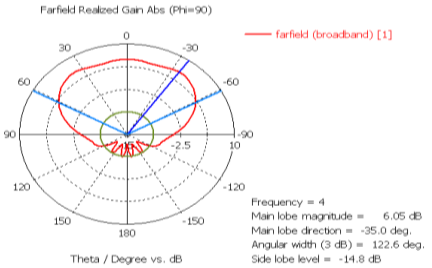

Farfield Realized Gain Abs (Phi=0)
farfield (broadband) [1]
Frequency = 3
Main lobe magnitude = 6.43
Main lobe direction = 30.0 de
Angular width (3 dB) = 96.4
Side lobe level = -15.7 dB
Theta / Degree vs. dB


Farfield Realized Gain Abs (Phi=90)
farfield (broadband) [1]
Frequency = 3
Main lobe magnitude = 4.02 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 131.0 deg.
Side lobe level = -15.1 dB
Theta / Degree vs. dB


Farfield Realized Gain Abs (Phi=90)
farfield (broadband) [1]
Frequency = 4
Main lobe magnitude = 6.05 dB
Main lobe direction = -35.0 deg.
Angular width (3 dB) = 122.6 deg.
Side lobe level = -14.8 dB
Theta / Degree vs. dB


Farfield Realized Gain Abs (Phi=90)
farfield (broadband) [1]
Frequency = 3.5
Main lobe magnitude = 6.88 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 100.9 deg.
Side lobe level = -17.2 dB
Theta / Degree vs. dB


Farfield Realized Gain Abs (Phi=0)
farfield (broadband) [1]
Frequency = 4
Main lobe magnitude = 6.15 dB
Main lobe direction = 15.0 deg.
Angular width (3 dB) = 64.9 deg.
Side lobe level = -10.8 dB
Theta / Degree vs. dB


Farfield Realized Gain Abs (Phi=90)
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Frequency = 4
Main lobe magnitude = 6.05 dB
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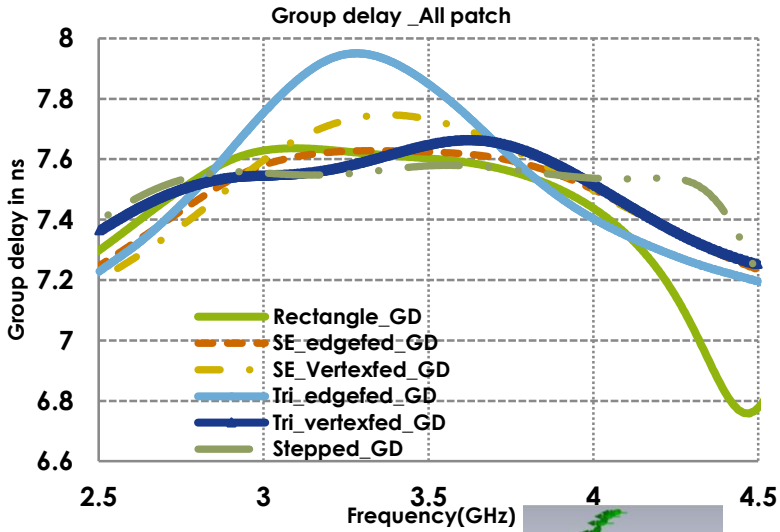
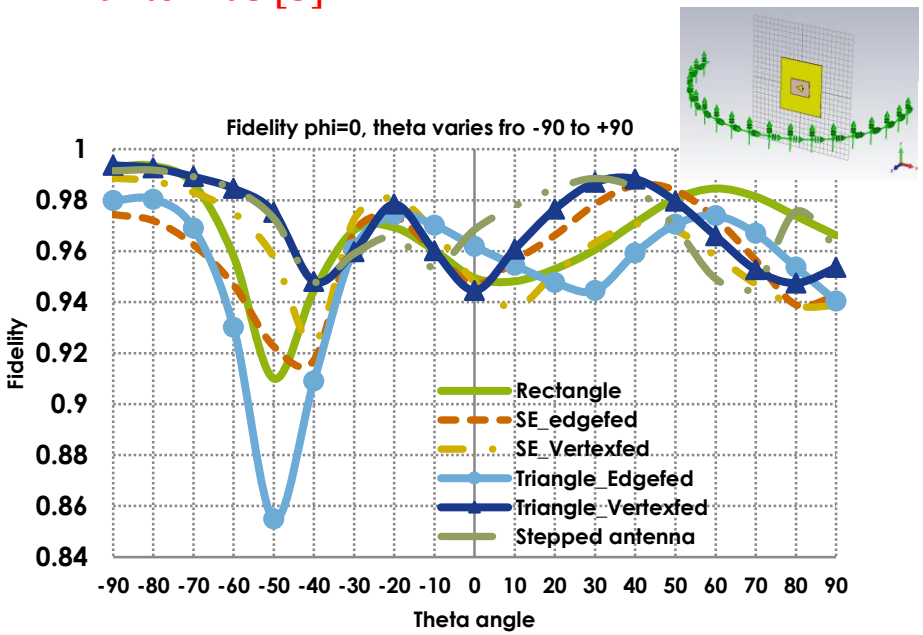
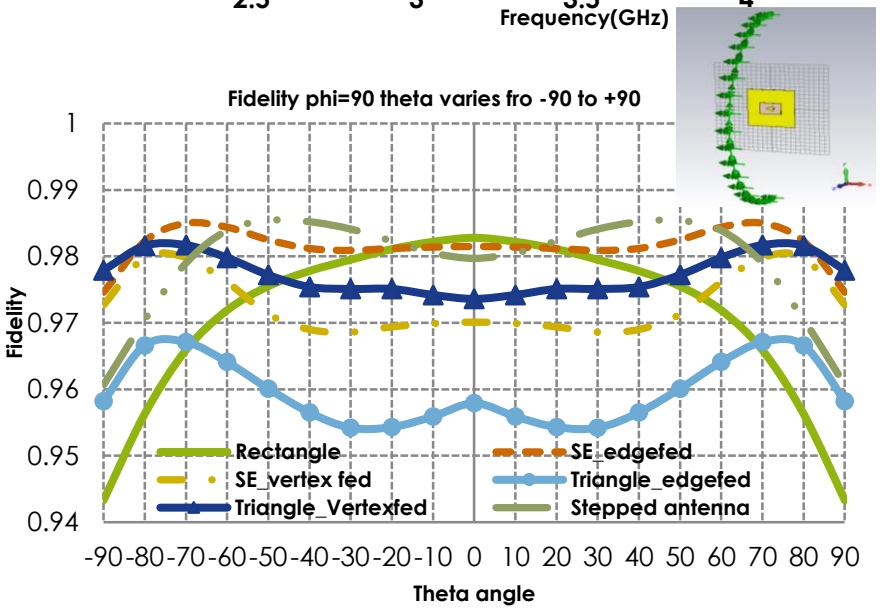
Angular width (3 dB) = 122.6 deg.
Side lobe level = -14.8 dB
Theta / Degree vs. dB

Time Domain Antenna Characteristics

- ❑ Time Characterization
- ✓ Group Delay-Low variation in group delay ensures dispersion-less transmission.
- ✓ Pulse Fidelity Factor(PFF)
  - ❖ Degree of correlation between input and out waveforms[3]
  - ❖ Range[0 1]
  - ❖ PFF values are greater that 0.8 for all designed antennas.[3]

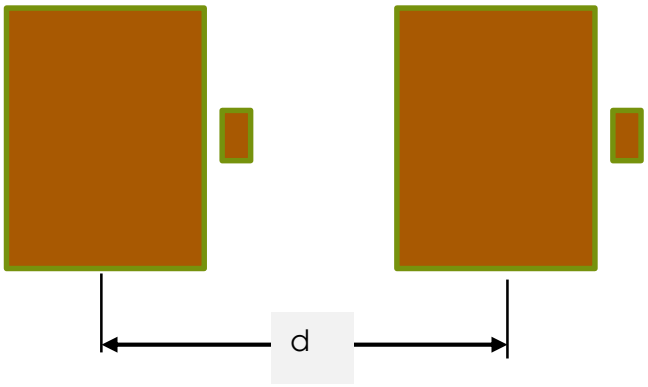






Mutual coupling and Array Characteristics

- Effects of mutual coupling between array must be addressed when designing array.
- Due to thick substrate and coaxial feed, the antenna has high cross-polarization level which can be decreased using defected ground structure or by making cavity backed structures.



Conclusion and Future Work

- Microstrip capacitive probe fed antennas are investigated for time and frequency characteristics.
- The operating frequency range of these antennas are from 3.1 GHz to 4.2 GHz.
- Uni-directional radiation pattern of these antenna makes it unique in the group of omnidirectional UWB antennas.
- Flat gain and flat group delay response vs. frequency.
- PFF values of all antenna are greater than 0.8, which means the antenna receives and transmits signal without distortion.
- Working on approaches to reduce cross polarization of this antenna by cavity backing and by defected ground structure.

References

1. V. T. Bhat and K. J. Vinoy, "Studies on ultra wideband triangular patch antennas for imaging applications," *Antennas and Propagation (APCAP), 2012 IEEE Asia-Pacific Conference on*, Singapore, 2012, pp. 253-254. doi: 10.1109/APCAP.2012.6333233

2. V. G. Kasabegoudar and K. J. Vinoy, "Coplanar Capacitively Coupled Probe Fed Microstrip Antennas for Wideband Applications," in *IEEE Transactions on Antennas and Propagation*, vol. 58, no. 10, pp. 3131-3138, Oct. 2010. doi: 10.1109/TAP.2010.2055781

3. J. Liu, K. P. Esselle, S. G. Hay and S. Zhong, "Effects of Printed UWB Antenna Miniaturization on Pulse Fidelity and Pattern Stability," in *IEEE Transactions on Antennas and Propagation*, vol. 62, no. 8, pp. 3903-3910, Aug. 2014. doi: 10.1109/TAP.2014.2322885

Thank you