

EARS: Collaborative Research: Enhancing Spectral Access via Directional Spectrum Sensing Employing

3-D Cone Filter Banks: Interdisciplinary Algorithms and Prototypes

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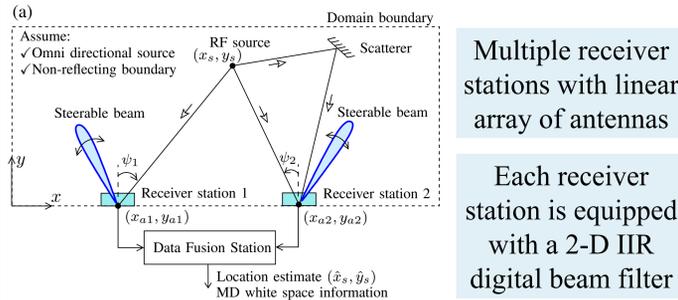
Institutions: University of Akron¹, University of Toledo², Norfolk State University³, Old Dominion University⁴ and Ohio Northern University⁵

Participants: Chamith Wijenayake, Sewwandi Wijayarathna, Dezarae Holman, Elizabeth Hammell, Arindam Sengupta, Mohammad Almalkawi, Judith Abeysekara and Khair Ayman

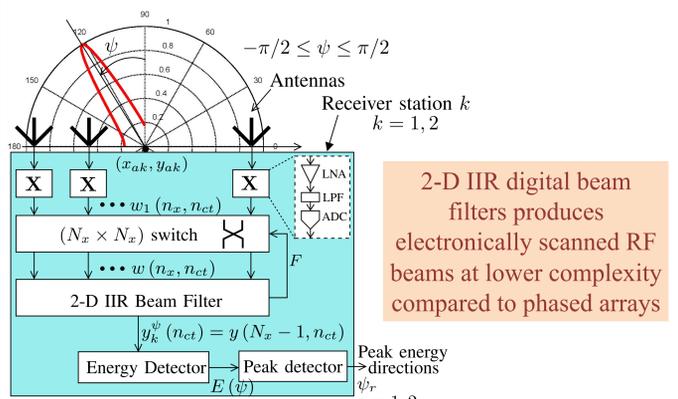


Intellectual Merit: Four journal publications [1-4] and two conference publications [5-6]

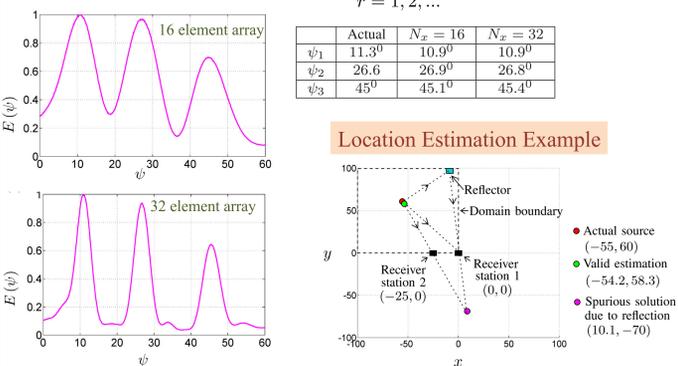
Direction of Arrival (DOA) and RF Source Location Estimation using 2-D IIR Digital Beam Filters [5]



Multiple receiver stations with linear array of antennas
Each receiver station is equipped with a 2-D IIR digital beam filter

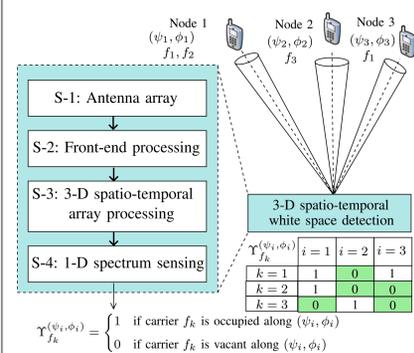


2-D IIR digital beam filters produces electronically scanned RF beams at lower complexity compared to phased arrays

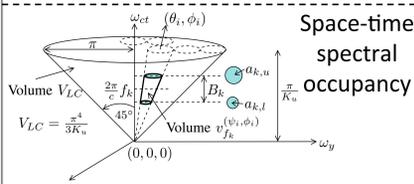
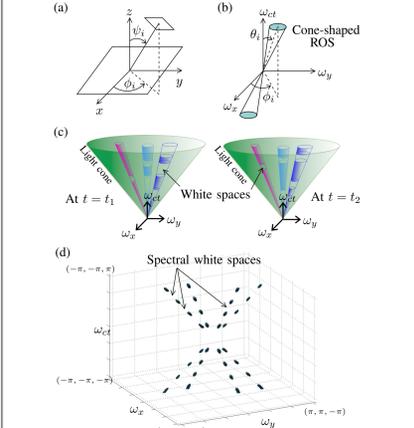


Three-Dimensional (3-D) Space-Time White Spaces: Theory, Detection Algorithms and Circuits [3]

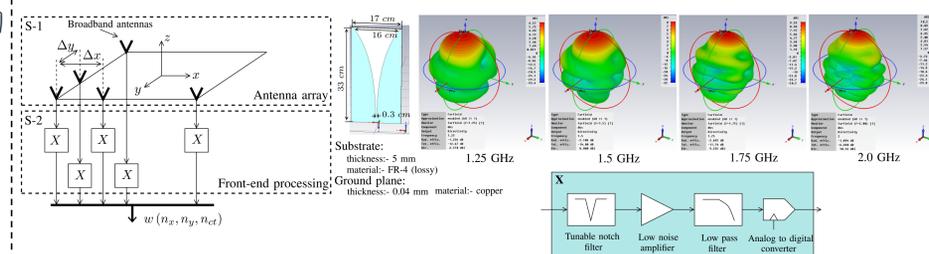
Proposed System Overview



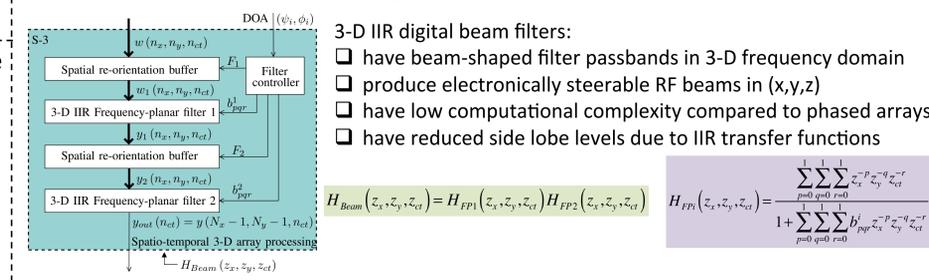
Spectral white spaces in 3-D space-time frequency domain



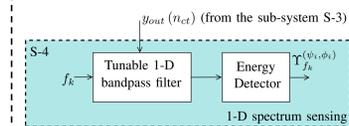
Antenna array and front-end sub systems



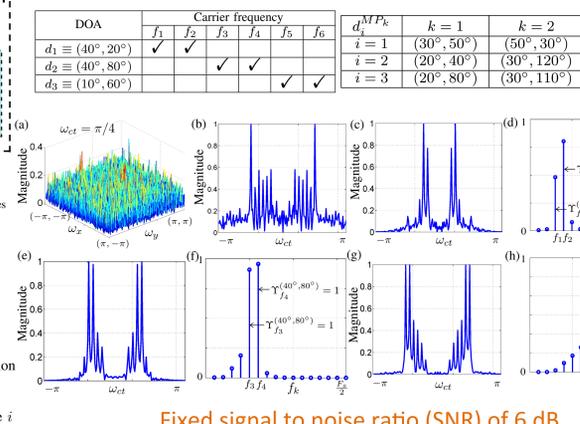
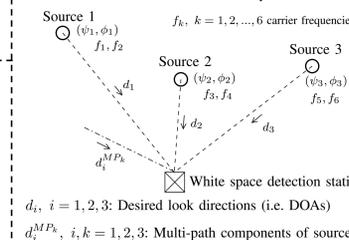
3-D Spatio-temporal array processing sub-system



1-D spectrum sensing sub-system



Simulation examples



Link Scheduling and Routing

- Formulate into an optimization problem
 - Ensure no interference to primary users
 - Ensure no interference between simultaneously transmitting links
 - Maximize end-to-end traffic flow transport capacity
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- Construct a map of primary users through 3D sensing
 - Classify paths into opportunistic and stable
 - Differentiate routing based on traffic type
 - Optimize throughput

Broader Impacts

Women in Engineering (WIE) Activities

Summer camp at Akron for female high school students, June 2013
Two hands on projects on basic electronics:
1. Audio amplifier
2. LED display according to audio signal



Outreach to Underrepresented Groups

Summer workshop at NSU, Norfolk for underrepresented high school students
Hands on projects to demonstrate basics of wireless communications



Outreach to Broader Scientific Community

Graduate students presenting at the CASPER workshop at the National Radio Astronomy Observatory (NRAO), GreenBank, 2012



Female Undergraduate Research

Undergraduate researcher, Elizabeth Hammell testing a Vivaldi antenna using a vector network analyzer



Female Graduate/Undergraduate Student Activities



Students presenting their research at Ohio Celebration in Women in Computing (OCWiC) conference

Graduate student Ms Uma Potluri (top-right) won the best poster award at the conference

Acknowledgement

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References

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- C. Wijenayake, A. Madanayake, and L. T. Bruton, "Space-Time Spectral White Spaces in Cognitive Radio: Theory, Algorithms and Circuits", Accepted for publication at IEEE Journal on Emerging and Selected Topics in Circuits and Systems (JETCAS), special issue on CR/SDR, 2013
- J. Adams, A. Madanayake, and L. T. Bruton, "Approximate Realization of Fractional-Order 2-D IIR Frequency-Planar Filters", IEEE Journal on Emerging and Selected Topics in Circuits and Systems (JETCAS), special issue on Fractional Order Systems, vol. 3, pp. 338-345, 2013.
- C. Wijenayake, A. Madanayake, L. T. Bruton, and V. Devabhaktuni, "DOA-estimation and source-localization in CR-networks using steerable 2-D IIR beam filters," in IEEE International Symposium on Circuits and System (ISCAS), 2013, pp. 65-68.
- Arjuna Madanayake, Chamith Wijenayake, Uma Potluri, Judith Abeysekara and Dale Mugler, "Low-complexity algorithms for spatio-temporal directional spectrum sensing with applications in cognitive radio", Proceedings of SPIE 8753, Wireless Sensing, Localization, and Processing VIII, 87530G, 2013