ELECTRICAL AND COMPUTER ENGINEERING SEMINAR

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Multidimensional Signal Processing Circuits for Low-SWaP Multi-Beam Arrays

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ISEC 138

11:00am- 12:00pm

Abstract: In this talk, array processing circuits that exploit the computing paradigm of approximate computing are explored. Low-size, -weight, and -power consumption (SWaP) algorithms and circuits are proposed to achieve thousands of fully-digital beams for emerging applications. The proposed low-SWaP multi-beam digital beamformers use approximate computing to enable up to 90% smaller circuit complexity compared to FFT-based techniques used to achieve multiple orthogonal RF beams. Furthermore, the proposed array processing systems exploit wave physics to improve the performance of key signal processing components in wireless base stations. Specifically, the spatio-temporal causality properties of electromagnetic plane waves - as described in Special Theory of Relativity - are used in novel multi-port transceiver circuits to improve energy efficiency, reduce additive white Gaussian noise, and improve linearity of array receivers at the physical layer. The multi-dimensional frequency-domain region of support (ROS) of all propagating plane waves, which correspond to wireless propagation channels, are shown to be confined inside the "Light Cone". The region of spacetime outside this light cone is a void (elsewhere) within which wireless communications signals cannot propagate. A "cone of silence" appears in the multidimensional spacetime frequency domain, which demarcates a conical region outside of which waves do not exist. The aim is to spatio-temporally shape noise and transceiver distortion into this electromagnetically silent region so that their presence does not affect the performance of arrays. The technique enables multi-port versions of LNAs, ADCs, and DACs for array processing that exploits noise and shaping in multiple dimensions in space and time to greatly improve performance.

Bio:

Dr. Arjuna Madanayake is an Associate Professor of Electrical and Computer Engineering at Florida International University. His research interests include multidimensional signal processing, array processing, FPGA and digital systems, microwave circuits, VLSI, analog and mixed-signal circuit design, fast algorithms, digital signal processing, alternative computing, wireless communications, mm-wave systems and 5G/6G topics, sub-THz and THz systems, satellite communications, wireless sensing and imaging, radar sensing, computing architecture, internet of things (IoT), RF sensing for unmanned aerial systems, and electronic warfare. He started an Assistant Professorship at the University of Akron in Ohio in 2010, and received early tenure and promotion to Associate Professor in 2015. Dr. Madanayake was selected as the most outstanding candidate in Electrical Engineering and Computing Sciences category for the NSERC 2009 Canada Post-doctoral Fellowship competition. Dr. Madanayake completed a postdoctoral associateship in 2009 in which he explored multidimensional signal processing and FPGA circuits for beamformer aperture arrays as part of the Canadian Square Kilometer Array (SKA) effort. He completed the Ph.D. and M.Sc. both in Electrical Engineering at the University of Calgary, specializing in multidimensional signal processing, circuits and systems, especially FPGA systems. In his current tenured appointment at FIU, Dr. Madanayake directs the RF, Analog and Digital (RAND) Circuits Lab at FIU which has been conducting multiple projects funded by 3 DARPA, 3 ONR and 7 NSF awards. Arjuna tries to pursue elephant conservation and rural development in Sri Lanka, and high-end audio engineering as hobbies.