

Communication

FACULTY

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Matt Blanton (left) and Chris Anderson (right) test the UWB software radio initial prototype

Tech builds multi-use UWB software radio

While building a software defined radio using ultra wideband signals (UWB) for naval applications, ECE researchers have developed a flexible, high-performance testbed that can be used in applications ranging from inventory tracking to heart-rate measurements and medical imaging.

“This is no other UWB software radio with the extreme amount of flexibility this one has,” said Ph.D student Chris Anderson, who serves as the student lead on the project. “Not only can the platform be used for such different applications, but it can also work with any other broadband waveform. It allows other graduate students to play with things like pulse shapes, modulation schemes, and multiple access schemes.”

The radio receiver was built for the Advanced Wireless Integrated Navy Network (AWINN) project, funded by the Office of Naval Research. The goal was to build a sin-

gle hardware platform that could be used for close in ranging and communications, such as ship-ship cargo container transfer, or synchronized with several other systems for longer-range communications.

The system uses off-the-shelf components and achieves a raw data rate of 100 Mbits/second at 10 meters, with a 2.2 GHz RF bandwidth and 8 GHz sampling frequency. The initial prototype uses two 1 GS/s time-interleaved analog-to-digital converters and will be scaled up to eight for the final platform. Anderson worked with Matt Blanton and Deepak Agarwal to incorporate FPGAs for fast parallel processing.

“The ultimate goal for this receiver is for it to be a test-bed,” Anderson said. “People could use it to play around with different UWB or other broadband signals and investigate the effects of different pulse shapes, coding schemes, etc. It gives them a tool to use in the lab or field to validate their algorithms or simulation results.”

Communications Overview

Communications research is inherently interdisciplinary, and often coupled with device, circuit and networking technologies. It is common for interests to span multiple areas and for multidisciplinary teams to tackle major topics.

Communications research aims to understand the basic limitations on communication system performance; analyze, model, and characterize performance; devise, implement and evaluate new techniques to improve performance; and contribute to a range of communications applications.

Wireless Communications: Research has progressed from a long-standing involvement in radio technology to propagation and antenna studies for satellite communications, to wireless networking across distances and appli-

cations. Researchers model mobile communications channels, develop multiuser modulation and detection techniques, and devise techniques and applications for new spectral bands, even across spectral bands. New efforts involve developing UWB techniques and cognitive radios. Research on antennas, RFICs, digital ICs, and wireless networking protocols contribute to wireless efforts.

Digital Signal Processing: An important component of wireless research involves implementing functions in DSP chips to boost efficiency and functionality.

DSP research reaches well beyond software radios, and covers investigating efficient signal representation, compression, and interference cancellation, for applications in imaging, speech

recognition, sonar detection, medical diagnosis, and spatial beamforming. New efforts apply signal processing to microscope signals in biomedical research.

Fiber Optic Communications: Fiber communications work probes the interrelation between technology, system architecture, and applications.

Recent activities include modulation techniques to counter the effects of dispersion and non-linearity in long distance systems, subcarrier multiplexing and coding for extending bit rate limitations of multimode fiber systems, information theoretic limits on capacity, and architectures for survivable communications. Current efforts involve broadband access and interfaces between wireless and fiber systems.

UWB for Position Location in Harsh Environments

Many activities requiring position location — such as emergency response, urban troop deployment — must operate in a harsh communications environment with significant multipath and interference.

Current GPS systems, as well as indoor position technology based on laser, ultrasound, or narrowband RF, are severely limited in these environments, according to Michael Buehrer. Buehrer is leading a team that seeks to assist people in these situations by developing position location technology for ad hoc networks, using an ultra wideband sensor.

With a \$174,000 grant from the NSF, his team is investigating four issues: UWB signals in non-line-of-sight environments; signal acquisition of the primary path in dense multipath scenarios; MAC design for UWB-based position location networks; and network position determination with a limited number of anchors. “We are hoping to address these challenges using a mixture of local signal processing methods and collaborative, network-level techniques,” he said.

Wireless @ Virginia Tech

www.wireless.vt.edu



Develops technology for wireless applications, from theory through fully tested and operational prototypes ready for production. Investigates propagation, receiver design, signal processing, networking, and usability in voice, video, and data communications. Facilities include the Antenna Group, CWT, MPRG, VTVT, and the Wireless Microsystems labs.

Director: Jeff Reed

Extending Tech’s Open-Source SDR tool

ECE’s open-source software radio tool, OSSIE (Open-Source SCA Implementation: Embedded) has been downloaded over 1000 times.

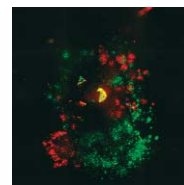
The modular, reusable, software framework, libraries and tools for software defined radio (SDR) development is accelerating wireless communications development and research, according to its creators. “Even though it was created to support graduate teaching and research, companies and governments around the world have told us that they are evaluating OSSIE for inclusion into their products,” said Jeff Reed, faculty advisor on the project.

With a \$250,000 grant from the NSF NeTS program, the team is adapting OSSIE for use in investigating more efficient SDR design and for allowing rapid prototyping and testing of new waveform with minimal hardware dependencies.

The effort will address several limitations in the SCA, on which OSSIE is based. The team plans to enhance code portability, reduce overhead, increase radio flexibility to support dynamic changes, and reduce power consumption.

Digital Signal Processing & Communications Laboratory

www.ece.vt.edu/fac_support/DSPCL



Conducting research in the general areas of signal processing and image processing with applications to systems biology and digital communications.

Director: Amy Bell