Ultra-wideband (UWB) communication technology offer inherent advantages such as the ability to coexist with previously allocated Federal Communications Commission (FCC) frequencies, simple transceiver architecture, and high performance in noisy environments. Spread spectrum techniques offer additional improvements beyond the conventional pulse-based UWB communications. This thesis implements an UWB communication system using a surface acoustic wave (SAW) correlator receiver with orthogonal frequency coding (OFC) and software defined radio (SDR) base station transmitter.

Orthogonal frequency coding (OFC) and pseudorandom noise (PN) coding provide a means for spreading of the UWB data. The use of OFC increases the correlator processing gain (PG) beyond that of code division multiple access (CDMA); providing added code diversity, improved pulse ambiguity, and superior performance in noisy environments. Use of SAW correlators reduces the complexity and power requirements of the receiver architecture by eliminating many of the components needed and reducing the signal processing requirements necessary for digital matched filtering of the complex spreading signal.

The OFC sequence located in the receiver is hard-coded in the device due to the physical SAW implementation. The use of modern SDR forms a dynamic base station architecture which is able to programmatically generate a digitally modulated transmit signal. Embedded Xilinx Zynq system on chip (SoC) technology was used in this dissertation to implement the SDR system; taking advantage of recent advances in digital-to-analog converter (DAC) sampling rates. Baseband SDR waveform samples are generated in in-phase and quadrature (I & Q) pairs and upconverted to a 491.52 MHz operational frequency.

The development of the OFC SAW correlator ultimately used in the receiver is presented along with a variety of advanced SAW correlator device embodiments. Each correlator device fabricated on lithium niobate (LiNbO3) with fractional bandwidths in excess 20% fractional bandwidth. The SAW correlator device presented in system was implemented with a center frequency of 491.52 MHz, a multiple of the SDR master clock rate. Parasitic electromagnetic feedthrough becomes problematic in the packaged SAW correlator after packaging and fixturing due to the wide bandwidths and high operational frequency. Reduction techniques for reduction of parasitic feedthrough are discussed with before and after results showing approximately 10:1 improvement.

Received correlation and demodulation results are shown using the SAW correlator under operation in an UWB communication system. Bipolar phase shift keying (BPSK) is used to modulate and demodulate a binary bit sequence. Matched OFC code reception is compared to a mismatched, or cross-correlated, sequence after correlation and demodulation. Finally, the signal-to-noise power ratio (SNR) performance results for the SAW correlator under corruption of a wideband noise source are presented.
Approved for distribution by Donald C. Malocha, Committee Chair, on May 7, 2015.

The public is welcome to attend.