Okan Zafer Batur

Thesis Supervisor: Prof. Günhan Dündar
Thesis Co-Supervisor: Assoc. Prof. Mutlu Koca

Robust Ultra-Wideband Transceiver Integrated Circuit Design

Abstract

Pulsed based wideband and UWB radios are well known for their use in radar technology. UWB has also been popular for its use on high data rate applications in recent years. UWB wireless sensor networks known for their low power and long range operation. UWB is not only a low cost and low complexity technology with precise ranging and multipath immunity properties, but it has also has its challenges such as pulse based synchronization, which requires low jitter and precise delay blocks.

The thesis covers various aspects of RF and mixed signal VLSI circuit design. It is focused on the design of a low power high data rate, and moderate range IR-UWB transceiver design with robustness to impulsive noise. A co-simulation tool is developed for the top-down design and automation of the UWB transceiver. The non-idealities of the receiver and the transmitted pulse are also studied by the co-simulation tool to create an efficient IR-UWB transceiver. As a first step, the existence of the impulsive noise in wideband channels is shown with measurements and fitted noise models. Then, top level computer automated system models are written, extensive simulations are performed and performance metrics are defined. The circuits are designed in reference to system models in a top down design fashion. Various transceiver architectures are reviewed in terms of performance and hardware complexity. A non-coherent energy detection receiver architecture is designed with high data rate and meter range communication capability. A template based coherent transceiver is designed with a very fine Vernier delay line for template synchronization. The receiver is planned to be controlled by FPGA. Two extremely low power transmitter architectures are developed with dual band and re-configurability features. Both coherent and non-coherent IR-UWB transceiver architectures are realized in standard CMOS technology. Three chips were fabricated using 130nm CMOS. The thesis presents successful experimental results on the fabricated chips. Various measurement results for commercial MB-OFDM and IR-UWB development kits are also included for comparison.

PUBLICATIONS

Journals

1. **Batur O. Z**.,Akdag, E., Akkurt H., Oncu A., Koca M., Dundar G., "An Ultra-Low Power Dual-Band IR-UWB Transmitter in 130nm CMOS", Transactions on Circuit and Systems II, pp 710-705, Vol 59, Nov 2012, (SCI-E)
2. **Batur O. Z**., Akkurt H.K., Dundar G., Koca M., "240 Mbps Non-Coherent IR-UWB Energy Detection Transceiver in 130nm CMOS", Transactions on Circuit and Systems II, *Revizyonda* - (SCI-E).

Conferences

1. **Batur, O. Z**., Koca M., Dundar G., "MATLAB-VHDL design automation for MB-OFDM UWB," Ultra-Wideband, 2009. ICUWB 2009. IEEE International Conference on , pp.423-427, 9-11 Sept. 2009

2. **Batur, O. Z.**, Koca M., Dundar G., "Measurements of Impulsive Noise in Broad-band Wireless Communication Channels", Proceedings of IEEE PRIME 2008, pp. 233-236, June 22-25 2008, Istanbul, Turkey.

Defense Jury Members

1.	Prof. Günhan Dündar	Boğaziçi University
2.	Assoc. Prof. Mutlu Koca	Boğaziçi University
3.	Assoc. Prof. Arda Deniz Yalçınkaya	Boğaziçi University
4.	Prof. Avni Morgül	Fatih Sultan Mehmet Vakıf Üniversitesi
5.	Prof. Catherine Dehollain	École Polytechnique Fèdèrale de Lausanne (EPFL)

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