Program
6th IEEE UWB Forum on Sensing and Communications 2011

6th IEEE UWB Forum on Sensing and Communication organized by the Signal Processing and Speech Communication Laboratory, Graz University of Technology in cooperation with the IEEE Student Branch of Graz University of Technology.

May 5, 2011
Graz University of Technology
Lecture Hall HS i5 (KNAPP Logistik Hörsaal), Inffeldgasse 25D/1, 8010 Graz, Austria

09:30-10:00  Registration, Coffee

10:00-12:00 Session 1: UWB for RFID Systems

10:00-10:20  "Sensing with UHF RFID: an Overview"
Pavel Nikitin
Intermec Technologies Corporation, WA, USA

There is a growing interest to sensing using UHF RFID systems based on modulated backscatter because of their long range and low cost of the tags. The subjects of interest in sensing include temperature, light, touch, pressure, humidity, position, activity, etc. This talk will cover various sensing methods which can be used in modern Gen2 UHF RFID systems: on/off sensing, analog sensing, tag ID modulation, and dedicated sensors which can be used with either custom tag integrated circuits or more flexible discrete tag platforms.

10:20-10:40  "Ultra-wideband identification tag with On-Chip Antenna"
Nikola Gvozdenovic
Vienna University of Technology, Austria

Ultra-wideband is suitable transmission scheme for identification tag due to low power consumption. Implementation of an chip antenna decreases tag's size and cost significantly. Current prototype, with the size 1x1.3 mm² and 100 Mbps on the uplink, is a result of combination of these two technical solutions. The identification tag transmits UWB pulses modulated through a pseudo random bit generator. Due to small power of the identification tag transmission is possible only in the near field of receiving antenna. The known bit sequence allows us to estimate BER for the received signal. Based on the measurement we propose a near-field UWB channel model.

10:40-11:00  "A Flexible Energy Detection IR-UWB Receiver for RFID and Wireless Sensor Networks"
Qin Zhou
Royal Institute of Technology, Sweden

Asymmetrical wireless link (IR-UWB uplink from tag to reader and UHF downlink from reader to tag) is a promising solution for RFID and WSN applications. As the most challenging part of the asymmetrical link, an energy detection IR-UWB receiver with high sensitivity, low energy consumption and low complexity implementation is presented. The proposed receiver is featured by a flexible and reconfigurable back-end (timing and baseband processing) to facilitate adaptive link in dynamic circumstances, such as scalable system capacity, quality of service (QoS) requirements and channel conditions.
11:00-11:20  "UWB RTLS basics and standards"
Josef Preishuber-Pflügl
CISC Semiconductors, Austria

One of the many advantages of UWB is in the high accuracy for positioning and consequently for localization. ISO/IEC JTC1 and IEEE are actively working on UWB based RTLS (Real Time Location Sytems). Measurements and demonstration results of feasibility and design studies provide major input into the standardization in order to specify a globally useable system despite the differences in global operation for the UWB in the band below 10 GHz.

11:20-11:40  "The Smart Data Grain, an active driven UWB RFID tag"
Philipp K. Gentner
Vienna University of Technology, Austria

Our research focuses on UWB impulse radio for future RFID tags. We miniaturize the tag by placing the antenna directly on chip which enables many new application scenarios. In this contribution, a first prototype of the so-called "Smart Data Grain" is discussed from simulation through manufacturing in CMOS to validation measurements. The flexible active driven grain consists of a voltage controlled oscillator with a wide tunable frequency range, a Pulse Amplitude Modulator with variable data rate, and an on-chip antenna. The prototype with a size of 1x1.3 mm$^2$ is used for characterizing the on-chip antenna and benchmarking the proposed communication scheme.

11:40-12:00  "Tag Localization in Passive UHF RFID"
Daniel Arnitz
Graz University of Technology, Austria

This talk addresses the problem of passive UHF RFID tag localization, with a focus on supply chain applications. It shows how environment and system setup influence the propagation channel and why this creates a harsh environment for any type of localization. Based on the conclusions drawn in this channel analysis, tag localization approaches are investigated. Three methods are discussed in detail: phase-based continuous-wave ranging, frequency-modulation continuous-wave ranging, and impulse radar.

12:00-13:20  Lunch
Based on an impellent need for power efficient and low complexity communication systems, noncoherent UWB systems are in the focus of research interest. However, as noncoherent UWB systems are characterized by an unlicensed usage of an extremely wide bandwidth there is a potentially high interference resulting from other licensed/unlicensed radio systems. Hence, a crucial concern is the efficient treatment of interference operating simultaneously in the same frequency region.

In this presentation an overview on ongoing research activities regarding the efficient treatment of interference is given. Thereby, a noncoherent multiband impulse radio UWB (MIR UWB) system is considered for high data rate communication over short distances. The presentation is structured as follows: At the beginning, an introduction into the MIR UWB system architecture is given. To increase the broad- and narrowband interference robustness of the MIR UWB system the second part focuses on the interference robustness of the noncoherent receiver used in the system. The third part introduces in adaptive coexistence based interference handling which is based on the usage of low complex image processing. Lastly, possible methods of low complex interference mitigation are described. Thereby, a mitigation approach for broadband interference and one for narrowband interference is presented. The presentation concludes with a summary as well as an outlook.

This talk presents a multichannel noncoherent autocorrelation receiver architecture which supports energy detection of a multiband ultra-wideband (UWB) signal. It is a robust, power-efficient receiver architecture that is capable of collecting energy from the multipath components of the channel response and has a scalable increased data rate. Central element of the demonstrator is the multichannel analog frontend that lowers the requirement for digital signal processing and for power hungry analog-to-digital conversion. The proposed receiver may be used in wireless systems that perform data transmissions at extremely large data rates (\( \geq \) 500 MBit/s) over limited distances (\( \leq 5 \) m). It could be used to connect mass storage as available in todays mobile handsets to personnel computers, home entertainment systems, or some public/commercial information kiosk, for instance. The discussed receiver with this radically different system architecture may be capable of providing these ultra-high data rates at a significantly reduced energy per transmitted bit, compared with conventional systems. The focus of this talk addresses the signal analysis and signal processing using a noncoherent OFDM transmission scheme. The novel architecture will be discussed in detail and the modification of the signal due to nonlinear operations, e.g. of the multiplication-devices, will be described.
14:00-14:20  "Status Report on the FCC-Compliant UWB Transceiver Implementation"
Lukasz Zwirello
Karlsruhe Institute of Technology (KIT), Germany

This contribution presents the theoretical considerations regarding a FCC-compliant UWB communication system with localization capabilities, as well as its practical hardware implementation. First the targeted application scenario will be introduced, together with the expected characteristics of the channel. Furthermore the localization precision limit, that could be achieved in the chosen configuration will be investigated and the measures to improve this in real scenarios will be named. Moreover the test of the hardware, allowing the precise time difference measurements, required in the TDOA-system, will be shown. Finally the UWB-transceiver concept will be introduced and the measurements of the system building blocks, along with documentation of the laboratory-scale wireless transmission test, will be presented and discussed in details.

14:20-14:40  "Exploiting multi-core architecture capabilities in UWB communications"
Csaba Jozsa
Pazmany Peter Catholic University, Hungary

Nowadays the multi-core architectures (GPU, FPGA) are getting a prominent role in the field of information technology. This is because their price is getting cheaper and the computational possibilities are far beyond the general purpose processors. This is very important because the computational power of the supercomputers can be reached by scientists with this kind of systems at a reasonable cost. Despite the fact that the number of this new architectures are permanently increasing, the change is not trivial. The successful utilization of the facilities provided by these parallel architectures necessitates rethinking the programming paradigms, to redesign and implement the old algorithms and softwares. In our work we have analyzed that how can the parallel digital signal processing improve the UWB communication using the GPU. We showed that significant performance increase can be achieved with these multi-core architectures when we want to filter, transform or correlate huge amounts of data.

14:40-15:00  "Integration of Measurement Equipment in a Matlab Environment for the Example of RadarChirps"
Spiro Moskov
Agilent Technologies

A demonstration will be given of state-of-the-art (ultra)-wideband measurement equipment for signal generation and analysis. The integration in a MATLAB environment will be shown for wideband radar chirps.

15:00-15:30  Coffee Break (by x.test GmbH)
15:30-17:10 Session 3: Localization and Signal Processing

15:30-15:50
"Overview of Message Passing Algorithms for Cooperative Localization in UWB wireless networks"
Samuel Van de Velde
University of Ghent, Belgium

Sensor localization in wireless networks has become an active area of research in recent years. In large networks it may be unpractical or too expensive to manually supply every sensor with its position or equipping each sensor with a GPS receiver. Furthermore, GPS does not provide reliable position estimates in harsh environments, such as indoors or under tree canopies. In this overview, we review several message passing algorithms that can provide self-localization in a cooperative and distributed manner using UWB radios. These algorithms include belief propagation (BP), mean field (MF), and expectation propagation (EP). All perform inference on factor graphs and differ mainly in term of complexity, message representation, and overall accuracy. Contrary to optimization-based algorithms, which only provide point estimates, BP, MF, and EP all yield distributions of the nodes' positions. Hence, they can be extended to a dynamic scenario where all sensors are moving. Some of the main future challenges include making the algorithms more robust in case of multipath or non-line-of sight conditions, dealing with ambiguities, and performing heterogeneous sensor fusion.

15:50-16:10
"Direction-resolved Estimation of Multipath Parameters for UWB"
Georg Kail
Vienna University of Technology, Austria

We propose a Monte Carlo method for determining the parameters of multipath components (MPCs) for ultra-wideband channels. A partially collapsed Gibbs sampler is used for jointly estimating the number, times-of-arrival, angles-of-arrival, and amplitudes of the MPCs as well as the sounding pulse from signals received by a 2D antenna array. Our system model accounts for propagation delays between the receive antennas. Temporal-angular sparsity of the detected MPCs is ensured by a 2D minimum distance constraint. Numerical results for synthetic and real signals demonstrate the excellent performance and fast convergence of our method.

16:10-16:30
"Tracking Algorithms for Multipath-Aided Indoor Localization"
Paul Meissner
Graz University of Technology, Austria

One of the key problems for indoor localization systems is multipath propagation. Non-line-of-sight situations between base stations and mobile agents can cause large biases in the corresponding range estimates. Instead of identifying and discarding measurements from NLOS situations, our approach explicitly uses reflected signal components for localization. We use given floor plan information to map reflected paths to virtual signal sources. In this way, a single physical anchor node can provide rich localization information. A statistical model is used that describes typical error sources concerning the estimation of the ranges to the virtual anchors. This model leads to heavy-tailed and multimodal noise terms and likelihood functions. To this end, we introduce several variants of popular state-space estimators to obtain both accurate and robust location estimators. Performance simulations confirm the excellent performance of the estimators and show important directions for future research.
"Application of pulse compression technique to generate IEEE 802.15.4a-compliant UWB IR pulse with increased energy per bit"
Tamas Krebesz
Budapest University of Technology and Economics, Hungary

The radio coverage is limited by the energy per bit transmitted. UWB pulses used in impulse radio are extremely short and, consequently, carry a very little energy per bit that results in an unacceptable short radio coverage. The energy per bit could be increased by enlarging the duration of UWB carrier pulse, however, this solution cannot be used because the correlation of pulse envelope with a reference pulse defined in IEEE Std. 802.15.4a has to exceed a prescribed value. To solve the problem the pulse compression approach is proposed here where the duration of radiated UWB carrier pulse is enlarged considerably to get enough energy per bit and the duration of received UWB pulse is compressed by a matched filter at the receiver. The increased energy per bit increases the radio coverage and the envelope of compressed UWB pulse satisfies the requirements of IEEE Std. 802.15.4a. The gains in energy per bit are about 18 dB and 22 dB when the UWB pulse durations are set to 100 ns and 300 ns, respectively.

"Scatterer and Virtual Source Detection for Indoor UWB Channels"
Markus Froehle
Graz University of Technology, Austria

An extension of an existing outdoor UWB scatterer detection algorithm is presented, making it usable for indoor scenarios. The algorithm is extended with the capability to find virtual sources, which can explain reflections from extended, plane surfaces. This extension thus removes the restriction to just single-bounce signal paths. Single-bounce scatterers, as well as virtual sources extracted from the channel impulse response, are assigned to positions in 2-dimensional space and can be matched to given floor plan information. The functionality is demonstrated with indoor measurement data obtained in a large office environment that represents a challenging dense multipath scenario. Results show that estimated locations of virtual sources and scatterers fit very well with the expected locations. Performance results are presented and discussed in detail. Problems in the existing implementation are addressed and an outlook for future work is given.

Beer (by x.test GmbH) and Student Contribution Award (by IEEE Austria Section)