Achievements of PULSERS II WP3b
UWB System for Communication and Positioning in Industrial and Logistics Environments

Objectives
A versatile and autonomous UWB system, which can coexist with other UWB systems in an uncoordinated manner, was targeted in WP3b. The integration of impulse-based communication and ranging functionality into a single transceiver was a major objective, so as to enable the exploitation of joint data transfer and position determination, i.e. the double use of any transmit frame. This approach features some outstanding advantages resulting in high accuracy range measurements with a detectable range increment of 4 cm and asynchronous communication of up to several Mbit/s between a huge number of UWB nodes.

Results
A dual branch non-coherent receiver, designed to receive position-modulated pulses of 1.5 GHz RF bandwidth and 7.68 GHz centre frequency, was developed. The outputs of both branches are processed in an CPLD/FPGA-based digital baseband. Several boards (UWB nodes) were assembled, integrated and tested. The limited number of technology runs permitted by the tight project schedule resulted in a working transceiver, with some performance shortfalls, however. The transmitter output power is more than 10 dB lower than expected and the receiver sensitivity suffers from diffusion of the PLL reference oscillator signal across the RF board, which jointly reduce the nominal range of operation of 30 meter to approx. 3 meter.
Communication

Communication capabilities have been implemented to the degree allowing a radio link between two devices to be set-up. Frame structure and modulation (M-PPM) are adaptable to provide data rates up to several Mbit/s after Viterbi decoding. In default configuration 800 kbit/s user data can be transferred.

Ranging

Ranging tests (see figures below) confirm the targeted range resolution of 4 cm. Under LOS conditions, unaided by inertial navigation, the range histogram typically fills three bins, one primary and one preceding and trailing bin with a substantially lower frequency of occurrence each than the primary bin. A single range value is obtained per beacon frame. A beacon burst contains 172 pulses which are TOA pre-processed in both ends before the Median range is obtained as the representative range per frame. This procedure is repeated at a rate of 50 Hz (max. 10 kHz). The beacon frame rate, however, is configurable since the beacon burst is only 32µs long. The figures below show a time sequence (transition between two stationary phases) and a typical range histogram under stationary LOS conditions. The former (left figure) demonstrates a drift-free measurement result during the two phases when the distance between nodes is constant. The narrow range histogram (right) confirms the stability of the threshold detection w.r.t. noise. The maximum time resolution of 250 ps, due to two-way-ranging, translates into a detectable range increment of approx. 4cm.
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