

RF-Based Time-of-Flight Locationing System

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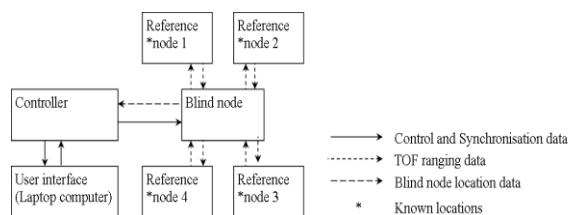
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Project Aims

To develop an **narrow-band RF-based Time-of-Flight (TOF) locationing** system with **sub-meter positioning resolution** which can be used to location nodes within **wireless sensor networks (WSNs)**. This will enable accurate locationing without the requirement of wired infrastructure and synchronisation between devices. Further development will involve the adaption of these techniques to relative locationing algorithms.

RF Time-of-Flight based locationing system

Radio Frequency Identification (RFID) is an identified technology for management, control and security of not only assets but also locationing and tracking in applications such as the movement of personnel in specialised environments. Previous techniques of achieving high accuracy two and three dimensional position estimations have used Time-difference-of-arrival (TDOA) ranging with fixed reference architectures. Those systems require wired infrastructure between references for data transfer and timing synchronisation which sets constraints on the system limiting its applications. This project aims to develop an RF-based locationing system without the requirement of wired infrastructure and timing synchronisation. This will not only allow the techniques to be used in fixed reference node locationing systems, but also in relative locationing systems.



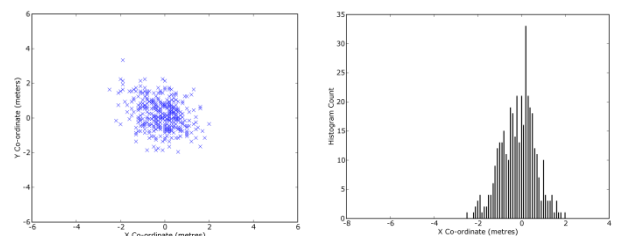
Architecture of prototype RF-based locationing system using fixed reference nodes.



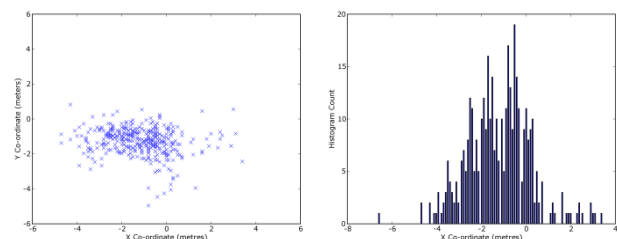
Chipcon CC2431 development kit used to prototype RF-based TOF locationing system.

The prototype RF-based locationing system has been developed using a Chipcon CC2431 development kit. The CC2431 is a fully integrated IEEE 802.15.4 compliant RF transceiver and Intel 8051 MCU. The algorithm is fully implemented in software and requires no additional hardware for operation. Transceiver-transceiver synchronisation is relaxed with ranging performed on a single 250kb/s channel in the 2.4Ghz ISM band.

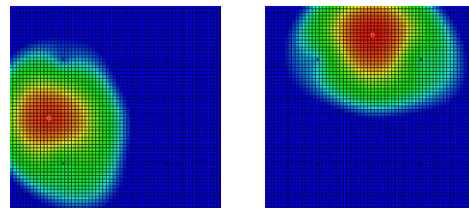
Prototyped system performance



Real time position estimate of prototyped RF-based TOF locationing system for Line-of-Sight (LOS) condition with blind node placed at (0,0) and references at (+/-4, +/-2).



Real time position estimate of prototyped RF-based TOF locationing system for non-line-of-sight (NLOS) condition with blind node placed at (-0.5,-0.5) and references at (+/-4, +/-2).



Typical real-time graphical display of position estimate using brute force for a blind node positioned between two reference nodes denoted by black dots. Warmer colours represent closer approximation of blind nodes position. A single white dot is placed on the best estimate.

References

1. T.C. Karalar and J. Rabaey. **An RF ToF Based Ranging Implementation for Sensor Networks**. *IEEE International Communications Conference*, University of California, Berkeley, Vol 7, pp. 3347-3352, Jun 2006.
2. R.J. Fontana, S.J. Gunderson. **Ultra-Wideband Precision Asset Location System**. *IEEE Conference on Ultra Wideband Systems and Technologies*, Baltimore, MD, 2002.
3. R.J. Fontana, E. Richey, J. Barney. **Commercialization of an Ultra Wideband Precision Asset Location System**. *IEEE Conference on Ultra Wideband Systems and Technologies*, Reston, VA, Nov 2003.