Master Thesis: Robust Real-Time Tracking for UWB based Smart Car Access Systems (m/w/d)

Scope:

Modern cars are equipped with a passive keyless entry & start (PKES) system which allows users to access and start the car without actively using the key fob. Existing systems use a combination of two technologies: a low-frequency (LF) magnetic field to determine the location of the fob (ranging), and an ultra-high radio frequency (UHF/RF) link to establish communication between fob and car.

The fob location can be accurately determined by measuring the received field strength (RSSI). However, LF fields can easily be relayed which makes this technology vulnerable to so-called man-in the-middle attacks. Given the ubiquity of smart devices (phones, watches, etc.) there is a shift towards smart car access systems, with LF/UHF being replaced by other RF technologies.

UWB (Ultra-Wideband) is the most promising RF technology for a PKES system where it will be used for both secure ranging and communication between device and car. Due to its comparably large bandwidth, UWB enables the use of time-of-arrival for high-accuracy ranging, which inherently prevents man-in-the-middle attacks.

However, while, LF magnetic fields remain largely undisturbed by environmental factors (e.g., human body shadowing), UWB pulses are significantly affected.

In this master thesis you will set up a positioning system with NXP's state-of-the-art UWB chips and investigate algorithms that use statistical knowledge about the transmission channel and the user motion to create a robust real-time algorithm that mitigates these undesirable effects.

Objectives:

- Review literature/papers on graphical stochastic models and probabilistic data association.
- Acquire representative measurement data at the laboratory site of NXP using state-of-the-art UWB chips.
- Implement and evaluate advanced tracking algorithms in Matlab based on an existing framework.
- Adapt the algorithms to cope with the physical impairments of the chip.
- Build a real-time demonstrator for your tracking algorithm and evaluate it in challenging scenarios.

Profile:

- Master student in information and computer engineering, electrical engineering, audio engineering or similar studies
- Interest in development and Matlab implementation of advanced signal processing algorithms
- Good programming knowledge in Matlab (or Python)
- Basic knowledge of statistical signal processing is beneficial
- Eager to interact with a team of professionals from university and private industry

This thesis is in cooperation with NXP Semiconductors and the Christian Doppler Laboratory for Location-Aware Electronic Systems at TU Graz. Remuneration of the master's student by part-time employment is planned.

Contact: Alexander Venus (a.venus@tugraz.at), Klaus Witrisal (witrisal@tugraz.at)