



A hybrid opto-inertial Tracking System Prototype

Project Management and Software Development
for Medical Applications

General Info

Project Title: A hybrid opto-inertial Tracking System Prototype

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Project Abstract

The goal of this project is to develop a software prototype that fuses the data streams of both an inertial measurement unit (IMU) and an optical tracking system (OTS) in order to provide meaningful tracking information. This allows for pose estimation in the typical case of temporal object occlusion or line-of-sight restrictions.

Background and Motivation

Modern surgical interventions often need systems to track one or multiple medical instruments or imaging devices to spatially localize or fuse data streams to provide necessary information to the physician.

In the operation theatre, line-of-sight issues arise naturally due to persons or objects in the vision cone of optical tracking systems. To overcome such problems, sometimes electromagnetic tracking systems are used. These systems suffer from various problems such as electromagnetic interference or spatial accuracy restrictions. This is why optical systems are preferred in a wide variety of interventions. However, the line-of-sight problems remain.

For this to overcome, the project partner FRAMOS wants to use the data of an IMU to provide the

necessary information to bridge the gap between two consecutive non-occluded object pose estimations by fusing low-rate optical measurements with high-rate inertial data.

Student's Tasks Description

The first target for the student is to integrate the IMU and stream the data from the electronic device. An OpenIGTLink interface via TCP/IP enables the communication with the FRAMOS OTS to collect 6D pose data from the optical tracking system. The interface is already specified and tested and the given generic implementation has to be adapted and integrated in the same framework.

After studying the relevant literature, a calibration and comparison of the two data streams can be done and a sample fusion algorithm has to be implemented and adjusted to facilitate a first hybrid opto-inertial tracking prototype.

In a defined test scenario, the prototype is finally tested and the performance is evaluated and graphically illustrated.

After this project, the student is able to understand and implement a pose estimation algorithm and calibration process. The implementation of an industrial API and a medical communication interface is learnt while the student organises different software elements which are integrated into a bigger software framework. Moreover, the constant coordination with FRAMOS gives some insight into the working procedures in the industry.

Please send the completed document to benjamin.frisch@tum.de before the project proposal deadline on April 1st, preferably earlier. Please note that this proposal will be evaluated by the BMC coordinators and will be assigned to a student only in case of acceptance.



Technical Prerequisites

- Basic knowledge of C++
- Basic skills in linear algebra

Optional requirements that can also be learned during the project are:

- The use of Kalman filters
- 6D pose estimation expertise
- Some basic understanding of projective geometry
- Ability to work with versioning tools such as SVN / GIT

References

Foxlin et al. "FlightTracker: A Novel Optical/Inertial Tracker for Cockpit Enhanced Vision". International Symposium on Mixed and Augmented Reality. 2009.

Lang, Pinz. "Calibration of hybrid vision/inertial tracking systems". Workshop on Integration of Vision and Inertial Sensors. 2005.

Parnian, Golnaraghi. "Integration of vision and inertial sensors for industrial tools tracking". Sensor Review. 2007.

Ren, Kazanzides. "A Paired-Orientation Alignment Problem in a Hybrid Tracking System for Computer Assisted Surgery". Journal of Intelligent & Robotic Systems. 2010.

Ren, Kazanzides. "Investigation of Attitude Tracking Using an Integrated Inertial and Magnetic Navigation System for Hand-Held Surgical Instruments". Transactions on Mechatronics. 2012.