

Optical Tracking System for Medical Procedural Simulator

Project Management and Software Development
for Medical Applications

Contact Partner

Benjamin Busam
b.busam@framos.com

Project Abstract

The goal of the project is to design and to develop an optical tracking system, which will be integrated into a virtual reality (VR) medical simulation environment. The optimal tracking geometry has to be determined and approaches for instrument identification have to be validated.

Background and Motivation

Simulation-based training enables medical residents and surgeons to conduct complex procedures before the treatment of patients. They learn in a safe, virtual environment how to use medical imaging and how to perform a procedure with real medical instruments.

One of the challenges of the VR simulation is the integration of flexible instruments. Furthermore multiple instruments are normally used during a procedure. Thus it is necessary to track and to recognize these instruments in order to provide haptic sensation and simulated medical imaging.

The cooperation partners of the project are MEDABILITY and FRAMOS. MEDABILITY has its expertise in the field of simulation solutions for medical education. Therefore it provides a simulation setup consisting of two haptic-devices, a C-arm control unit, a foot pedal, and medical instruments (see Fig.1). FRAMOS as imaging system expert gives

advice on the optical tracking system (OTS) e.g. the choice of appropriate hardware, stereo geometry setup and instrument identification approaches.



Fig. 1: Simulation setup

FRAMOS and MEDABILITY want to develop together a system prototype that is capable of automatic identification and tracking of medical instruments which are used during minimally-invasive surgeries e.g. radiofrequency (RF) tumor ablation or implant insertion, in order to simulate X-ray imaging showing the instrument in use at the correct position with its current shape.



Student's Tasks Description

After understanding the practical needs of such a medical demonstrator, the first requirement for the project is to define the functional specification for the prototype.

Secondly, the vision components of a hardware prototype are designed and a solution to the specified setup is developed.

First tests with rigid medical instruments validate the system before the student develops an image processing pipeline for the tracking of the flexible tool tip which needs to be implemented and tested. An existing OpenIGTLink interface via TCP/IP enables the communication with the optical tracking system that collects 6D pose data.

Finally this prototype is tested in a predefined test scenario. The results are evaluated and graphically illustrated.

Outcome

The expected outcome is a system prototype integrating the FRAMOS OTS with a software module that can identify and track various instruments and their rigid and flexible tips while using the MEDABILITY framework for the visualization and the haptic feedback.

Acquired knowledge

In this project the student gains knowledge in optical tracking systems for non-rigid objects and their use in VR simulations. Additionally, the student is able to understand and implement a pose estimation algorithm and use a calibration pipeline. Furthermore the implementation of an industrial API and a medical communication interface is learnt while the student organizes different software elements which are integrated into a bigger software framework. She/he learns medical terminology and benefits of interdisciplinary work with industrial designers, medical experts and hard-/software engineers. Moreover, the continuous coordination with MEDABILITY and FRAMOS gives some insight into the working procedures in the industry.

Technical Prerequisites

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

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

- Basic knowledge of OpenGL
- Basic knowledge of Qt
- Non-rigid object tracking expertise
- Some basic understanding of projective geometry
- Ability to work with versioning tools such as GIT

References

Du, Xiaofei et al. "Combined 2D and 3D tracking of surgical instruments". IJCARS 2016.

Wen, Longyin et al. "JOTS: Joint Online Tracking and Segmentation". CVPR 2015.

Duffner, Stefan et al. "PixelTrack: a fast adaptive algorithm for tracking non-rigid objects". ICCV 2013.