



## **BA/FA/MA: Indoor localization with fiducial markers**

**Description:** Indoor localization has seen an emerging interest over the last years. As Global Navigation Satellite System (GNSS) signals cannot be used indoors, dedicated systems have to be deployed for indoor localization.

Camera-based localization approaches can achieve high accuracy at low system cost by making use of cheap cameras with high resolution in combination with fiducial markers as passive reference points. These markers can be printed on a piece of paper and allow for marker identification by marker encodings. Such systems can therefore be scaled to large areas with only minor increase in system complexity. They have further shown to achieve centimeter or even sub-centimeter localization accuracy under ideal conditions.

The goal of this thesis is the development and refinement of a fiducial marker based indoor localization system using a low-cost camera. The developed system further represents a potential reference system for a radar-based indoor localization system for mobile robots currently developed at the ISS.

### **Work package: (Scope depends on thesis type (BA/FA/MA))**

- Literature study of fiducial marker localization systems.
- Selection of a suitable fiducial marker system (e.g. ArUco & OpenCV) based on a set of to be defined metrics (accuracy, ease of use etc.)
- Accurate installation of the markers in our test lab. Different setups (marker locations, marker sizes, camera parameters etc.) can be evaluated.
- Development of an algorithm that detects, identifies and estimates the poses of the visible markers in the room.
- Development of an algorithm that uses the detected markers to estimate the camera pose.
- Evaluation of the system by comparing camera and marker pose estimates with collected ground truth.
- (Optional: Evaluation of the applicability of the proposed fiducial marker system as a reference system for a currently developed radar-based indoor localization system at the ISS).

### **Prerequisites:**

- Interest in the topic and ability to work independently
- Advanced mathematics
- Image processing basics
- Ideally participation in new „Advanced Visual Processing“ course
- Programming experience (likely Python or C++, depending on chosen marker system)