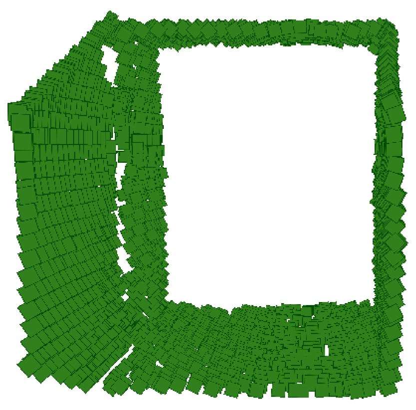
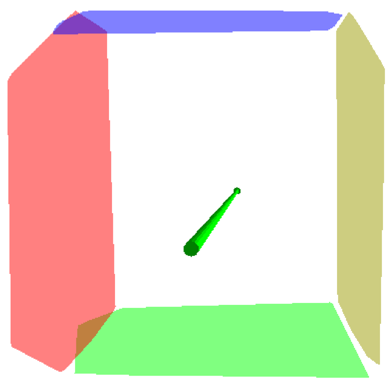
Department of Electrical Engineering and Information Technology

process automation

Sven Lange, Niko Sünderhauf, Peer Neubert, Sebastian Drews, Peter Protzel

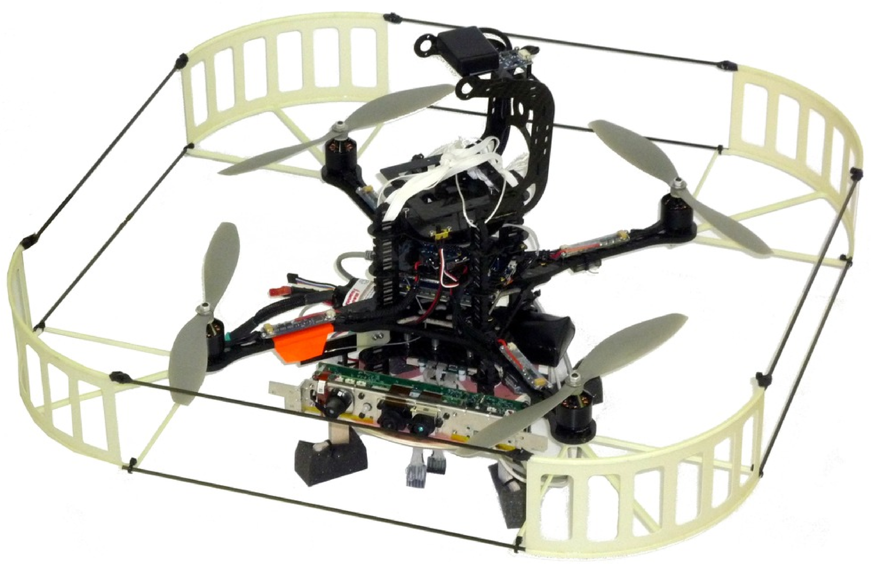




Autonomous Corridor Flight of a UAV Using an RGB-D Camera

System Overview

We describe the first application of the novel Kinect RGB-D sensor on a fully autonomous quadrotor UAV.
We apply the UAV in an indoor corridor scenario. The position and orientation of the UAV inside the corridor is extracted from the RGB-D data. Subsequent controllers for altitude, position, velocity, and heading enable the UAV to autonomously operate in this indoor environment.



The UAV we use in our project is a Pelican system that is manufactured by Ascending Technologies. We extended the UAV's configuration and equipped the quadrocopter with additional hardware: An SRF10 sonar sensor measures the altitude, an ADNS-3080 optical flow sensor board provides information on the current velocity. Altitude, velocity and position are controlled using cascaded PID controllers that are implemented on an ATmega644P. The Kinect RGB-D device is connected to the onboard embedded PC system and interfaced using ROS.

CHEMNITZ UNIVERSITY OF TECHNOLOGY

Autonomous Corridor Flight Using the Kinect Device

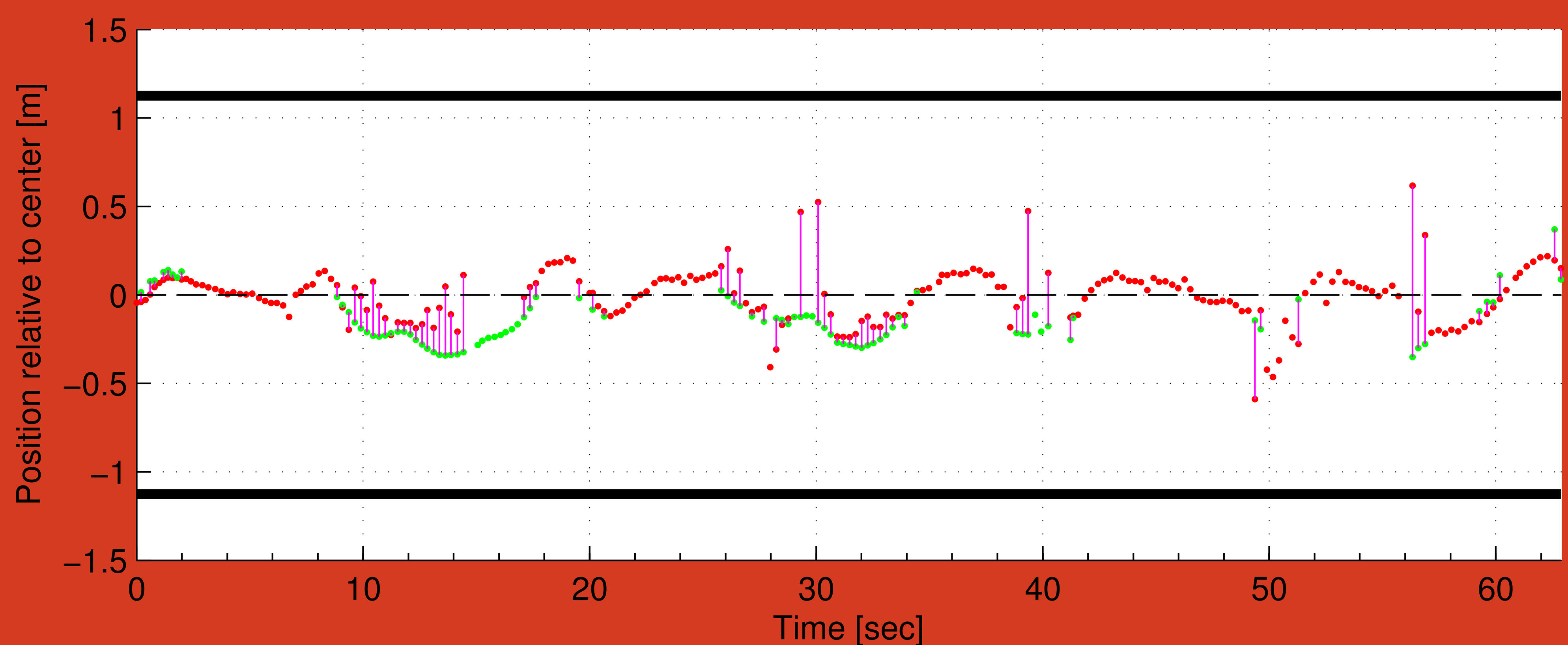
The Kinect driver of ROS provides a 640×480 3D point cloud that is downsampled (thinned) to approximately 3,000 points for further processing. For performance reasons, we implemented a specialized downsampling algorithm that runs five times faster compared to the function provided by the Point Cloud Library.
After downsampling, large planar sections are found in the remaining points by applying a sample consensus (MLESAC) based parameter estimation algorithm. The Point Cloud Library already provides convenient algorithms that extract the planes in their parameter form.

Given these parameters, the distances from the UAV to the walls and their orientations are calculated. To keep the UAV aligned with the corridor and in the center of the corridor, motion commands are generated from the plane distances and the yaw estimates. Weight factors are used to ensure that those walls that were supported by more scan points during the plane extraction have a stronger influence on the resulting motion command.

Results

The figure below shows the position estimates inside the corridor while performing autonomous flight. According to these internal measurements, the maximum deviation from the corridor center was 35 cm.

The source code for efficient point cloud downsampling and trajectory generation is available to the community as part of our ROS repository at http://www.ros.org/wiki/tuc-ros-pkg.



Department of Electrical Engineering and Information Technology • www.tu-chemnitz.de/etit/proaut • sven.lange@etit.tu-chemnitz.de