Research visit report - Mobilita 200

Viktor Walter

Multi-Robot Systems
Czech Technical University in Prague

January 29, 2018

From November 8 to December 8 I was visiting the Robotics and Interactions laboratory led by Antonio Franchi of the Laboratroy for Analysis and Achitecture of Systems (LAAS) in Toulouse, France. The goal of my stay in the insitution was to test out the precision and applicability of my system for detection and localization of unmanned aerial vehicles (UAVs) from physically filtered image of ultraviolet LEDs attached to said UAVs. The system is based on application of a camera with fisheye lens and a bandpass UV filter attached on the observer UAV. This camera, when correctly tuned, sees bright sources of ultraviolet light as white blotches on dark background, making it a lightweight and robust detector of artificial markers. This has been observed to make the aforementioned artificial UV markers easily distinguishable even outdoors during daylight. Additionally, I made the effort to obtain the specialized knowledge of the staff about ways to apply thus obtained position information in stabilization and building of multi-UAV formations.
The institution has provided me with access to their equipment - mainly their motion-capture system spanning large part of the interior - to measure the position of the observing camera and the object marked with the aforementioned UV LEDs. This allowed me to relate a range of values to the mutual distance of these locations on the fly, and thus to construct dense characteristics of these dependencies. The parameters measured were the angular precision of the estimated vector from camera center to a given UV LED, the precision of estimated distance of the object based on the interdistance of two such LEDs with known mutual distance but slightly ambiguous angle of their connecting line and also notably the size of the area of image affected by the LED. The latter information may eventually lead to the possibility of estimating the distance of the marker, despite the fact that the marker itself is practically a single point - due to the imperfections of the camera it is not displayed as such. Near the end of my stay, I managed to record datasets with real UAVs in flight, equipped with an array of UV LEDs. These will be later used for a more detailed analysis. In addition to these pre-planned activities, I have, after discussing the issue with the people in the institution, developed an advanced algorithm for tracking and frequency estimation of blinking light sources, based on specialized modification of the Hough transform. This algorithm makes it possible to distinguish individual blinking UV markers based on the frequency of this blinking, thus eliminating the problem of anonymity of the markers inherent to the near-binary image the camera produces. If the markers can be individually classified, then this vision system will also allow for classifying individual UAVs as well as for estimating their relative rotation with respect to the observer. These tests and especially the development involved would be impossible to perform without my visit of the institution, which would make the whole project difficult, imprecise and much more time consuming to work on.