Abstract

In this thesis, we focus on robots with a marsupial relationship that use computer vision as their main sensor. We focused our work on two separate projects.

In computer vision, drift is still a major drawback when using vision-based localisation methods. The first project of this thesis combines the position information from two Unmanned Ground Vehicles (UGV) to reduce this drift in GPS denied environments. We use the relative pose measurements between two robots in a similar way to loop-closure. The robots start at a neighbouring location and share a common field of view. The sharing of the information is done periodically. The pose of each robot is calculated using visual odometry. The relative position of the robots is calculated using both monocular and stereo image pairs, for initial estimation and refining respectively. We then formulated an algorithm to combine the visual odometry and relative pose estimations from one robot to another in a pose graph optimisation scheme to reduce the drift. We have conducted experiments on both simulations and real-life.

In our second project, we introduce two new methods that enabled us to autonomously take-off, track and precisely land with an Unmanned Aerial Vehicle (UAV) on a UGV using a dual monocular camera setup. In these methods, we used predefined markers to compute the relative position of the UAV from

the landing platform that is attached to the UGV. The cameras on the UAV have different focal lengths, which are providing better performance than using a single camera. We analysed and compared different markers and detectors pairs to achieve a reliable pose estimation. For a UAV, the most critical parts of the flight are take-off and landing, as this is the time most prone to crashes. We proposed a method, which we named as ”landing calibration”, that helped us to land at the precise position we want the UAV to land in a GPS denied environment. We verified each method with more than hundred real-world experiments.

Author's Publications

Patents:

Infinium Robotics Pte. Ltd. (Singapore), Autonomous Taking off, positioning and Landing of UAV on a Mobile Platform, 10201802386T, 2018, (Patent Pending)

Journal Papers:

1.Wang, H., Mou, W., Mou, X., Yuan, **S., Ulun**, S., Yang, S., Shin, B.-S.: An automatic self-calibration approach for wide baseline stereo cameras using sea surface images. *Unmanned Syst. 3, 277-290 (2015)*

Conference Papers and Workshops:

Wang, H., Mou, X., Mou, W., Yuan, **S., Ulun,** S., Yang, S., Shin, B.-S. "Vision based long range object detection and tracking for unmanned surface vehicle." in *Proceedings of the IEEE International Conference on CIS-RAM, Cambodia (2015)*

S. Ulun, H. Wang, "Reducing drift using visual information in a multi-robot scheme,"

in *13th International Conference on Control and Automation, ICCA 2017.*

S. Ulun, H. Wang, 'Combining visual odometry of multi-robot using UWB range information," in *Workshop on Multi-robot Perception-Driven Control and Planning, ICRA 2017.*