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Annotated Bibliography

1. Vishnu R. Desaraju, Nathan Michael, Martin Humenberger, Roland Brockers, Stephan Weiss and Larry Matthies. Vision-based Landing Site Evaluation and Trajectory Generation Toward Rooftop Landing. In *Proceedings of Robotics: Science and Systems*, 2014.

In this paper these doctors made a robot who was able to autonomously determine if a roof is fit for landing and then lands on it. This functionality is mainly used for military and spying purposes. The robot is told to monitor an object, it then autonomously finds an elevated position near the object and determines if that position is fit for landing before proceeding to land. It only uses a camera downward looking camera as well as two baseline cameras, and an IMU (internal measurement unit). The robot is able to get three different pictures of a landing area and it uses a dense motion stereo to build a 3D representation of that area. It then transforms this 3D map in image space to a spatially-varying conditional probability distribution via a Gaussian process. This gives the robot a confidence in its landing spot. This paper referenced my third paper on this list Autonomous Vision-based Landing and Terrain Mapping Using an MPC- controlled Unmanned Rotorcraft. This is a very important aspect of this problem. It describes methods for mapping a terrain, something that is essential to the original paper.

At this point this robot is not completely functional. All components are implemented but a complete outdoor testing of its perception and planning is yet to be done. Because the robot only looks at an area the size of the robot it could take a very long time to test outdoors and in turn would be very expensive. All tests run indoors with controlled parameters have been promising. The doctors plan on completing these tests soon. They also plan on adding functionality, giving the robot

the ability to land on more sophisticated surfaces.

2. Lionel Heng, Gim Hee Lee, and Marc Pollefeys. Self-Calibration and Visual SLAM with a Multi-Camera System on a Micro Aerial Vehicle. In *Proceedings of Robotics: Science and Systems*, 2014.

This paper details an aerial vehicle that uses multiple cameras to get a full awareness of its surroundings. Multiple cameras can give a robot a much better view of its surroundings. This is very important to my main paper. It was also able to use multiple cameras to build a 3D terrain map. This paper deals more with the calibration of the cameras. An accurate calibration is an essential prerequisite if vision-based localization and mapping is expected to provide reliable pose estimates for a micro aerial vehicle with a multi-camera system.

The authors of this paper came up with a SLAM based self-calibration method to keep track of an objects poses as it switches from camera to camera. They used there intrinsic camera calibration to compute the cameras pose with respect to the chessboard. They used this to obtain an initial guess of both the intrinsic cameras parameters and the transform between each camera and the MAV. They optimized these parameters and camera-MAV transforms via non-linear refinement. From pose and IMU measurements, they performed a hand-eye calibration to find a ground-truth estimate of the rotation between the MAV and the IMU, and thus, the camera-IMU transforms.

To test how accurate their method is, they had the robot track the pose of a chess board on the ground as well as the robot itself as it varied between different heights. Their SLAM-based self-calibration method produced accurate extrinsic calibrations for a MAV with multiple stereo cameras as long as there was a sufficient number of inter-camera feature correspondences. Through real-world experiments in indoor and outdoor environments, they demonstrated real-time on-board SLAM on a MAV with multiple cameras. The MAV was able to perform autonomous flight based on the pose estimates from SLAM. They plan

on adding capabilities such as dense mapping and 3D exploration to our MAV platform in future works.

3. T. Templeton, D. H. Shim, C. Geyer, and S. S. Sastry. Autonomous vision-based landing and terrain mapping using an MPC-controlled unmanned rotorcraft. In *Proc. of the IEEE Intl. Conf. on Robot. and Autom.*, pages 1349 1356, 2007.

This paper also deals with terrain mapping for an aerial vehicle except this robot only uses one camera, compared to the multiple camera systems of the other two papers. It is essential for an intelligent aerial vehicle to be able to autonomously locate, and then land at, a suitable landing site. This was something that was essential to both other papers. It was referenced by Vision-based Landing Site Evaluation and Trajectory Generation Toward Rooftop Landing. The things accomplished in this study laid the framework for the other two papers to accomplish what they wanted to do.

The vision landing problem was tested in many previous research projects, but many of them required an easily-recognizable landing target. This paper, however, created a robot that found a flat surface that was suitable to land on. They were able to do this by using Geyer et al.s Recursive Multi-Frame Planar Parallax algorithm (RMFPP), which accurately estimates 3D structures using georeferenced images from a single camera.

They tested this by reconstructing a terrain using an experimental aerial imagery that was geo-registered offline and then processed using the RMFPP algorithm in real time on hardware similar to that in the vehicle vision computer. They concluded that the RMFPP algorithm required higher camera localization accuracy than they were able to achieve using existing algorithms, but they were able to show accurate results for other components of the vision system when the camera localization was computed offline. Their flight control algorithm showed to be a viable approach for producing plausible trajectories in real time

using the identified vehicle model.