Placeholder

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Abstract

An abstract.

1 Introduction

Micro aerial vehicles (MAV's) which include quadrotor and unmanned aerial vehicles (UAV's) have the potential to become more prominent over the next several years. These aircraft allow easy access for many places which are difficult for humans to go in a safer manner for both humans and the environment and have applications reaching into search and rescue, tracking, mapping, and others. In order for the higher level tasks to be handled these vehicles must have a reliable navigation system.

There are GPS solutions for navigation work out of the box (e.g. the AscTec series of quadrotors), but are limited in use to locations where GPS is available. While much progress has been made to solve to create a navigation solution for these cases, we still strive to have a system that works in unknown, GPS denied, and cluttered environments. As many MAV's are limited in both carrying capacity and power, laser range finders are too heavy and consume too much power to be of use. Stereo camera's become highly inaccurate after a set distance rendering them of no more use than using a single camera.

The common structure from motion approach to visual navigation using a single camera has been shown to suffer from some drawbacks. In order to generate a 3D map, two types of camera translation may be necessary [Shah et al. 2010]. While a quadrotor may be capable of such a maneuver, a UAV is not. In [Shah and Johnson 2009] the amount of computation required using this approach increased by about 15 times with only an increase from 8 to 35 feature points, and the number of features in a real scene can number in the hundreds or thousands.

As an attempt to solve this problem [Lee et al. 2011] proposed an approach to reduce the number of points required to represent the 3D structure of a scene. The authors used multiscale oriented patches (MOPS) [Brown et al. 2005] to create outlines of objects. Since the outlines themselves are unable to tell if an outline is empty or not, they used the 3D location of SIFT features [Lowe 2004] located within the outlines to obtain this information.

Although the proposed method cited collision avoidance for a quadrotor as its intended application, the authors did not dispense any data on its effectiveness in real scenes from images taken using a quadrotor. This paper provides just such an evaluation using images taken from the AR-Drone 2.0 quadrotor with the processing being performed on a laptop connecting to the quadrotor using a wireless network. In addition, we evaluate the use of the parallel tracking and mapping (PTAM) [Klein and Murray 2007] approach that was adapted as an online solution for quadrotors in [Weiss et al. 2011].

2 Related Work

Due to weight and energy restrictions aboard MAV's a vision based approach is seen as one of the most viable navigation solutions in GPS denied environments. Progress in using visual senors for navigation purposes include performing specific tasks such as in [Johnson et al. 2005] where a single camera was used to guide and land a MAV, or [Huang et al. 2011] where an RGB-D camera was used to map an environment and localize a quadrotor within that map but is restricted for use in indoor environments.

Another common approach in the literature uses optical flow to estimate the relative motion between the frames of a camera. In these systems one is able to detect collisions by measuring the relative rate of expansion of objects. This method behaves poorly when light intensity doesn't remain constant [Horn and Schunck 1981] and tends to be sensitive to noise and an unstable camera. As all MAV's will contribute to some vibrations in the camera, this leads to inaccurate estimates in flow vectors.

Some recent work attempts to use image segmentation to identify an obstacle and build a dense map around it [Ha and Sattigeri 2012]. This approach shares some motivations as the first method attempted in this work in that it attempts to reduce the number of computations required for navigation by using a limited number of feature points. As with [Lee et al. 2011], the approach has only be evaluated in theory. The authors note that in some cases image segmentation is not possible and intend to evaluate and extend their work to ascertain any benefits it may have.

3 Approach

4 Experiments

5 Analysis

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