UAV Navigation using Camera

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Introduction

The goal of the project is to navigate through a room using augmented reality (AR) markers to know the position of the unmanned aerial vehicle (UAV) and detect landing platforms to land on them. The research is mainly focused on visual servoing of the UAV to navigate and perform proper landings.

ROS

Robot Operating System (ROS) is an open source software framework for robot software development by Willow Garage. Here are a few features:

- Hardware abstraction
- Message passing between process
- Package management

Visual Servoing

Visual Servoing is the technique which uses feedback information extracted from a vision sensor to control the motion of the robot. Two web-cams are used to get the feedback. With the help of ARToolKit, it is possible to get the position and orientation of the web-cam with respect to a target marker.

Fish-eye lens

Due to the limited area of view of the web-cams, fish-eye lens are attached to have a wider view.

Undistortion

- Calibrate camera
- Tune camara matrix and distortion coefficients
- Undistort image

Normal Lens

Fish-eye Lens

200% of image
with normal lens

Rectified
Fish-eye Lens

180% of image
with normal lens

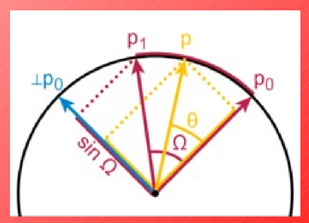
Exponential Weighted Moving Average

A filter is implemented since the position of a marker can be incorrect for a frame and for the movements to be smoother. We want to eliminate all the noise.

$$S_t = Y_t * \alpha + S_{t-1} * (1 - \alpha)$$

Slerp

Shperical linear interpolation is used for the orientation filter, is also used as an exponential weighted moving average.



Navigation

With the position of the markers, using transforms, we can easily calculate the goals desired depending on the marker we see and with which camera sees it.

Results

At first, the calibration for the fish-eye lens was not really good, and the positions and orientations of the marker were not precise and used to moved a lot. After, adjusting the camera properties and distortion coefficients the marker tracking improved in consistency.

The visual part was successfully done and the markers were displayed in the correct place, the navigations goals were also given correctly.

Conclusion

This research is useful for navigation and objection recognition. The AR markers could be put in walls or objects to get their locations.

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