mAEwing1 Camera Calibration Technique

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Introduction

This document describes how the camera system mounted to the mAEWing1 series aircraft was calibrated for intrinsic parameters such as lens distortion. A Mobius action cam is used on these aircraft.

Method

1. A checker board pattern with known "checker square" size was created. In our case we used square sizes of 1.5 inches, in a 7 by 9 square pattern.
2. The video camera was set to its inflight settings. In our case this was .MOV file type, high video data rate, wide dynamic range on, field of view narrow, resolution 1280x720 (720p), 60 frames per second, and time lapse off.
3. The checker board pattern was attached to a flat rigid plate.
4. The winglet was removed.
5. The camera was turned on to its inflight video capture mode.
6. The checker board was then held at various positions and angles with respect to the camera. These positions included all of the checker board in the video frame. i.e. the whole checker board pattern was always captured in the video taken. These positions were as close to the actual winglet position as possible to ensure proper application.
7. After the videos were captured the video was transferred to a computer with MATLAB.
8. The video was then run through the MATLAB script frameRIPPER.m. This script takes every individual video frame and saves it as .png file.
9. The image files were then sorted through to find the best stills (not blurry from motion, etc.) that included the whole checker board.
10. The selected stills(images) were then imported to MATLAB's camera calibrator app. In our case the following parameters were chosen to be evaluated: 2 coefficients, skew, and tangential distortion.
11. The calibration was then run.
12. After the results are found from the application, the images with the most "reprojection errors" were removed as they didn't allow for the most accurate calibration.
13. After the bad images were removed, the calibration is run again and the parameters are exported to the MATLAB workspace. The workspace is then saved as CameraParameters.mat.

Parameters

Coefficients: this parameter is to correct for radial distortion. Which occurs when light rays bend more near the edges of a lens then at the optical center. Generally the smaller the lens the greater the distortion. 3 coefficients are generally used in the case where sever distortion is present, such as a wide angle lens.

Skew: This is a correction for the case where the cameras x and y axis are not perfectly perpendicular to each other. Most of the time this parameter is not significant.

Tangential Distortion: tangential distortion occurs when the image plane and the lens are not parallel. This parameter corrects for that.

Additional details are included in *cameraParameters class.pdf*

Application

The found camera parameters can be used to undistort the video frames, which ideally would minimize error caused by the lens distortion. This can be done using functions in the MATLAB computer vision, and image processing tool boxes. In our case we used a MATLAB script called UndistortVideo.m. This script reads in a video file frame by frame and calls the undistortImage function, from the tool boxes previously mention, to apply the camera parameters and correct the image. Once this is complete the video can be analyzed for inflight data.

See Also

MATLAB/Simulink video for camera calibration:

http://www.mathworks.com/videos/camera-calibration-with-matlab-81233.html

Mathworks documentation:

http://www.mathworks.com/help/vision/camera-calibration.html