ROBUST ATTITUDE STABILISATION OF A TRACK FOLLOWER MICRO AERIAL VEHICLE USING A VISION-BASED SENSOR

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Autonomous track follower Micro Aerial Vehicles (MAVs) have been considered by researchers for the past few years. Recently there are many studies on achieving a stable and reliable MAV flight to perform accurate missions with high performance. Since human access is highly restricted in harsh environments, conventional navigation systems are not able to complete many of the required tasks. Track follower MAVs are implemented to many applications such as water channels [1] and railways [2] inspections and etc. Here, we propose a line following method and compare two attitude controllers. The aforementioned line following method can be divided into three tasks: 1) image processing algorithm, 2) path planning strategy and 3) attitude stabilisation. The environment under study contains a ground floor with predetermined red tracks in which MAV is allowed to move on. Next, we explain each task briefly.

1. Image Processing

First, a colour detection algorithm is applied to form a thresholded image. Then to make the image smoother and to reduce noise effects, a Dilation algorithms is applied (Fig. 1.b). Thereafter, the edge of tracks in thresholded image is extracted using the Sobel algorithm (Fig. 1.c). Next, Hough Transform and "*Hough peaks*" algorithms are employed to detect the side lines of the tracks (Fig. 1.d). In the next step, the dominant side lines in the previous step are extracted for each side of the track based on their orientations (Fig. 1.e). Then desired lines can be easily found by averaging the side line parameters (Fig. 1.f). Finally the intersections of desired lines and image boundaries tend to provide p_1, p_2, p_3 and p_4 points in the image frame which can be useful for path planning (Fig. 1.f).

2. Path Planning

The intersections of desired lines and image boundaries in pervious section indicate the correct target. The methodology for selecting the appropriate point is to filter out some points that do not contain any filled pixels in the binary image (Fig. 1.b).

3. Attitude Controller Design

Two controllers are considered to stabilise the attitude of the MAV. First, a linear Proportional-Integral-Derivative (PID) controller is selected. Then, a robust nonlinear sliding mode controller is designed and its stability is guaranteed using the Lyapunov's direct method.

4. Simulation Results

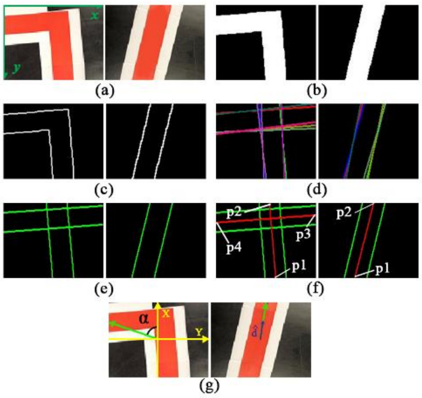

Fig. 1. Image processing and path planning

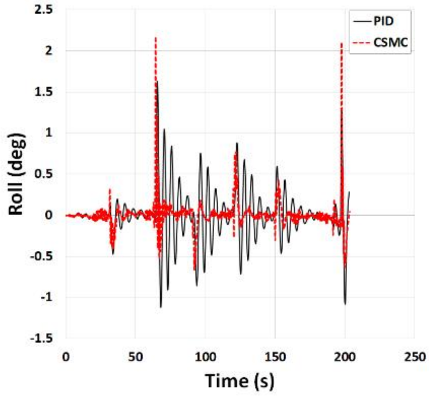

Fig.2 Time history of the roll angle

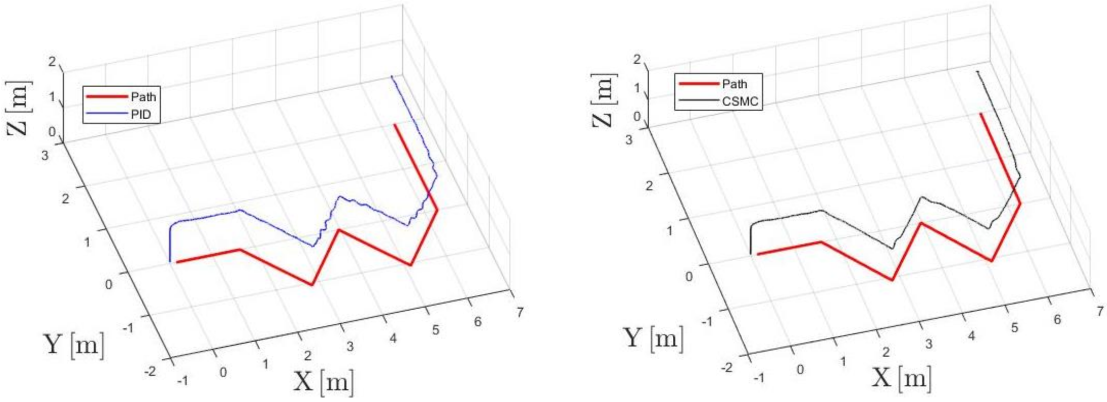

Fig. 3. System trajectory based on the linear PID and nonlinear conventional SMC algorithms

References:

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