Developing a Figure of Merit for Image Stability

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Introduction

This project is an industry-academia cooperation between Intuitive Aerial and LINK-SIC. Intuitive Aerial is a company that develops and manufactures advanced systems for camera stabilization and control.

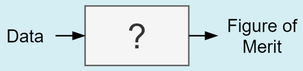
Newton

Intuitive Aerial's main product is a stabilized head called Newton that is used together with a camera to capture shake-free video footage. Newton has three motors attached to its arm that counteracts external disturbance and allows the camera to move around in all three rotational axes, called pan, tilt and roll.

Newton with a camera attached.

Problem description

The customers of Intuitive Aerial see Newton's stability as the most important performance parameter. To be able to verify this performance the task of this project is to develop a stability figure of merit (FOM) for the entire system and for each axis. It is also of interest to investigate if the FOM could be extracted from the camera rather than the inertial measurement unit (IMU), since camera footage is easier to access as of now.

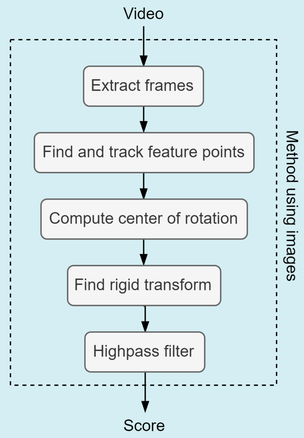


Method

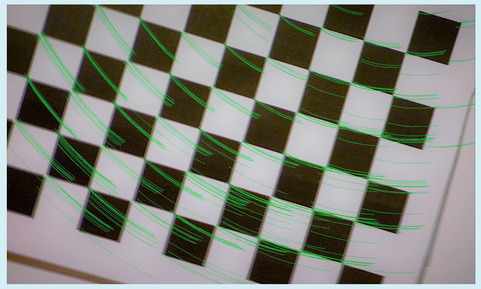
Two methods have been implemented to measure the stability performance of Newton. One method uses image data to evaluate the performance while the other uses IMU data.

FOM using images

This method finds feature points in a captured video and tracks them over time. The average trajectory of the points are high-pass filtered in order to separate intentional movements from disturbances. The filtered trajectory is then used to compute a final score and to find the axis with most disturbances.



A high-level abstraction of the method using images.



Tracked feature points during a rotational movement.

FOM using IMU

The method using data from the IMU is similar to the image method. However, since the angular velocities can be retrieved immediately from the gyroscope it is possible to directly use a high-pass filter. A final score is then computed in the same way as for the method using images.

Tests

Multiple tests have been designed and executed to validate and compare the methods. The tests are listed below.

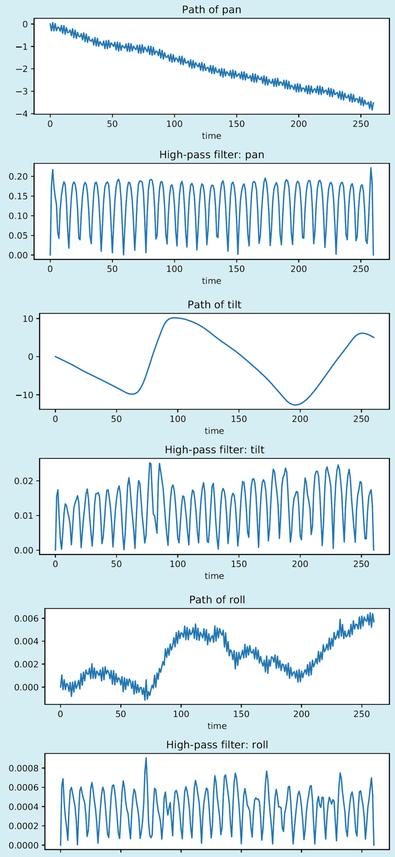
- Investigate repeatability
- Determine noise levels
- Detect disturbances
- Detect disturbances with intentional movements

The rig used during tests.

Results and Conclusion

Both methods agree on the stability of the different test runs. In addition, both methods are able to identify the axis with most disturbances but with different levels of confidence. Thus, the test results confirms our hypotheses and it can be concluded that image data is just as valid as IMU-data for measuring stability.

The following figures illustrate the outputs from a test run.



Plots from the method using image data when there are vibrations in pan and intentional movements in tilt. The percentage contribution for each axis according to method: Pan 91.4 % , Tilt - 5.2 %, Roll - 3.4 %.

Acknowledgements

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