WS 2016-2017, SGM, CSE minor, DISAL SP-95 | Project Summary

Experimental Validation of a Sense and Avoid System for Unmanned Aerial Vehicles

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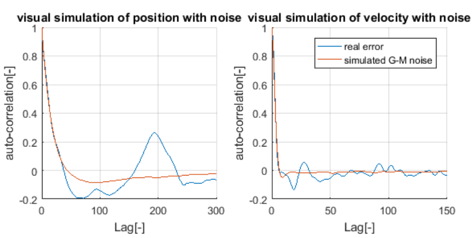
Recently, the rapid development of Unmanned Aerial Vehicles (UAVs) makes it possible to be utilized for numerous areas. Fully autonomous UAVs are required to further reduce the difficulty for manipulation. Several sense and avoid systems, which allow the UAV to sense, detect, track and avoid another UAV safely using only on-board sensors, have been developed in the Distributed Intelligent Systems and Algorithms Laboratory (DISAL) at EPFL. Performance of the on-board sensor system impacts the performance of the avoidance algorithm, in particular safety. In order to validate the on-board sensor system, experiments need to be carried out.

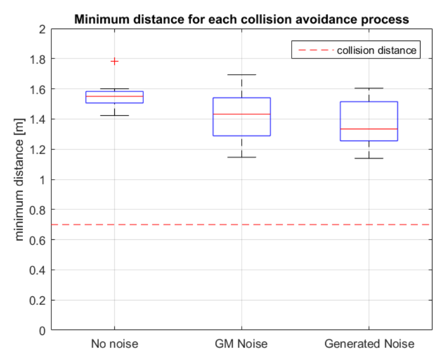
This project was actually driven by three objectives. The first objective was to study the characteristics of the on-board sensor system from data acquired in previous experiment. The characteristic chosen was the error between the ground truth and the on-board sensor data, because it impacts the performance of the avoidance algorithm in safety aspects. The analysis is done with three sensor related coordinate systems.



The autocorrelation of the error from the real experiment and the noise generated by the Gauss-Markov model

The second objective was to emulate the on-board sensor using ground truth data. In this part four types of error modeling methods were tried to simulate the on-board sensor error. Three of them failed to capture the characteristics of the sensor's noise. The on-board sensor error is not simply linear related to the sensor-orientated position or velocity. Meanwhile, the random part of the on-board sensor error is of great importance. The final model utilized was the Gauss-Markov Model with both the dynamic part and Gaussian noise part. Both first order and second order Gauss-Markov model were identified and realized as the suitable model. The second order Gauss-Markov model was utilized for the experiments.

Two experiments were executed for the third objective to validate the error model and the reliability of the algorithm SAVO as the third objective. The first experiment validated that the GM model could be utilized for simulating the sensor error. The second experiment was done for three group of model with different noise level. It validated that the collision avoidance algorithm in \cite{chong2003} is still reliable with uniform or sensor noise. The model with less noise had better performance in safety level and the energy consumption.



The minimum distance between the two quadcoptors

Interesting phenomenons are also found during the experiment. For example, the safeness performance (the minimum distance between UAVs) of the collision avoidance system is related to the sensor noise level and the directionality of the noise distribution. It can be an interesting direction for further research.