Building a UAV Flight Data Set

Bachelor Thesis

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Context

Unmanned Aerial Vehicles (UAVs) are operated in different use cases, such as transporting packages or monitoring an area. In the near future, UAVs will perform their missions completely autonomously. We, thus, need to ensure that these systems behave safely and do not harm anybody or anything while operating. For testing the safe behavior of autonomous systems, scenario-based testing [1, 2] is often used. In this approach, the UAV is tested in typical situations that it might encounter, e.g., transporting a package to a destination point while encountering two static obstacles.
For testing the UAV in these so-called logical scenarios, we first need to derive those logical scenarios. They can either be created manually based on mental models of experts or literature or automatically by clustering collected flight data. As a first step towards automatically deriving logical scenarios, a framework for generating such a data set of collected flight data is needed. As a source of inspiration, a framework for generating "good" test cases for testing the safe behavior of UAVs in a few specific logical scenarios is provided. This framework uses Gazebo [3] as a simulation environment for testing the safe behavior of the open-source flight control system PX4 [4].

Goal

The goal of this thesis is to build a framework that generates versatile simulated flight data of UAVs. In a first step, data sets about UAV's flight data in the literature are explored. Then, manually derived logical scenarios and parameters of the UAV to log are carefully selected for generating various concrete scenarios to include in the data set. On this basis, an easily extendable framework for generating a data set of collected flight data with derived labels will be implemented.

Working Plan

1. Familiarize yourself with the idea of testing the safe behavior of UAVs with scenario-based testing, the simulation framework Gazebo, and the flight control system PX4.
2. Investigate data sets in the literature that include collected flight data and discuss their advantages and shortcomings.
3. Identify the UAV's parameters to log for generating the data sets as well as manually derived logical scenarios to base your implementation on.
4. Implement an extensible framework for building a UAV flight data set.
5. Record your literature results, design decisions, implementation, and application results in form of a thesis.

Deliverables

- Source code of the implementation.
- Technical report with comprehensive documentation of the implementation, i.e., design decision, architecture description, API description, and usage instructions.
- Final thesis report written in conformance with TUM guidelines.

Application for Thesis

Please apply for this thesis topic with your CV, grade report, and a short motivation, why you are interested in this topic. Based on these documents, we will invite some students for a personal meeting to see if the topic fits the student.

Please note that the student working on this thesis needs to have access to a Linux-based operating system (provided framework works on Ubuntu 18.04) to execute the simulation environment.

References

[1] J. Cem Kaner, “An introduction to scenario testing,” Florida Institute of Technology, Melbourne, pp. 1–13, 2013.

[2] T. Menzel, G. Bagschik, and M. Maurer, “Scenarios for development, test and validation of automated vehicles,” in 2018 IEEE Intelligent Vehicles Symposium (IV). IEEE, 2018, pp. 1821–1827.

[3] N. Koenig and A. Howard, “Design and use paradigms for gazebo, an open-source multi-robot simulator,” in IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), vol. 3, 2004, pp. 2149–2154.

[4] L. Meier, D. Honegger, and M. Pollefeys, “Px4: A node-based multithreaded open source robotics framework for deeply embedded platforms,” in IEEE International Conference on Robotics and Automation (ICRA). IEEE, 2015, pp. 6235–6240.

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