A General Method for Controlling Aircraft in Simulations with Minimal Tuning

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With the recent push towards sustainable aviation, novel aircraft designs are being researched rapidly. Simulation is a key part of this research for evaluating different designs. This thesis presents a method for controlling general aircraft within a simulation that controls all aircraft equivalently with almost no tuning. This greatly reduces the work needed to simulate and compare new designs.

Suppose you want to design a new aircraft and have a number of different proposed propulsion systems, the same with different proposed wing designs, cargo and fuel solutions. In the search for the most promising combination of these parts, a huge number of simulations need to be performed to evaluate their performance. The traditional way to perform these simulations is to decide one or more missions you want the aircraft to fly (descriptions of how the aircraft should fly, e.g. at a specific altitude and speed). Then create a model of the aircraft, design and tune a control system for it and finally simulate the mission.

The third step, designing and tuning a control system, is incredibly tedious if there are many different simulations to do (or combinations of parts to try). This thesis presents an alternative way to perform these simulations, where the method of feedback linearization is employed. Feedback linearization works by inverting the aircraft model to calculate what the required input is to achieve a certain desired derivative of the output. This could for example be to calculate what the throttle position should be to achieve a certain acceleration. By controlling the desired derivative the system is effectively linearized, allowing for use of a very simple controller to determine what the desired derivative should be (desired acceleration in the example above). This enables a user to control all parametrizations of aircraft, meaning all combinations of parts, in a simulation equivalently without having to tune the controller for the specific parametrization. A mission can thus be simulated easily for a wide range of different aircraft, reducing the amount of work needed to compare them greatly.

The method was found to work well for simple test cases with some important simplifications and limitations. Getting it to simulate required some work which limits the usefulness if the work is simply shifted to somewhere else, but once done all simulations are significantly easier to perform. In future work the method could be investigated for controlling more advanced aircraft models.