Aircraft Control Toolbox

The Aircraft Control Toolbox, for use with MATLAB®, provides you with all of the tools needed to design and test control systems for aircraft – all within the MATLAB environment. The toolbox is used worldwide by leading research and industrial organizations. The newest version brings many exciting features, including sophisticated performance and analysis tools for gas turbine engines, and modeling, design and simulation tools for airships.

Features

The Aircraft Control Toolbox provides a comprehensive set of functions for the design, simulation, and analysis of aircraft models and their control systems. Specific features include:

- Aircraft dynamics modeling including flexibility, actuator, sensor and engine dynamics, and the effects of added mass and inertia for buoyant vehicles.

- Non-linear models for military and commercial aircraft, including subsonic and supersonic aircraft with all data contained in a convenient database format.

- Aircraft control system design and analysis including classical, eigenstructure assignment, output feedback and many other design methodologies.

- Environmental modeling, including the standard atmosphere, a steady-state horizontal wind model, and a transient wind-gust model.

- Dynamic models and performance analysis tools for gas turbine engines

- Suite of design, modeling, simulation and analysis tools for airships.

Every function is fully documented. Descriptions of the inputs and outputs are provided, along with examples for proper usage. References to relevant textbooks, papers, and websites or included throughout. Most functions include built-in demos, which automatically produce illustrative plots. In addition, a powerful *FileHelp* system is provided with the toolbox – it enables you to search all function titles and headers for keywords so that you may navigate the depth of the toolbox with ease.

Prototype Systems Quickly

The Aircraft Control Toolbox allows you to design and test control systems in a matter of hours, not days or weeks. You can simulate any kind of aircraft. Changes are easy to make and you have excellent visibility into the resulting software. Prototyping your control systems and simulation models will reduce both development time and cost. MATLAB frees you from the expensive edit/compile/link cycle because it is interpretive and fully interactive.

Controller Design

The toolbox provides a variety of control design tools including frequency domain, eigenstructure, output feedback and linear quadratic design functions. For example, the plot below shows longitudinal pitch pointing for a Control Configured Vehicle (CCV) type aircraft with a controller realized using eigenstructure assignment.
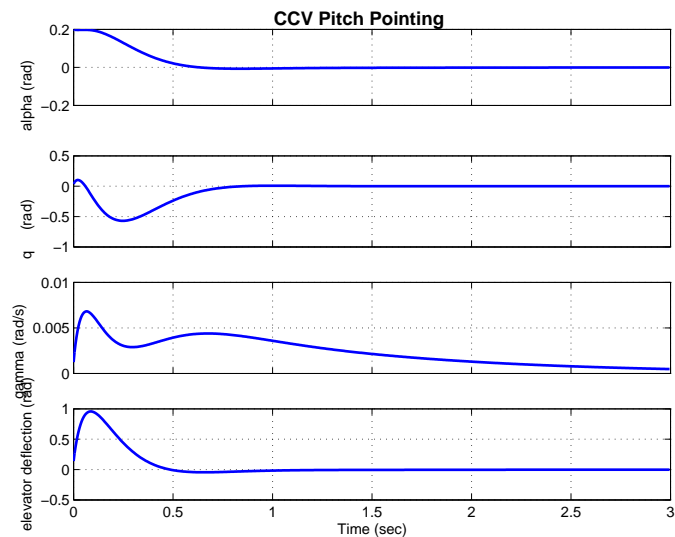

Gas Turbine Models

The toolbox now includes complete gas turbine analysis and performance tools. Models for ramjets, turbofans, turbojets and turboprops are included. These models can be used to generate performance information for aircraft simulations in the toolbox or independently for engine design and analysis.

Built-In Aircraft

The aerodynamic coefficients and general properties of several different aircraft are easily accessible to speed your design work. The following plot shows the x-axis aerodynamic force coefficient for the dynamic model of an F-16 obtained by typing `F16('cx coeff')`:
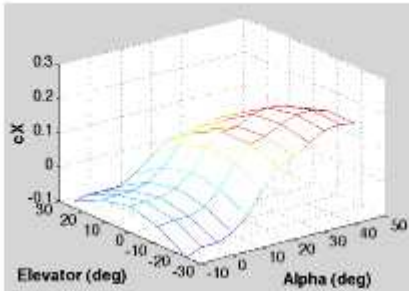

A linearized CCV type aircraft model is also included. Typing `CCV` will give you a plot of the eigenstructure, a singular value plot and step responses.

The eigenstructure plot provides a quick view of the level of interaction between the different states. Notice that each state is labeled, a feature of the toolbox's state space class.
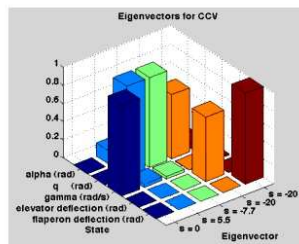
Airship Modeling

The toolbox includes a suite of modeling and analysis tools developed specifically for airships. In the plot below, a classic teardrop shape is approximated with a double-ellipsoid geometry for the hull.
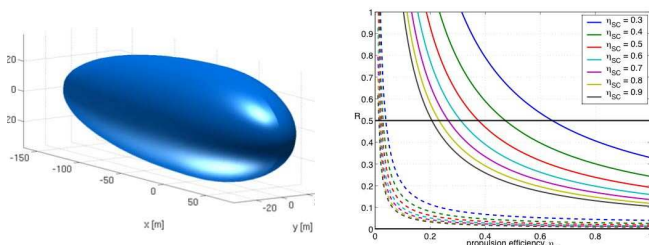

Static modeling tools in ACT are used to size the airship, using daily energy constraints and static buoyancy principles, assum-ing the airship draws all of its power from solar cells. The required solar cell coverage ratio is obtained as a function of the solar cell and propulsive efficiencies.

Graphics and Simulation

The toolbox allows you fly any of your designs using its graphical user interface. The interface is shown below. Using the controls, you can fly your aircraft like any other flight simulator. The nonlinear simulation allows you to add flexible aircraft components, sensor and actuator dynamics, engine dynamics and disturbance dynamics. States for inertia, mass and center-of-gravity are included for vehicles in which the mass properties change significantly. The simulation uses an ellipsoidal earth model so you can simulate aircraft from the ground up into space.
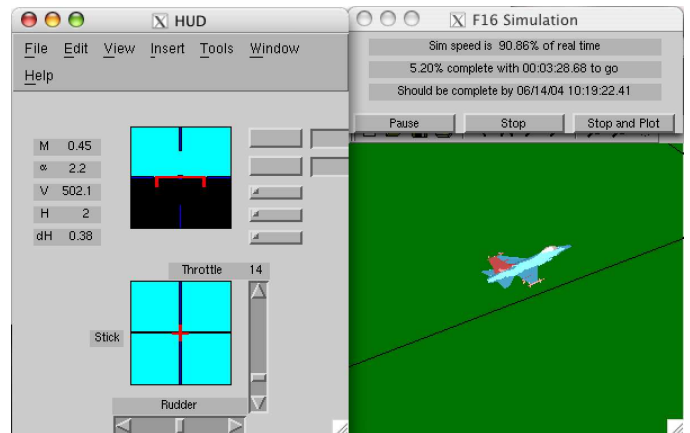
The simulation function also will automatically linearize the nonlinear dynamics and generate a state space model. In addition, a trimming algorithm is included which can trim the aircraft in a variety of flight modes.

Some recent enhancements have been made to the simulation engine. The effects of added mass and inertia may now be included. This is particularly important for buoyant vehicles, such as airships and balloons. In addition, the simulation has been further generalized to allow for a non-zero CG offset. This enables you to choose any point as the origin of the rigid body model.

Compatibility

The toolbox is compatible with MATLAB v5.2 through 7, Windows XP/NT/2000, UNIX, and MacOS.