AeroSim

Aeronautical Simulation Blockset for MATLAB

Overview

The AeroSim blockset provides a complete set of tools for developing nonlinear 6-degree-of-freedom aircraft dynamic models. The Simulink blocks include the nonlinear equations of motion, linear aerodynamics based on component build-up, piston-engine propulsion, aircraft inertia model including weight variation due to fuel consumption, atmosphere models including standard atmosphere, wind gusts and von Karman turbulence, Earth models which provide Earth radius, gravity and magnetic field components at current aircraft location. In addition the AeroSim blockset provides basic analog sensor and nonlinear actuator models, unit conversion blocks for translation between metric and English units, as well as transformations between various reference frames (wind, body, navigation and Earth-centered frame).

In addition to the individual blocks, several pre-built aircraft models are available, which can be customized through parameter files.

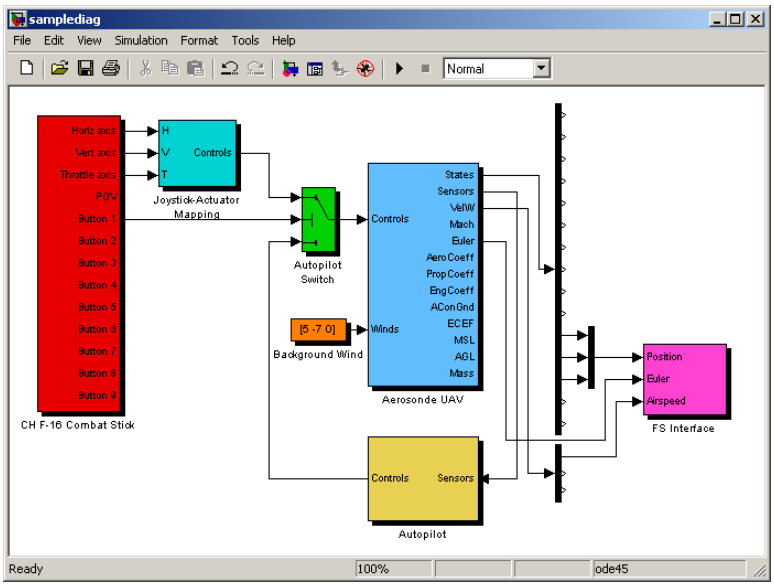
Since the AeroSim blockset components are built using only basic Simulink blocks and portable C code, you can use Real-Time Workshop* to automatically generate C code that can be included in hardware-in-loop simulation applications.

Aircraft Dynamics

The dynamics of the aircraft are described by the nonlinear 6-DOF equations of motion which are integrated forward in time. The attitude equations are implemented using Euler-Rodrigues quaternions for computational efficiency and to avoid gimbal lock. Blocks that compute the Euler angles and the Direction Cosine Matrix from quaternions are provided.

Pilot Interface

The Aerosim blockset provides blocks for reading joystick input in case manual flight is desired. For visual output of the aircraft behavior, you can use the Flight Simulator or the FlightGear output blocks which can send the aircraft state data to either Microsoft Flight Simulator or FlightGear Flight Simulator running on any computer on the local network. Running the aircraft model and the visual interface on separate computers provides a clear separation of processor resources for these two computationally-intensive applications.



KEY FEATURES

- Implements non-linear 6-degree-of-freedom aircraft dynamics.
- Provides linear aerodynamics, piston-engine propulsion, and time-varying inertia model which are fully-customizable; the model can also accept aerodynamic, propulsion and inertia from user-defined sources.
- Contains standard atmosphere model, background wind, wind shear and turbulence models.
- Provides detailed Earth models including WGS-84 geoid, EGM-96 geoid undulation, and WMM-2000 magnetic field model.
- Provides transformations to and from various reference frames including body axes, wind axes, navigation frame, and ECEF coordinates.
- Provides unit conversion blocks for common engineering units.
- Features pilot interface blocks for reading joystick input and for visual output in Microsoft Flight Simulator or FlightGear Flight Simulator running on any computer on the local network.

For visual output, aircraft states can be sent in real-time from the Simulink model to Microsoft Flight Simulator or FlightGear on any computer on the local network.

Unmanned Dynamics

Sample Models

The practical implementation examples provided with the AeroSim blockset include the Navion - a general-aviation airplane, and the Aerosonde UAV - a long-range weather-reconaisance autonomous airplane.

Atmosphere models

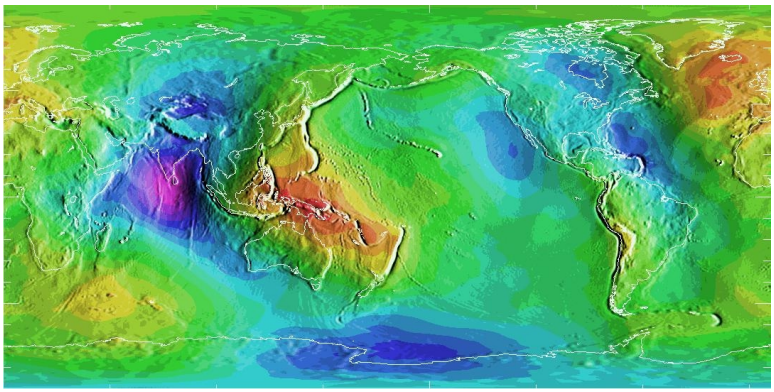
For simulating atmosphere effects the AeroSim blockset provides a Standard Atmosphere block, which outputs the static pressure, temperature, density and sound speed at current altitude (up to 86,000 m from sea-level). The simulated wind effects include background wind, wind shear, and a von Karman turbulence model.

Earth models

The Earth model blocks available in the AeroSim blockset include a WGS-84 geoid model which provides the local Earth meridian and normal radius for computing the aircraft latitude and longitude, as well as the local gravity vector.

In addition, the EGM-96 geoid undulation model provides the mean-sea level (MSL) altitude at current location - which can be used for simulated static pressure sensor output.

Finally, the WMM-2000 Earth magnetic model provides the magnetic field vector components at current aircraft location - which can be used for simulated 3-axis magnetometer output.



The EGM-96 Geoid Undulation Model provides the sea-level altitude with respect to the WGS-84 geoid.

Required Products

Matlab* 6 or later version
Simulink* 4 or later version

Optional Products

Microsoft Flight Simulator** 2000 or later version
FlightGear 0.7.9 or later version

Available Platforms

AeroSim Blockset for Windows - available now
AeroSim Blockset for Linux - available soon

Contact Information

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BLOCK REFERENCE

Actuators

1st-order and 2nd-order actuator models, D/A converter

Aerodynamics

Force and moment coefficients, dynamic pressure, wind-axes velocities, aerodynamic forces and moments

Atmosphere

Standard atmosphere, background wind, turbulence, wind shear, wind forces and moments

Earth

WGS-84 geoid, EGM-96 geoid undulation, WMM-2000 magnetic field model

Equations of Motion

Nonlinear 6-DOF force, moment, kinematic and navigation equations in body frame as well as in geodetic (navigation) frame

Inertia

Aircraft mass and moments of inertia, fuel flow rate integration, total airframe forces and moments

Math functions

Cross product, vector norm, angle bounds

Pilot Interface

Microsoft Flight Simulator output, FlightGear output, Joystick input

Propulsion

Fixed-pitch propeller, piston engine

Sensors

1st-order and 2nd-order sensor dynamics, A/D conversion, GPS position-velocity, noise correlations

Transformations

Earth-Centered Earth-Fixed position, Body-to-wind frame transformation, body-to-navigation frame transformation, Euler angle computation

Units

Distance, velocity, mass/weight, angle, angular rate

Complete Aircraft

Complete aircraft models configurable by parameter files