Development of a high-fidelity non-linear rotorcraft dynamics model using OpenModelica framework

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A rotorcraft platform (helicopter, quadrotor, etc.) is a complex system composed of several subsystems interacting with each other. The overall rotorcraft dynamic behavior depends on the dynamic behavior of the propulsion system, actuators, rotor blades, rotor hub, fuselage, etc.
In general, each subsystem is described by a set of non-linear dynamic equations making the overall rotorcraft dynamics highly non-linear and difficult to solve.

A common approach to rotorcraft dynamic modeling is to linearize the dynamic equations around an operating condition and solve the linearized modeling problem. However, such a model is only valid around the linearization point and not globally. It is highly beneficial to have a full non-linear dynamic model description of a rotorcraft platform for several reasons. First of all, a high fidelity simulator can be used for training purposes. A pilot can train risky maneuvers close to the platform flight envelope limits without risking the platform. In addition, a non-linear model can be used to test and validate the performance of an automatic control system (usually synthesized from a linearized model) in flight conditions that are far away from the design point.

The goal of this master thesis is to develop a high-fidelity non-linear rotorcraft dynamics model using OpenModelica framework for real-time usage under Linux on the LinkQuad platform - a Micro Air Vehicle quadrotor system shown above.

In general, the non-linear dynamic equations for the rotor blades, rotor hub, fuselage together with the aerodynamic rotor-blade airfoil characteristics are well known in implicit form. They are to be used in the OpenModelica framework to derive the non-linear rotorcraft dynamic model of the LinkQuad platform.

[1)] UAS Technologies Sweden AB - www.uastech.com

OpenModelica provides an open-source Modelica-based modeling and simulation environment intended for industrial and academic usage. OpenModelica, including the OpenModelica Compiler (OMC) of the Modelica language, is developed at PELAB, together with the Open Source Modelica Consortium (an international open source effort supported by 43 organizations, see www.openmodelica.org).

The master thesis project requires some knowledge of real-time systems, control, as well as some experience and interest in advanced programming.

[1] Principles of Object-Oriented Modeling and Simulation with Modelica.Published by Wiley-IEEE Press, 2003.

[2] Principles of Helicopter Aerodynamics (Cambridge Aerospace Series), J. Gordon Leishman, 2006

[1)] UAS Technologies Sweden AB - www.uastech.com