Modeling and Simulation of Liquid Propellant Rocket Engine Transient Performance Using Modelica

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Liquid propellant rocket engines are widely used and play a very important role in aerospace. This paper presents a liquid propellant rocket engine model library in Modelica language, which contains component models such as pipes, valves, tanks, turbo-pumps, combustion chambers, nozzles, injectors, gas generators, etc. The control equations of some most important components are given. We present the general method for applying the characteristics of Modelica to modeling procedure of LPRE. These component models can be applied to establish a variety of liquid rocket engine systems with the capability of predicting engine transient performance during startup, shutdown and regulation processes. Typical gas-pressurized liquid propellant engine system and turbo-pump liquid propellant engine system are modeled in the paper. Some simulations and analyses are performed to validate models qualitatively. All work is implemented in MWorks, which is a modeling and simulation platform that fully supports Modelica.
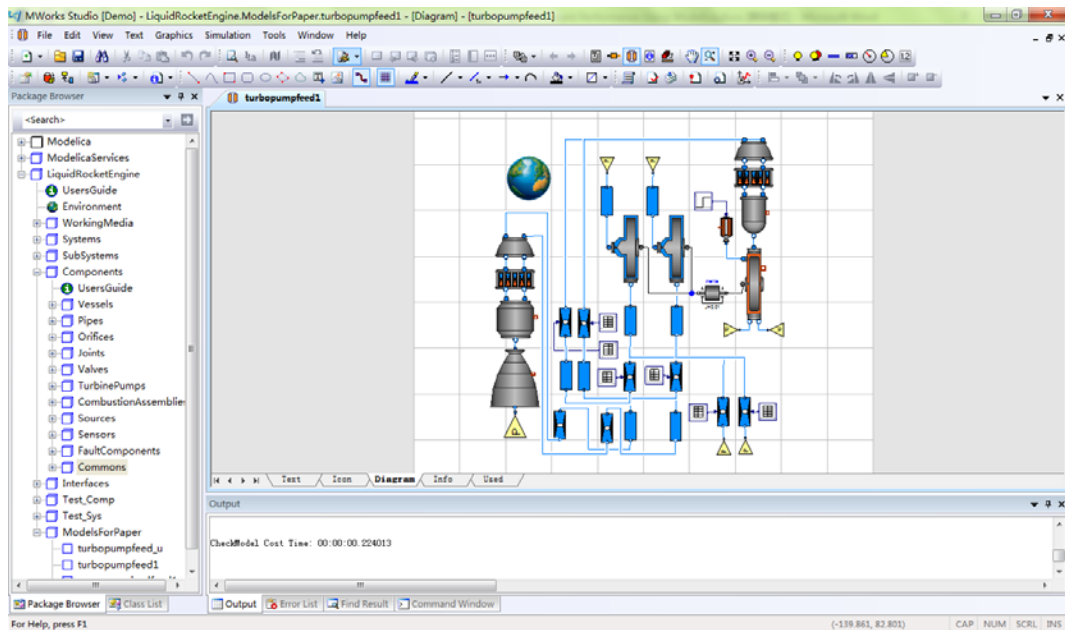
Figure 1. Example of MWorks and liquid propellant rocket engine model