An Extended Simulink Library for Modeling and Control of Inverted Pendula Systems

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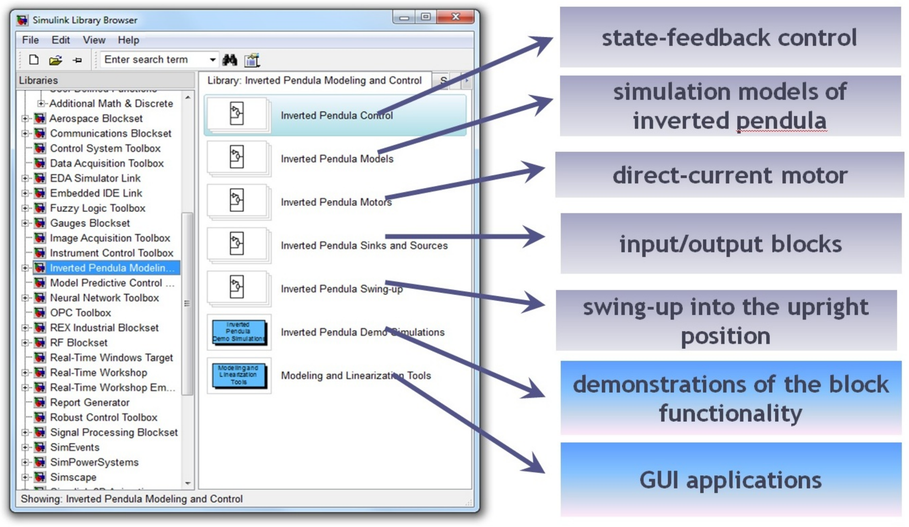
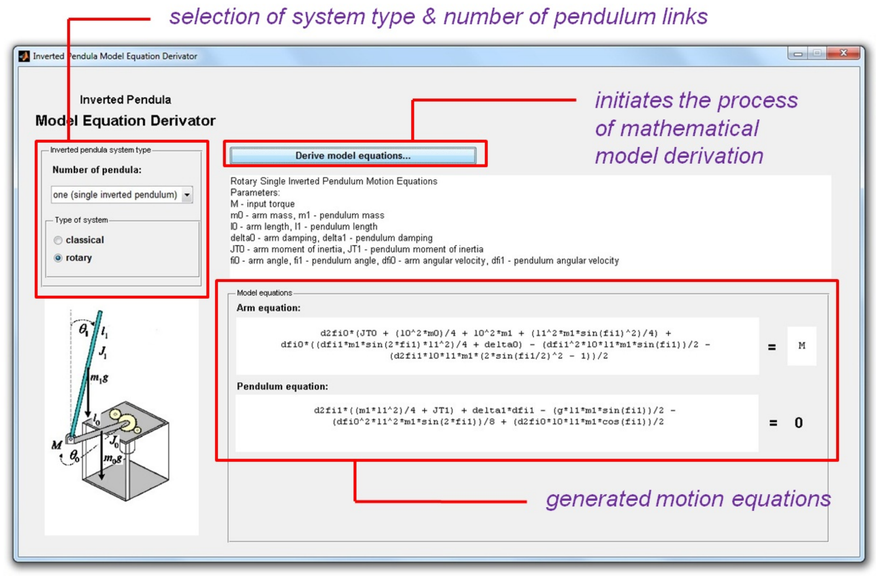
Inverted Pendula Modeling and Control (IPMaC)

- structured, thematic *Simulink* block library (extended & improved 2009 version)
- comprehensive software framework for the problems of analysis & control of inverted pendula systems
- supports classical & rotary inverted pendula systems
- strong emphasis on the generalized approach to modeling
- contains custom function blocks, GUI applications and a set of links to demo simulation schemes



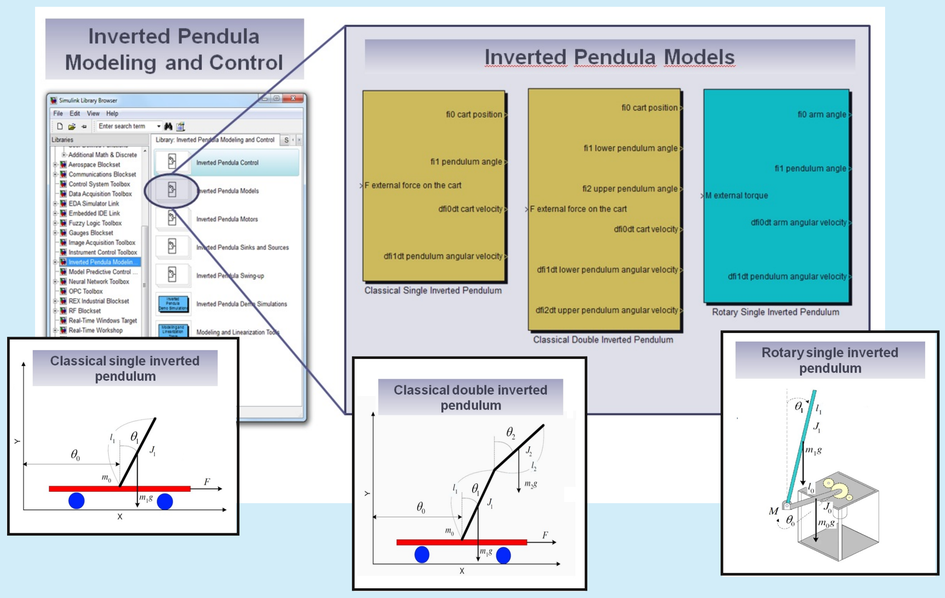
Inverted Pendula Model Equation Derivator

- generates the mathematical model (equations of motion) for a user-chosen type of inverted pendula system
- implements a general procedure which derives the motion equations for a generalized (n-link) classical and a generalized rotary system of inverted pendula



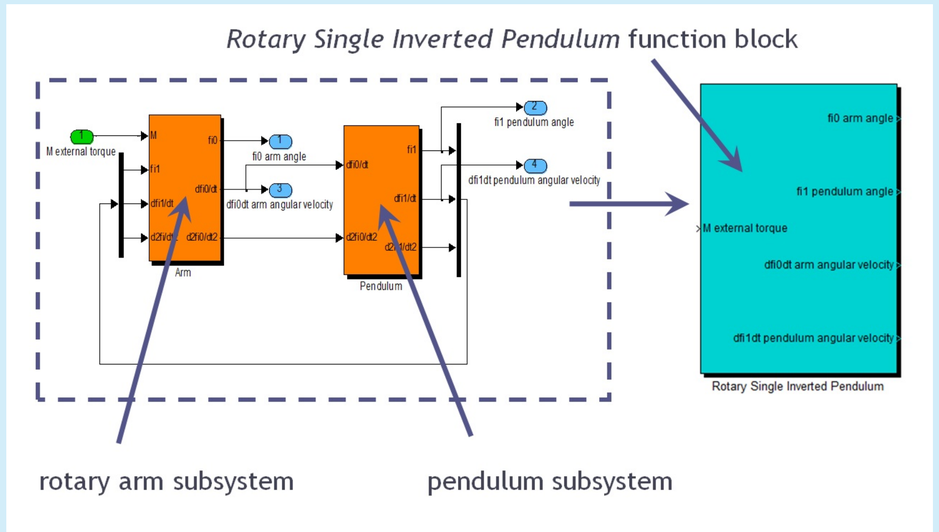
Simulation Models of Inverted Pendula Systems

- *Inverted Pendula Models* sublibrary contains function blocks which implement the generated motion equations for three characteristic representatives of inverted pendula systems

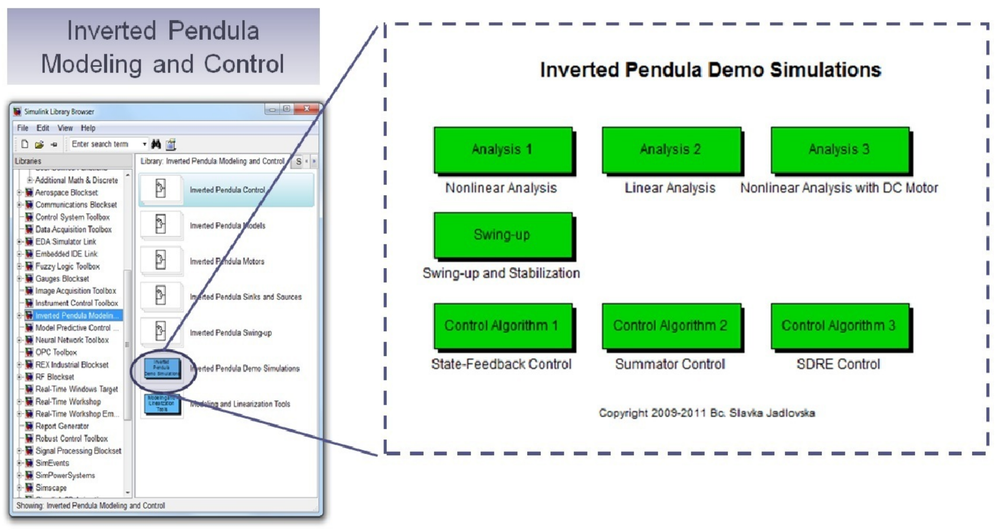


Example Structure of a Simulation Model (Rotary Single Inverted Pendulum)

- each block is equipped with a dynamic block mask which enables the user to edit the physical parameters and initial conditions, to enable or disable the input port and to flexibly adjust the number of the block's output ports

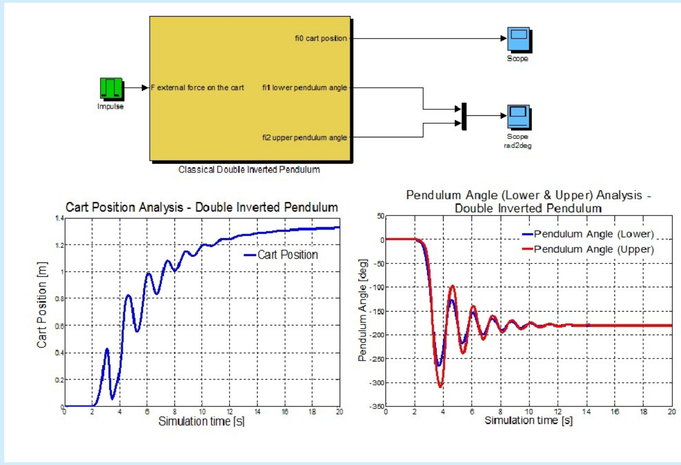


Inverted Pendula Demo Simulations

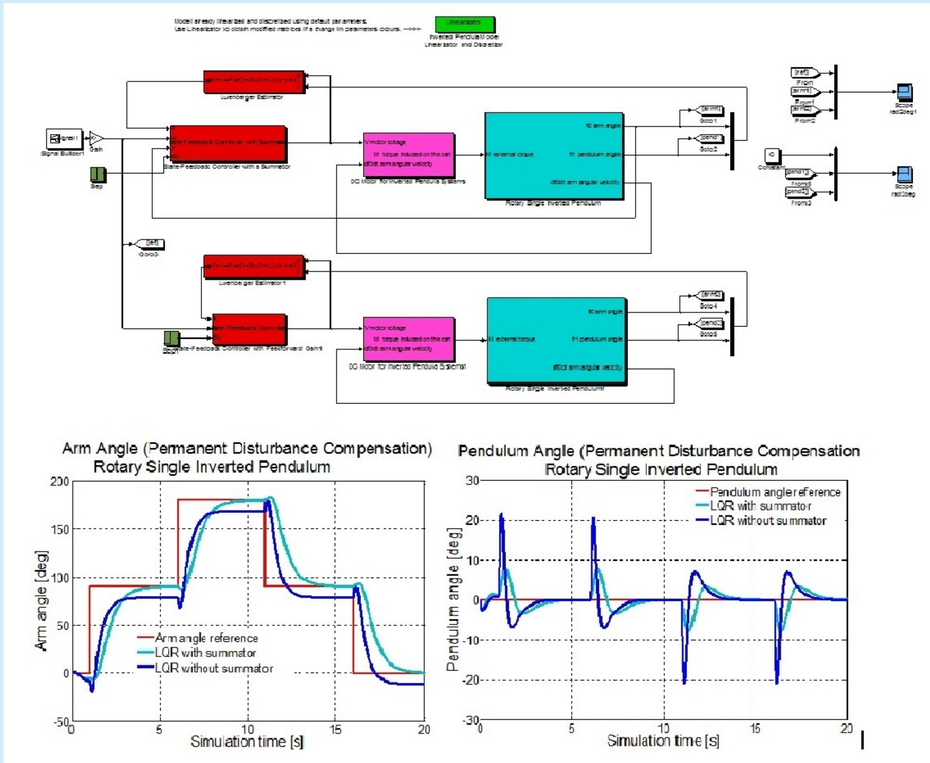


Examples of Demo Simulations

Open-loop response to an impulse signal for a classical double inverted pendulum system (force model) – simulation scheme and time behavior results (cart position and pendula angles). The scheme is located in the Analysis 1 / Nonlinear Analysis section.



Applying LQR control (optimal state-feedback control) to a rotary single inverted pendulum system (voltage model) – simulation scheme and time behavior results (arm and pendulum angles). The scheme is located in the Control Algorithm 2 / Summator Control section.



Inverted Pendula Model Linearizator & Discretizer

- generates the state-space matrices of the continuous-time linear approximation of the system in a selected equilibrium
- also returns the matrices of the discrete-time state-space model if the sampling period constant is known
- performs the standard expansion of the symbolic nonlinear state-space description of the system into the Taylor series with higher-order terms neglected