Classical Double Inverted Pendulum - a Complex Overview of a System

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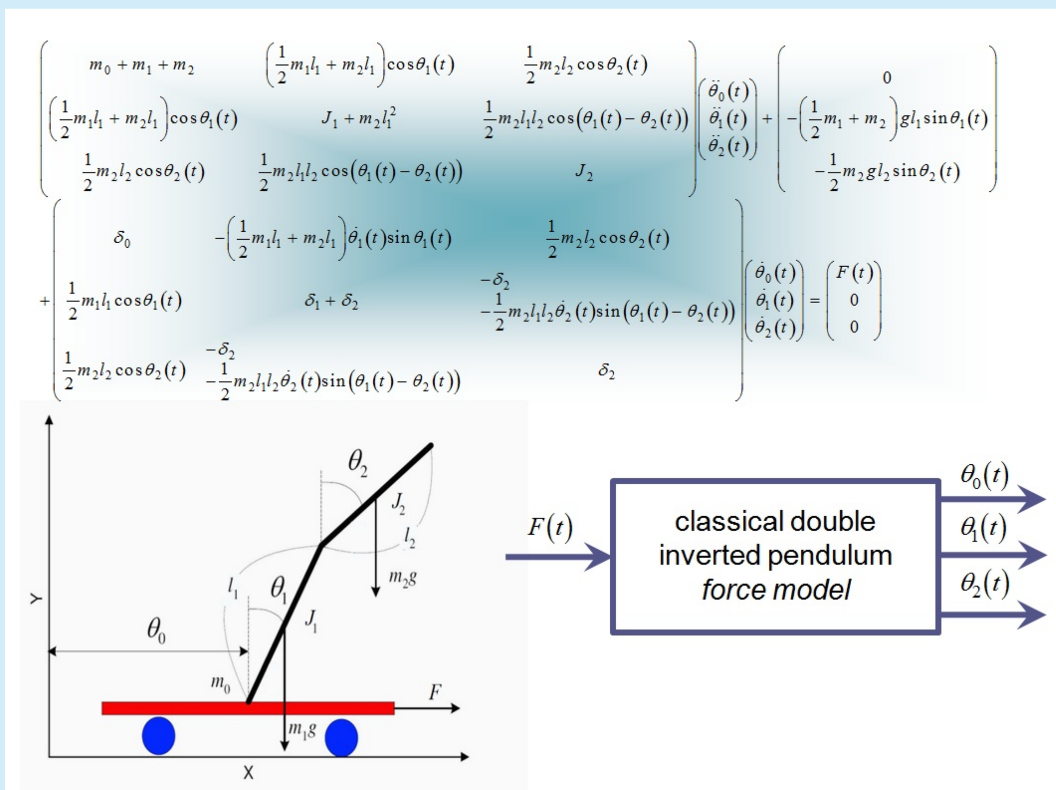
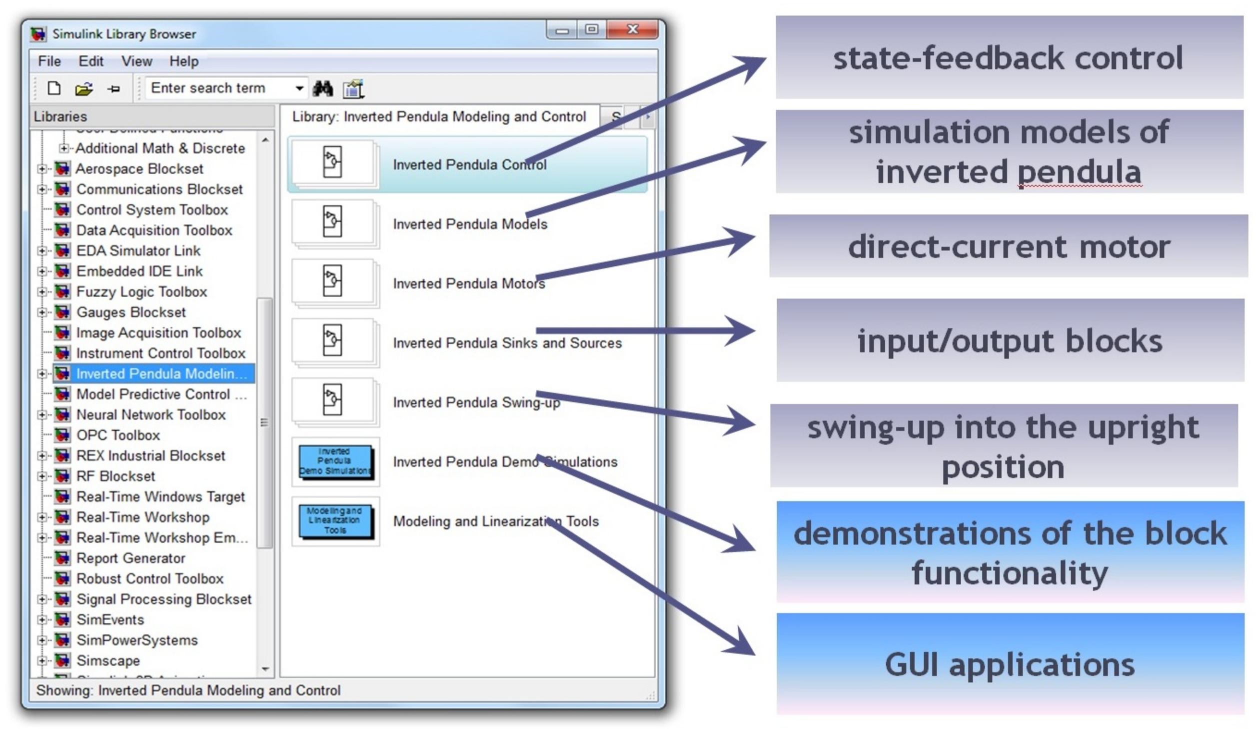
Classical Double Inverted Pendulum System

- mechanical system composed of a pair of rigid, homogenous pendulum rods interconnected in a joint; one of these is attached to a stable mechanism (cart) which allows for movement alongside a single axis
- a typical example of an underactuated system
- the only input (force acting upon the cart) is used to control the three degrees of freedom: cart position, lower pendulum angle and upper pendulum angle



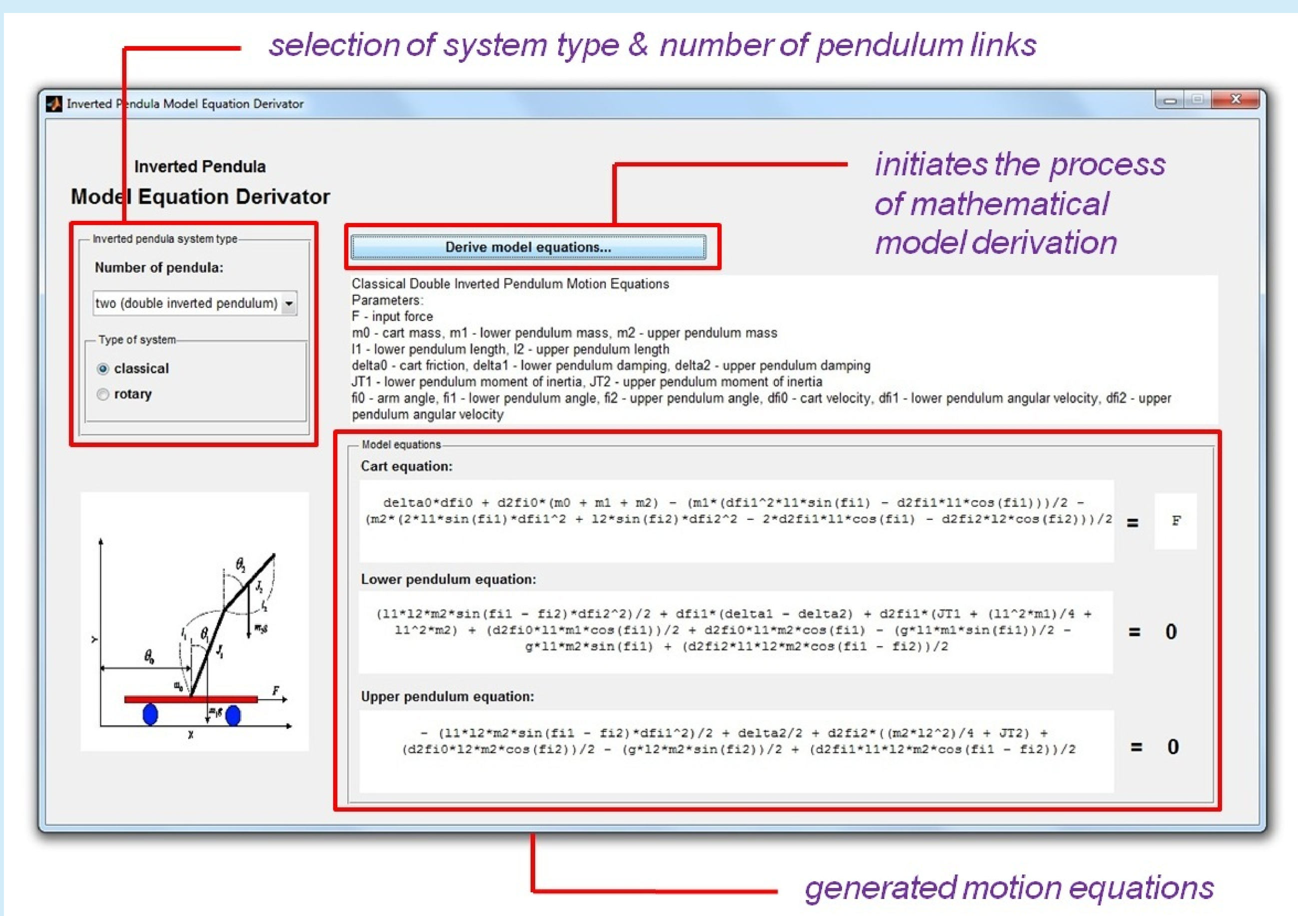
Inverted Pendula Modeling and Control (IPMaC)

- 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



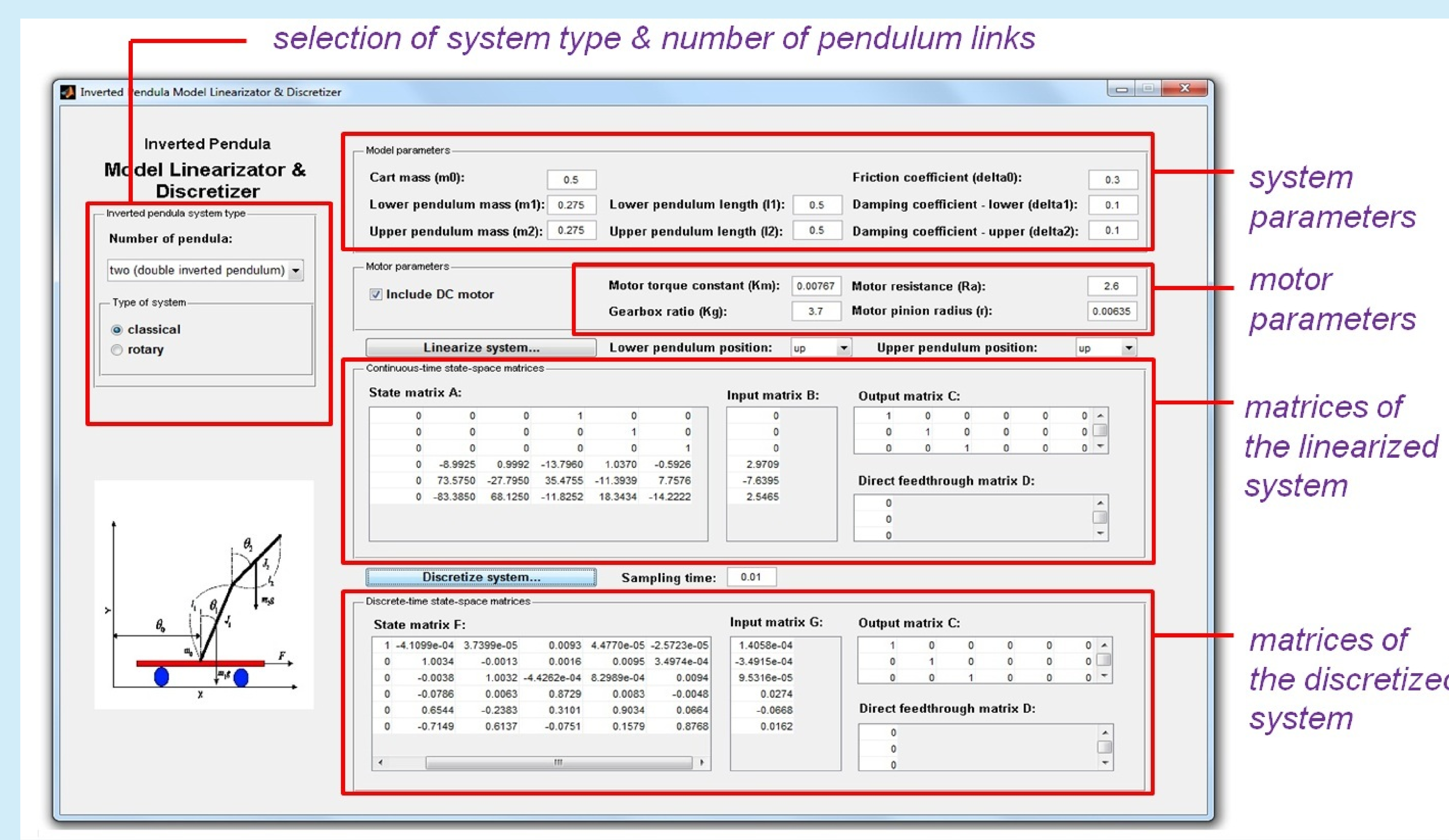
Inverted Pendula Model Equation Derivator

- generates the mathematical model (equations of motion) for a user-chosen type of inverted pendula system (classical double inverted pendulum system selected)
- implements a general procedure based on the the *Lagrange equations of the second kind*, which derives the motion equations for a generalized (n-link) classical and a generalized rotary system of inverted pendula

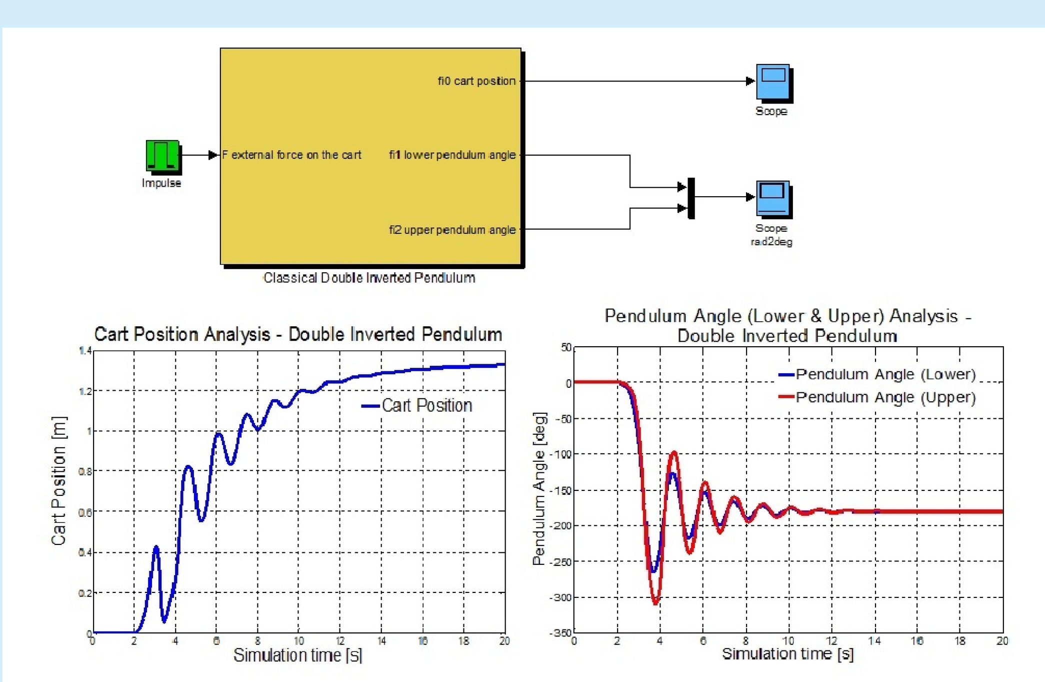


Inverted Pendula Model Linearizator & Discretizer

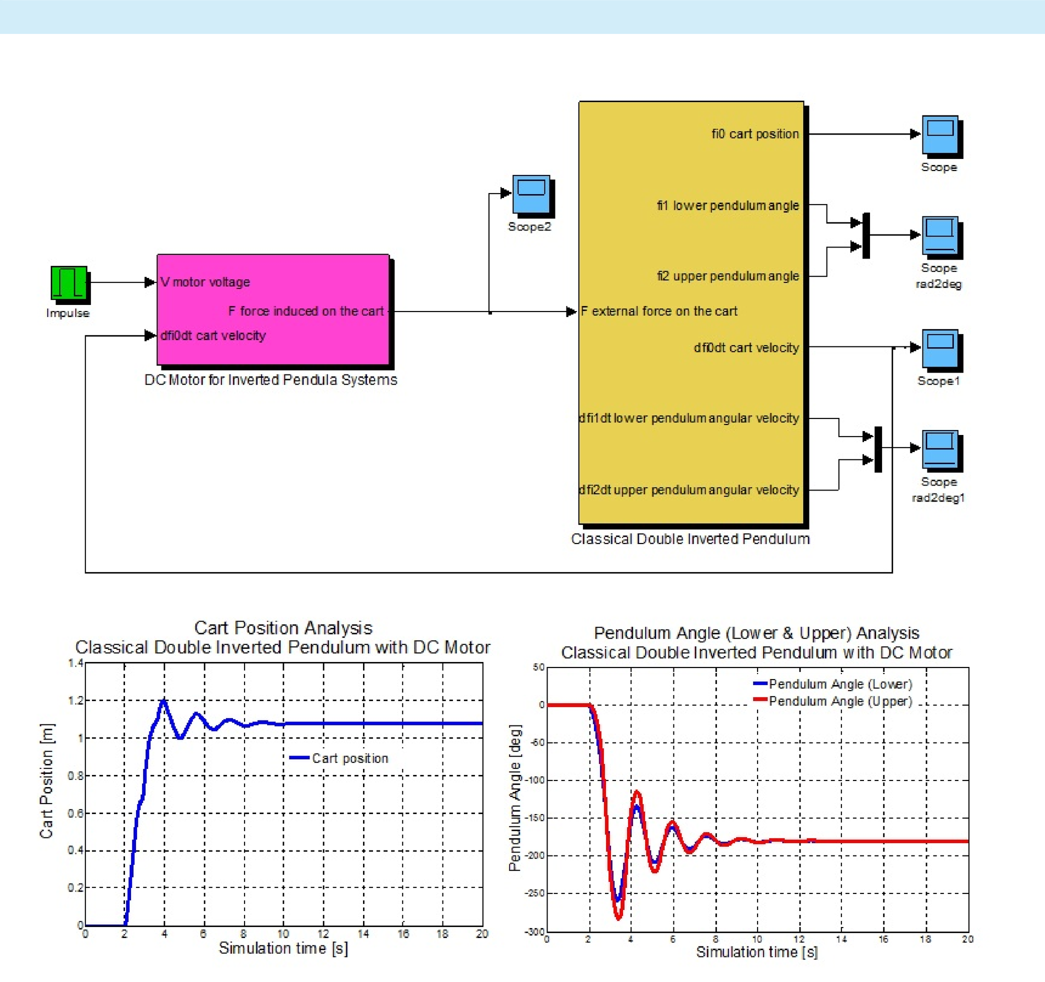
- generates the state-space matrices of the continuous-time linear approximation of the system in a selected equilibrium & also returns the matrices of the discrete-time state-space model if the sampling period constant is known
- performs the standard expansion of the symbolic nonlinear state-space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



Open-Loop Dynamical Analysis



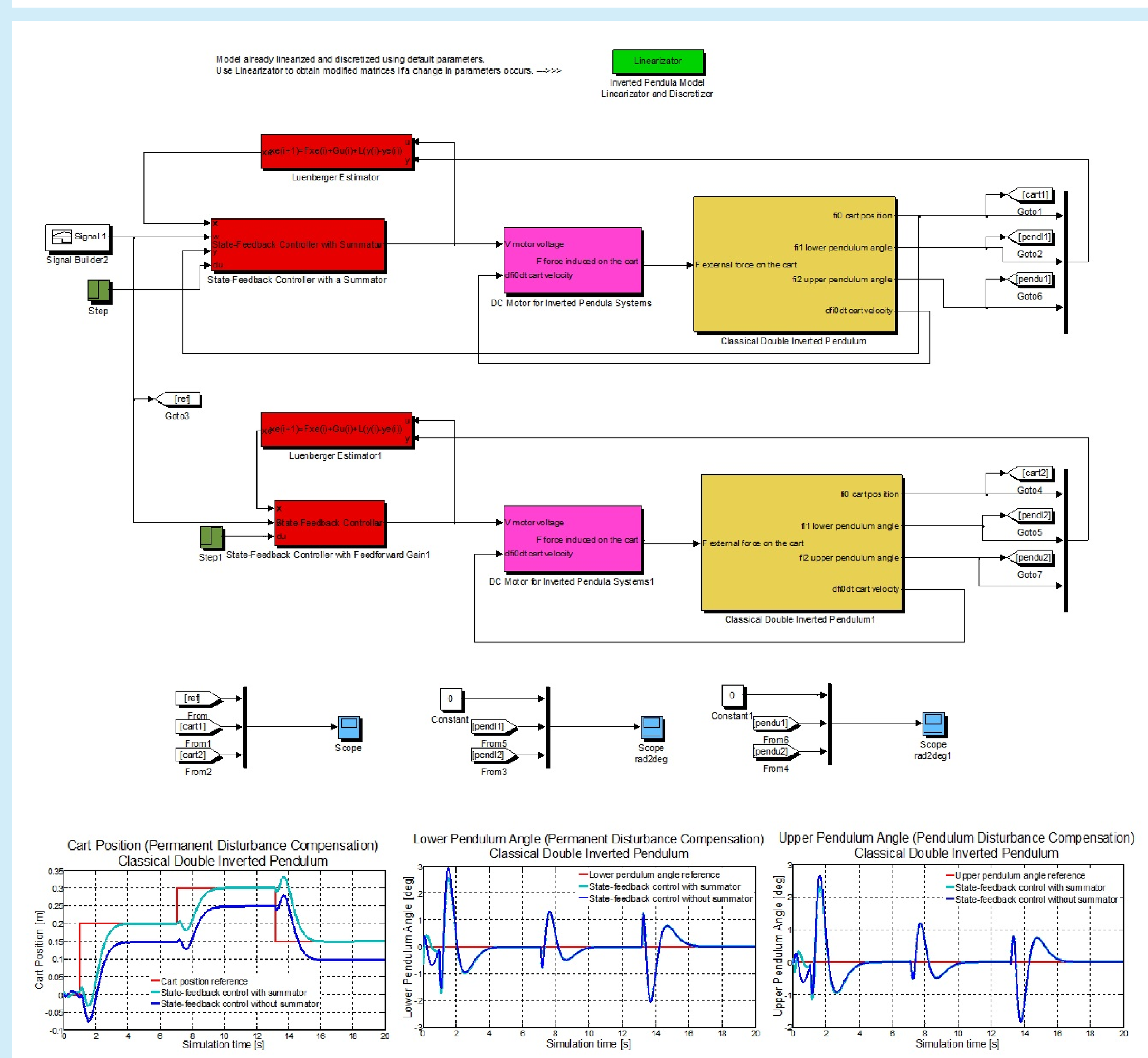
- open-loop response to an impulse signal for a ***force model*** of a classical double inverted pendulum system
- simulation scheme and time behavior of the cart position and pendula angles
- the scheme is located in the *Analysis 1 / Nonlinear Analysis* section of the *Inverted Pendula Demo Simulations*



- open-loop response to an impulse signal for a ***voltage model*** of a classical double inverted pendulum system (i.e. a model of a DC motor is attached to the inverted pendulum system to provide the force which actuates the cart and both pendula)
- simulation scheme and time behavior of the cart position and pendula angles
- the scheme is located in the *Analysis 3 / Nonlinear Analysis with DC Motor* section of the *Inverted Pendula Demo Simulations*

State-Feedback Control Examples

- LQR control (optimal state-feedback control) of a voltage model of a classical double inverted pendulum system; comparison of the performance of a standard LQR controller and a controller with a summator included in the control structure (permanent disturbance elimination)
- simulation scheme and time behavior of the cart position and pendula angles
- the scheme is located in the *Control Algorithm 2 / Summator Control* section of the *Inverted Pendula Demo Simulations.*



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