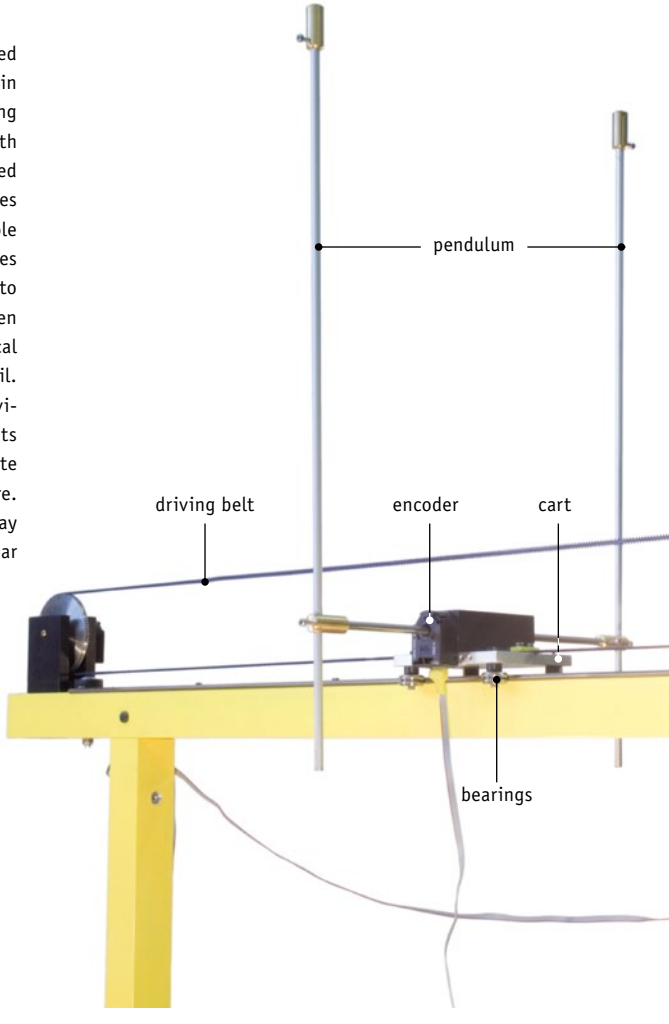
Pendulum & Cart Control System

The fourth order, nonlinear and unstable real-time control system

Pendulum & Cart Control System consists of a pole mounted on a cart in such a way that the pole can swing freely only in the vertical plane. The cart is driven by a DC motor. To swing and to balance the pole the cart is pushed back and forth on a rail of a limited length. The purpose of the inverted pendulum control algorithm is to apply a sequence of forces of the constrained magnitude to the cart such that the pole starts to swing with increasing amplitude and the cart does not override the ends of the rail. The pole is swung up to achieve a vicinity of its upright position. Once this has been accomplished, the controller is maintaining the pole vertical position and is bringing the cart back to the centre of the rail. The system operates directly in the MATLAB/Simulink environment. The user obtains ready preprogramed experiments in the real-time using the Real Time Windows Target to create code with the Simulink Coder code generation software. The user own controller can be generated in an easy way using Simulink and library of drivers. Moreover, the nonlinear and fourth order mathematical model of the system is included. MATLAB/Simulink control requires RT-DAC I/O internal PCI or external USB module (PWM control and encoder logics are stored in a XILINX chip). Besides the MATLAB or LabVIEW control environments all our systems can be also controlled from any PLC, e.g. SIEMENS SIMATIC S7-1200 PLC In the first figure below the simulated snapshots of the pendulum during a rulebased control are shown. In the second figure on the right the time-optimal control and corresponding pendulum trajectory are shown.

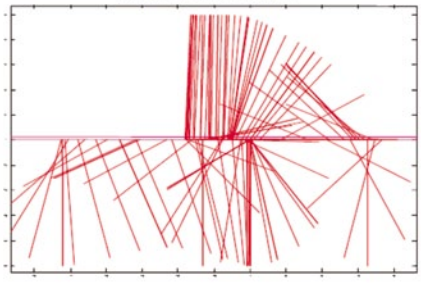


Hardware:

-Pendulum & Cart mechanical system driven by 12V DC flat motor
-PWM control generated in a PC or a notebook or in a PLC
-signal conditioning interface and power supply unit
-linear bearings

Dimensions: 2200x500x850 mm

Animation in MATLAB



Pendulum angle [rad] vs. time [s] (blue line)
Control [PWM] (green line)