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Title: Optimal Control of a Furuta Pendulum

Poster

Abstract: The Furuta pendulum is a rotational pendulum that is actuated at its basis by a direct current motor with a gear. Two control problems associated to it consist of swinging-up the pendulum, in order to move it from the downwards position up to the upwards one, and then to equilibrate the pendulum in the upwards position. In both cases, optimal control methods are used. The swing-up problem is solved by formulating it as an optimal control problem with a convenient cost, that is then solved by using a numerical method to approximate the Pontryagin's necessary conditions. The numerical method relies on the iterative solution of the state equation (forwards), of the adjoint equation (backwards), and on the optimization of the hamiltonian function with respect to the manipulated variable in a grid of time points.

Different aspects related to this problem are considered, that include the selection of an appropriate cost and numerical procedure details. The equilibration problem is solved with a standard LQG controller that is activated within a region of the state-space that is close to the upwards, zero velocity, state. A numerical study of the attraction region of the LQG equilibrating controller is performed, in order to show that this controller will fulfil its objective, even in the presence of a saturation non-linearity in the actuator. The algorithms used are described, as well as simulation and experimental results. The poster will be complemented with a short movie that shows the controller described applied to a real pendulum.