# Robust Controller for Nonlinear & Unstable System: Inverted Pendulum

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## Abstract

Most of optimal and/or adaptive control methods are only applicable on a stable system. Thus for designing such control-loop for unstable system, it is required to stabilize the system first, by a static-controller. While addressing stability problem, it is useful if this static-controller is as robust as possible to nonlinearity errors and other disturbances. Presence of ***effective-integral-control*** (EIC) in the control loop can minimize the effects due to nonlinearity errors, dynamic-disturbances and other uncertainties. And then, these uncertainties can be tackled by any adaptive control method. However a PID (or PI) controller does not always guaranty an effective-integral-control for the whole loop, and thus fails to give its disturbance rejection and robustness properties. This paper demonstrates how an effective integral-control can be ensured in control-loop. Balancing of inverted pendulum (on cart) is being considered here as an example of nonlinear unstable control system problem.

## Key words

Nonlinear & Unstable System, Effective-Integral-Control, Robust Controller.

## 1. Introduction

A controller design that works well with a large set of plant models (and bounded external disturbances) is said to be *robust*.

Whereas, an adaptive controller is defined to be *robust* if it guarantees signal boundedness in the presence of “reasonable” classes of unmodeled dynamics and bounded disturbances as well as performance error bounds that are of order of the modeling error.

Robust controller is not considered to be an adaptive system even though it can handle certain classes of parametric and dynamic uncertainties.

**(This paper accepted to be published in *Control System Journal of AMSE*, France in Dec.-00)**
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