

# Time Delay and Fluctuation on Biomimetic Visual Servoing

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## Abstract:

For human motor control mechanism, there are two remarkable properties, the existence of *time delays* and *random fluctuations* in the closed-loop system including sensory organs, musculoskeletal system and brain. For a control performance, these factors seem to be negative apparently. Nevertheless, the quick, smooth and precise voluntary movement of human can be achieved.

In this paper, we focus on these two properties and investigate the effects of the fluctuation to a stability and a behavior of a stochastic linear systems with the time delay. In particular, in conjunction with robot vision, we deal with an image-based inverted pendulum control system which corresponds to human stick balancing task. The control performance improvements due to fluctuation are shown from both aspects of numerical simulations and its theoretical analyses. For a conventional controller design, a random component such as fluctuation was a target to be eliminated from a system as a factor causing performance reduction. In contrast to this fact, the results in this paper suggest that an appropriate fluctuation in control systems can achieve the better control performances.

**Keywords:** Time Delay, Fluctuation, Stochastic Systems, Human Motor Control, Inverted Pendulum, Humanoid Robot