1 Introduction
The analysis and synthesis of feedback controllers for linear parameter varying (LPV) systems has received a lot of attention during the last decade. Since LPV system enables us to consider time variance as well as nonlinearity in a family of linear systems. When controlling a LPV system, the scheduling parameters that determine the parameter variations of the system are usually unknown in advance but assumed to be available through direct measurement or estimation in real-time. In this presentation, a recently developed LPV identification [1] and LPV control synthesis technique [2] are validated on an experimental overhead crane system.

2 Overhead Crane
The overhead crane system is a velocity controlled single input system with varying rope length. As it is shown in Fig. (1), considering 'yh' as the position of the cart and 'θ' the angle of the rope, it is possible to model the system as a function of the rope length. Assuming the position of the load as the output, the discrete-time state-space of the system can be written in the following form:

\[
\begin{align*}
    x(k+1) &= A(\ell)x(k) + Bu(k) \\
    y(k) &= C(\ell)x(k)
\end{align*}
\]  

(1)

where 'ℓ' is the rope length and changing it makes the family of LTI systems.

3 LPV modeling
The modeling approach that is used, is based on the results presented in [1], consists of the following steps. At first, determine a family of linear time invariant (LTI) models by selecting different operating conditions of the system. Assume that all the LTI models are consistent and state-space representations are with respect to the same state-space basis. Then the next step is calculation of a Homogeneous Polynomially Parameter Dependent (HPPD) LPV system through the interpolation of the LTI models. Exploiting the approach presented in [1], the system is modeled as an HPPD LPV system.

\[
\begin{align*}
    x(k+1) &= A(\alpha)x(k) + B(\alpha)u(k) \\
    y(k) &= C(\alpha)x(k)
\end{align*}
\]  

(2)

4 State-feedback gain scheduling control
The controller design problem of HPPD LPV model is then transformed to LMI conditions as described in [2]. Considering the control signal for reference tracking as

\[
u(k) = K(\alpha)x(k) + K_r(\alpha)r(k)
\]

an interpolating gain scheduling feedback controller is derived based on LTI controllers synthesized for different rope lengths.

This controller is also compared to the gain scheduled \(H_\infty\) state-feedback controller for discrete-time linear systems with time-varying parameters belonging to a polytope synthesized using the finite dimensional LMIs presented in [2].

References

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