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S.V. KHOROSHYLOV¹, C. WANG²

SYNTHESIS OF A PARAMETRICALLY ROBUST CONTROLLER WITH AN EXTENDED STATE OBSERVER

¹Institute of Technical Mechanics
of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine
15 Leshko-Popel St., Dnipro 49005, Ukraine; e-mail: skh@ukr.net
²Northwestern Polytechnical University, 127 West Youyi Road, Xi'an Shaanxi 710072, P.R. China

This paper considers the problem of control of a parametrically uncertain dynamic system using an extended state observer. The control system is implemented using a two-loop scheme, where the outer loop ensures the fulfillment of the selected criterion for controlling the state vector, and the inner loop compensates for or reduces the influence of the vector of the total equivalent disturbance.

The goal of the study is to develop a procedure for synthesizing an extended state observer taking into account the parametric uncertainty of the plant and the requirements for the closed loop of the combined control system specified in the frequency domain.

Methods of control theory, robust control, and computer modeling are used for this study.

The effect of the parametric uncertainty of the plant on its controlled motion is presented as a structured disturbance described in the form of a block-diagonal matrix. The concept of structured singular values is used to determine the measure of the system's robustness.

Using the methodology of optimization of structured singular values, a procedure is proposed for synthesizing the extended state observer when considering a closed loop of a combined control system taking into account the parametric uncertainty of its mathematical model. The requirements ensuring the specified performance and stability of the closed loop of the control system taking into account the spectral properties of disturbances and sensor noise are formulated in the frequency domain using frequency-dependent weighting functions. For the synthesis of combined controllers based on the minimization of structured singular values, a D-G-L-K iteration algorithm is developed. The efficiency of the proposed approach is illustrated by a numerical example. Recommendations are given for the synthesis of parametrically robust combined controllers. The practical value of the obtained results lies in the fact that the procedure developed reduces the conservatism of robust combined control systems and, as a result, improves the control performance in the case of parametric uncertainty of the plant.

Keywords: extended state observer, parametric uncertainty, robustness, structured singular value.

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