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Optimization of an extended H-infinity controller for unmanned helicopter control using Multiobjective Differential Evolution (MODE) (Article)

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Abstract

Purpose - The purpose of this paper is to develop a multiobjective differential evolution (MODE)-based extended H-infinity controller for autonomous helicopter control. Design/methodology/approach - Development of a MATLAB-based MODE suitable for controller synthesis. Formulate the H-infinity control scheme as an extended H-infinity loop shaping design procedure (H-LSDP) with incorporation of v-gap metric for robustness to parametric variation. Then apply the MODE-based algorithm to optimize the weighting function of the control problem formulation for optimal performance. Findings - The proposed optimized H-infinity control was able to yield set of Pareto-controller candidates with optimal compromise between conflicting stability and time-domain performances required in autonomous helicopter deployment. The result of performance evaluation shows robustness to parameter variation of up to 20 per cent variation in nominal values, and in addition provides satisfactory disturbance rejection to wind disturbance in all the three axes. Research limitations/implications - The formulated H-infinity controller is limited to hovering and low speed flight envelope. The optimization is focused on weighting function parameters for a given fixed weighting function structure. This thus requires a priori selection of weighting structures. Practical implications - The proposed MODE-infinity controller algorithm is expected to ease the design and deployment of the robust controller in autonomous helicopter application especially for practicing engineer with little experience in advance control parameters tuning. Also, it is expected to reduce the design cycle involved in autonomous helicopter development. In addition, the synthesized robust controller will provide effective hovering/low speed autonomous helicopter flight control required in many civilian unmanned aerial vehicle (UAV) applications. Social implications - The research will facilitate the deployment of low-cost, small-scale autonomous helicopter in various civilian applications. Originality/value - The research addresses the challenges involved in selection of weighting function parameters for H-infinity control synthesis to satisfy conflicting stability and time-domain objectives. The problem of population initialization and objectives function computation in the conventional MODE algorithm are addressed to ensure suitability of the optimization algorithm in the formulated H-infinity controller synthesis.

Author keywords

Autonomous helicopter control | Differential evolution | Multiobjective | Multiobjective optimization problems | V-gap metric

Indexed keywords

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