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ROBUST CONTROL DESIGN FOR AIRCRAFT CONTROLLERS VIA MEMETIC ALGORITHMS

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Abstract. *This article develops a novel method based on the memetic algorithm for optimal feedback control design. The aircraft controllers are designed to produce desired handling qualities. The robust properties of the linear quadratic regulator are exploited to obtain the desired aircraft handling qualities with an output feedback constrained linear quadratic regulator subspace based on a cost function minimization method. Numerical examples of lateral autopilot design are optimized with the memetic algorithm. The memetic algorithm designs lateral feedback gains based on the quadratic performance index to maintain heading and roll attitude. The memetic algorithm is compared to the eigen-structure assignment, genetic algorithm and gradient-based optimization methods [21] and genetic algorithm. The memetic algorithm can derive a better solution with fewer iteration steps. Most importantly, the memetic algorithm can obtain a global optimum using mutation and thus avoid being trapped in local optima. The simulation and experimental results demonstrate that the proposed method produces useful, feasible and good robustness.*
Keywords: Robust control, Linear quadratic regulator, Memetic algorithm

1. **Introduction.** The rapid development of computers has enabled modern numerical optimization techniques to optimize feedback control design. Optimal control is a mathematical field that is concerned with control policies that can be deduced using optimization algorithms. The optimal control method used in robust control design differs from conventional direct approaches to robust control. An optimal control method offers a complete robust control design, utilizing modern control theory in a concise manner. It includes up-to-date research and offers both theoretical and practical applications that include flexible structures, robotics, automotive aircraft control and air motor control [1-3]. The linear quadratic regulator (LQR) optimal feedback is one of the many tools that assure robust margins for a full state feedback system [4]. Using LQR theory, a set of optimal feedback gains may be found for a controllable linear time-invariant system to minimize a quadratic index, thus stabilizing a closed-loop system [5-7].

There are several kinds of numerical optimization methods: the conjugant gradient method (CGM), the neural network (NN), and genetic algorithms (GA), etc. Each of these has its advantages and limitations [8-10]. The CGM algorithm is a gradient-based method, fast and effective, but may easily get stuck in local optima. The NN algorithm can simulate the relation between the input and output signals, but needs samples for training the network before it can be run. The GA concept based on natural selection and evolutionary genetics was first established by Holland [11] in 1975. Genetic algorithms are known to be efficient for global optimization. Most GA-based approaches employ the fitness function as the performance index function for the control system. The purposes