International Journal of Innovative Computing, Information and Control
Volume **2**, Number **4**, August **2006**

pp. **737–748**

LMI-BASED RELIABLE H_∞ FILTERING WITH SENSOR FAILURE

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Received July 2004; revised December 2005

Abstract. *The reliable robust filter design methods are given against multi-sensor failures and single sensor failure, respectively. A more practical model of sensor failures than outage is considered. A given upper bound of the filtering performance in the sensor failures case is guaranteed and the performance in the nominal case is optimized. A new formulation in terms of LMI (Linear Matrix Inequality) is adopted without introducing additional conservativeness. An example is given to illustrate the proposed design procedures. Furthermore, the nominal robust H_∞ filter and the reliable robust H_∞ filter are compared to show the necessity of reliable design.*
Keywords: Sensor failure, Reliable filter, Robust, Linear matrix inequality

1. **Introduction.** The design problem of filter has been well studied over the past decades based on the minimization of the estimation error variance and H_∞ performance [1,2]. In recent years, as extensions of traditional Kalman filter which requires a precise model of the system, the modeling errors and other parameter uncertainties are taken into consideration in robust filter design. Several kinds of models are adopted to describe the parameter uncertainties, such as norm-bounded uncertainties [3,4], integral quadratic constraints [5].

A common assumption is that the sensors can provide a constant level of signals in the above filter schemes. In practice, however, contingent failures are possible for all sensors in a system which may result in a large degree of filter performance degradation. For example, the performance of a filter in an aircraft which provides information to flight control and navigation system is obviously safety critical. Therefore, the need for filter schemes which ensure performance despite the presence of sensor failures is fairly evident.

A control system designed to tolerate faults of sensors or actuators, while maintaining an acceptable level of the closed-loop system stability and performance, is called a reliable control system. Relatively few past attempts have been done in developing methodologies for the design of reliable filter systems. Among them, Levine and Marino [6] gave an observer which tolerates failures in a known output. However, only asymptotically tracking of states is achieved without performance analysis. More results can be found in literature concerning reliable control problems, where the same technique can often be transplanted