International Journal of Innovative Computing, Information and Control
Volume **4**, Number **11**, November **2008**

ICIC International ©2008 ISSN 1349-4198
pp. **2919–2926**

SELF-REPAIRING CONTROL AGAINST SENSOR FAILURES

Masanori Takahashi

Department of Mechanical Systems Engineering
Tokai University
9-1-1, Toroku, Kumamoto, 862-8652, Japan
masataka@ktmail.tokai-u.jp

Received November 2007; revised April 2008

Abstract. *This paper presents a new self-repairing control system (SRCS) for unknown stable plants with sensor failures. The proposed method can detect the sensor failure, and replace the faulty sensor with the healthy one. The advantage of the proposed fault detector is that no mathematical model of the plant is required. Therefore, one can obtain the SRCS of the simple structure that does not depend on the order of the plant, and the detection algorithm can be applied to any stable plant.*
Keywords: Sensor failures, Fault-tolerant, Dynamic redundancy, Switched system

1. **Introduction.** Sensor failure accommodation is one of the most important problems in fault-tolerant control. If a feedback signal measured by a faulty sensor is stuck at some value then the control system becomes an open-loop system. Thus, the sensor failure often causes considerable damage to the control system and degrades stability. To recover from the effect of the above fatal failure completely, the faulty sensor has to be detected exactly and replaced with the healthy one [1]. This is the basic concept of self-repairing control based on dynamic redundancy.

Fault detectors are necessary to know occurrence of sensor faults. Unfortunately, many existing fault detectors have utilized diagnostic observers and/or accurate mathematical models of plants [1, 2, 3]. Because their structures depend on the orders of the plants, the resultant fault-tolerant control systems become excessively complex for plants with large orders. In addition, these fault detection algorithms are based on comparing observed states with corresponding ideal (healthy) states. Obviously, they cannot find faulty sensors stuck at ideal states fundamentally.

As a remedy, this paper presents a new simple self-repairing control system (SRCS) for unknown stable plants with sensor failures, which can automatically detect the sensor failure and switch from the failed sensor to the reserved one. The fault detector in the SRCS exploits only the artificial test signal and the integrator. The test signal is well designed so that the output of the integrator exceeds a prescribed threshold if the measured feedback signal is stuck due to the sensor failure. Thus, to detect the failure, we have only to make sure whether the output of the integrator hits the decision threshold or not. This detection algorithm is not based on comparison of states, and so requires neither diagnostic observer nor mathematical model of the plant. Therefore, because the structure of the proposed fault detector does not depend on the order of the plant, one can construct the extremely simple SRCS even if the plant has a large order. Furthermore, the active fault detector using the test signal can successfully find any stuck sensor and also can be applied to any stable plant.