International Journal of Innovative Computing, Information and Control
Volume **5**, Number **2**, February **2009**

ICIC International ©2009 ISSN 1349-4198
pp. 311–321

FUZZY FEEDBACK SCHEDULING OF RESOURCE-CONSTRAINED EMBEDDED CONTROL SYSTEMS

Feng Xia[1,2], Youxian Sun[3], Yu-Chu Tian[2,*], Moses O. Tade[4] and Jinxiang Dong[1]

[1]College of Computer Science and Technology
Zhejiang University
Hangzhou 310027, P. R. China
f.xia@ieee.org

[2]Faculty of Information Technology
Queensland University of Technology
GPO Box 2434, Brisbane QLD 4001, Australia
y.tian@qut.edu.au
*Corresponding author

[3]State Key Laboratory of Industrial Control Technology
Zhejiang University
Hangzhou 310027, P. R. China

[4]Department of Chemical Engineering
Curtin University of Technology
GPO Box U1987, Perth WA 6845, Australia

Received August 2007; revised February 2008

Abstract. *The quality of control (QoC) of a resource-constrained embedded control system may be jeopardized in dynamic environments with variable workload. This gives rise to the increasing demand of co-design of control and scheduling. To deal with uncertainties in resource availability, a fuzzy feedback scheduling (FFS) scheme is proposed in this paper. Within the framework of feedback scheduling, the sampling periods of control loops are dynamically adjusted using the fuzzy control technique. The feedback scheduler provides QoC guarantees in dynamic environments through maintaining the CPU utilization at a desired level. The framework and design methodology of the proposed FFS scheme are described in detail. A simplified mobile robot target tracking system is investigated as a case study to demonstrate the effectiveness of the proposed FFS scheme. The scheme is independent of task execution times, robust to measurement noises, and easy to implement, while incurring only a small overhead.*
Keywords: Feedback scheduling, Fuzzy logic control, Embedded control systems, Resource management, Mobile robot

1. **Introduction.** Despite their popularity, embedded systems are typically resource limited [1, 2, 3]. For instance, there are usually constraints on the processing speed, memory size, and communication bandwidth. As the complexity of various applications grows continuously, multiple tasks have to compete for the limited processor resource in many cases. In this context, the overall quality-of-control (QoC) of an embedded control system depends not only on the design of control algorithms, but also on the scheduling of shared computing resources. With traditional open-loop scheduling schemes, however, the temporal attributes of these systems will be significantly affected by workload variations. This may potentially cause the overall QoC to deteriorate [4, 5].