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

ICIC International ©2008 ISSN 1349-4198
pp. 2965–2975

NEURAL FEEDBACK SCHEDULING OF REAL-TIME CONTROL TASKS

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Received August 2007; revised December 2007

Abstract. *Many embedded real-time control systems suffer from resource constraints and dynamic workload variations. Although optimal feedback scheduling schemes are in principle capable of maximizing the overall control performance of multitasking control systems, most of them induce excessively large computational overheads associated with the mathematical optimization routines involved and hence are not directly applicable to practical systems. To optimize the overall control performance while minimizing the overhead of feedback scheduling, this paper proposes an efficient feedback scheduling scheme based on feedforward neural networks. Using the optimal solutions obtained offline by mathematical optimization methods, a back-propagation (BP) neural network is designed to adapt online the sampling periods of concurrent control tasks with respect to changes in computing resource availability. Numerical simulation results show that the proposed scheme can reduce the computational overhead significantly while delivering almost the same overall control performance as compared to optimal feedback scheduling.*

Keywords: Feedback scheduling, Neural networks, Real-time scheduling, Computational overhead, Embedded control systems

1. Introduction.

Embedded control systems have been used in a wide variety of applications. These systems are typically resource constrained due to various technical and economic reasons [1-5]. In particular, the computing speeds of most embedded processors are limited as compared to general-purpose computers. Also, it is common that multiple control tasks have to compete for the use of one processor. For a real-time embedded control system, such resource constraint may significantly affect the system timing behaviour and may even yield unsatisfactory control performance. This problem will be further pronounced when the system operates in dynamic environments where the CPU workload varies over time. In the context of resource constraints, these dynamic variations in workload will possibly lead to low CPU utilization and/or system overloading. As a consequence, the performance of a multitasking control system will be jeopardized [4, 6].

Recently, feedback scheduling [1, 4, 7] has emerged as a promising technology for addressing the above mentioned uncertainty in resource availability. The basic idea of feedback scheduling is to allocate available resources dynamically among multiple real-time tasks based on feedback information about actual resource usage. In multitasking control systems, a straightforward objective of feedback scheduling is to optimize the overall quality of control (QoC) characterized by some sort of performance indices. Accordingly,