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A Study on a Task Scheduling Method for Real-Time Embedded Systems with Heterogeneous Task Sets

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Chapter 1 Introduction

In the wide variety of real-time embedded systems today, task scheduling scheme is becoming more important under the circumstances where there is difference in the importance of task and the task type. For example, a mixed system containing the hard real-time tasks that are periodically activated and soft real-time tasks which are activated aperiodically has been increasing, so it is necessary to schedule the tasks to meet real-time constraints of them. Generally, system's goal is to meet the deadlines of hard real-time tasks and to shorten the average response time of soft real-time tasks.

In this study, it is intended to propose and evaluate a task scheduling scheme while ensuring the schedulability of the high important periodic tasks to meet deadline thereof, and shortening the response time of aperiodic tasks as small as possible.

Chapter 2 Related Work

There are some scheduling algorithms in which there is no clear distinction

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between periodic task (hard real-time) and aperiodic task (soft real-time). Total Bandwidth Server (TBS) [1] is one of the most typical examples. TBS operates according to Earliest Deadline First (EDF) algorithm [2]. In EDF, when scheduling event occurs, it will select a task which has nearest deadline to schedule.

In TBS, the deadline d_k of aperiodic task k is calculated according to the following formula.

$$d_k = \max(r_k, d_{k-1}) + c_k/U_s$$

k	: arrival order of the aperiodic task
r_k	: arrival time of aperiodic task k
d_{k-1}	: deadline of aperiodic task k-1
c_k	: computation time of aperiodic task k
U_s	: Maximum processor utilization of all aperiodic tasks

Chapter 3 Proposal of How to Improve TBS

Because TBS uses the worst-case execution time(WCET) of a Task to calculate a deadline of the task, the deadline can be too large. So there is a limit on shortening the response time of aperiodic tasks.

In this study, we try a way to shorten the response time using the smaller deadline which can be calculated by using the predicted (usually shorter than WCET) execution time instead of the worst-case execution time(WCET) of aperiodic tasks. Thus, it is expected that the response time of aperiodic tasks becomes smaller as compared with conventional TBS.

Chapter 4 Implementation of Scheduler

Base software of the study is the ITRON-based OS where each task has a static priority. The Scheduling of the OS is based on the static priority. I modified the scheduling algorithm in the base environment to implement the scheduling algorithm of the study.

□Deadline calculation timing

Deadline of a task is calculated in system calls, cre_tsk/ act_tsk/iact_tsk

□Enqueue operation of the ready queue

Ready queue is based on linked-List structure. It is built in deadline order. When inserting an entity of TCB to the ready queue, position in the ready queue is determined by comparing the deadline to ones already in the ready queue. And inserting the task in the position

Chapter 5　Evaluation

Several task sets are prepared for evaluation. Evaluation is performed by multiple simulations while changing period and activation time in the task set. We evaluated the proposed algorithm with the conventional TBS based on the results obtained.

On average, the response time of aperiodic task in the proposed algorithm is reduced by about 24%.

Chapter 6　Conclusion

In this study, it is intended to propose and evaluate a task scheduling scheme while ensuring the schedulability of the high important periodic tasks to meet deadline thereof, and shortening the response time of aperiodic tasks as small as possible.

We have confirmed that the response time of aperiodic tasks in the proposed algorithm is shorter than the traditional TBS.

For the proposed method to be actually used, it must be evaluated in an actual real-time OS, not only in the evaluation of the scheduling. In addition, the multi-core embedded systems are rapidly increasing in recent years, so I should discuss the challenges to take part in TBS with the change.

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