論文の内容の要旨

論文題目 A Study on Execution Time Analysis of Real-Time Tasks
(実時間タスクの実行時間解析に関する研究)

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In a hard real-time system, it is important to complete a task before its deadline. In order to guarantee the reliability of a real-time system, when developing a system, we have to confirm that the worst case execution time (WCET) of a real-time task always meets a deadline. In a current development method mostly used at the industries, a task is run using various test cases so that WCET is estimated. However, by this method, it cannot guarantee that it is the true WCET. Moreover, in the system by which multiple real-time tasks are run, the execution of a task has preemption delay. In order for a system to always meet a deadline in any conditions, it is necessary to calculate the WCET of a task and preemption delay using reliable methods, and to examine schedulability analysis.

In this thesis, we propose a method of calculating the WCET in all the execution paths of a task in the analysis of a source code. And, we predict the timing of preemption using OS which can control interrupts, and propose the method of calculating for preemption delay in a preemptive multitask environment. With this method, it's decided correctly whether the schedule of the given task set is possible.

The WCET is calculated combining the measurement result of the execution time for each basic block of a program using a real machine and the simulation result. Since an analyzer uses Register Transfer Language (RTL) used as expression inside Gnu Compiler Collection (GCC), the WCET is calculated by various architectures. In order to calculate for preemption delay, it is assumed that periodic tasks are only running in a real-time OS in which interrupt except for timer interrupt do not occur. In such an environment, the preemption is not caused to arbitrary timing but the preemption point is known before execution. The reload time of cache is calculated from the available number cache entries at a preemption point, ant this is considered as preemption delay. The prediction method of WCET is evaluated on architectures, Pentium-M and XScale processor. In Pentium-M processor, the estimated WCET is 1.12 to 1.36 times longer

than the actual WCET. In XScale, the estimated WCET is 1.06 to 1.18 times longer than the actual WCET. In SH, the estimated WCET is 1.02 to 1.14 times longer than the actual WCET. Linux is extended in order to perform a real-time schedule. Schedulability analysis of task sets is evaluated using the proposed method. The result of this study that reliable schedulability analysis is possible in order to estimate the WCET and preemption delay correctly.