A Genetic Algorithm for Energy Efficient Device Scheduling in Real-Time Systems

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1 Introduction

Power is becoming a critical constraint for designing embedded applications,because the amount of power available to these systems is limited due to limitation of battery life [1]. For this reason energy consumption is an important parameter in evaluating performance of embedded systems.DPM (dynamic power management) has gained considerable attention over the last few years as a way to save energy in device that can be turned on and off by operating system control [2].Some successful designs have been made using this technique [3,4].

Genetic algorithms are an artificial intelligence technique based on the principles of evolutionary theory. it extensively used in solving many real-world problem. In this paper, we investigate a way to implement real-time I/O-centric DPM scheduling by using GA(Genetic Algorithm), and compare the efficiency with other exsiting schedulers.

2 Problem Description

In order to save energy, when a task is running, the unused devices can stay in the sleeping mode. But frequently switching a device between the active and sleep states also results in energy consumption. A schedule for these tasks must reduce the transitions as much as possible. The scheduler we present here takes as input a predetermined set of tasks and a device usage list for each task. The output is a task execution sequence such that the power consumption of the devices is near minimized.

3 Genetic Algorithm Implementation

3.1 The Chromosome

Each individual parameter is defined as a sub-chromosome, representing the delay between start time and submit time for each job. The chromosome simply concatenate many individual parameters.

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3.2 Fitness Function and the Reduction of Device Power Consumption

What we are trying to do is to reduce the device transitions between the working and the sleeping states through intelligent scheduling. From this point of view, if two or more jobs which are using the same device can be executed successively, it will reduce the transitions of the device and extend the sleep time for other devices. To find a schedule with many appearances of such a condition is our objective. The fitness is defined as the power saved by avoided transitions through reasonable schedule. It is calculated through the following eqution:

$$Fitness = 2 * P_t * T_t * Score \tag{1}$$

$$Score = T_{max} - T_s. \tag{2}$$

Where P_t is defined as the power consumed by wake up or shut down, T_t is defined as the time for transaction. T_{max} is defined as the maximum number of transitions without reasonable schedule, and T_s represent the transitions needed by the evaluated schedule.

4 Results and Conclusions

The shortcomings in memory and time requirements become obvious for traditional algorithms which deal with the scheduling problem as the problem size is increased. Experiment shows that our GA-based scheduler is not only attractive in less memory and time requirments, but also the well scaled feature for complex problems.

References

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