【主論文の要旨・記入例】

学位報告 4

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主　論　文　の　要　旨

論文題目　Model-Based Parallelization for Simulink Models on Multicore Processors
（Simulink モデルに対するマルチコア向けモデルベース並列化手法）

氏　　名　　鍾　兆前

論　文　内　容　の　要　旨

With the evolution of more complex embedded control systems, model-based development (MBD) with platforms such as MATLAB Simulink is becoming increasingly common. Further, owing to the power consumption and heat dissipation generated by the processors, it is becoming highly difficult to raise the clock frequency of these processors. To improve software performance, multicore processors are being increasingly adopted in the design of emerging complex embedded systems. To implement control models described in Simulink to multicore processors, it is important to partition the generated model-based software and execute them in parallel based on the characteristics of the multicore architectures.

This dissertation presents model-based parallelization methods of parallelizing Simulink models on the following multicore architectures.

- Homogeneous multicore processors
- Heterogeneous multicore processors of single instruction set architecture (ISA)
- CPU-GPU heterogeneous architecture

In the study of model-based parallelization for embedded control systems on homogeneous multicore processors, we propose a hierarchical clustering method to parallelize the embedded system control models and use integer linear programming (ILP) to discover the optimized parallelization solution. We evaluated the proposed approach with existing methods on randomly generated data and a real-scenario automotive control model to demonstrate the effectiveness of the proposed method.

In the study of model-based parallelization for embedded control systems on single- ISA heterogeneous multicore processors, we focus on processors w

ith ARM big.LITTLE architecture, where cores are marked as big cores which are relatively more powerful but power-hungry, or as LITTLE cores which are relatively battery-saving but slower in performance. We propose a model-based parallelization approach to parallelize embedded systems built in the Simulink MBD environment on such processors. The proposed approach uses the hierarchical clustering method on Simulink blocks to reduce the problem scale and an ILP formulation to determine the core assignment solution, considering load balancing and the minimization of inter-core communication across cores with different performances.

In many cases of MBD, a Simulink model (or a part of the model) is used to process a large amount of data such as in image processing and scientific data calculation. It is possible to accelerate the execution of such model-based applications by executing the data parallelism blocks on graphical processing units (GPUs) rather than on central processing unit (CPU) cores for improved performance. For implementing such Simulink models on a platform of both CPUs and GPUs, a model-based approach is proposed to parallelize the Simulink models of image processing on a homogeneous multicore CPU and identical NVIDIA GPUs, where the number of homogeneous CPU cores and GPUs is equal, thereby enabling multiple CUDA kernels to be executed concurrently. We implemented image-processing algorithms with MATLAB Simulink and parallelized the models with the proposed approach in evaluation experiments. On execution of the generated codes, we experimentally demonstrated that the proposed approach achieves a reasonable speedup over implementations with existing methods.