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Task Scheduling in Dataflow Computer Architectures

by
Dr. Constantine Katsinis
Associate Professor
Electrical and Computer Engineering
University of Alabama in Huntsville
Huntsville, AL 35899

Dataflow computers provide a platform for the solution of a large class of computational problems, which includes digital signal processing and image processing. Many typical applications are represented by a set of tasks which can be repetitively executed in parallel as specified by an associated dataflow graph. Research in this area aims to model these architectures, develop scheduling procedures and predict the transient and steady state performance.

Researchers at NASA have created a model and developed associated software tools which are capable of analyzing a dataflow graph and predicting its runtime performance under various resource and timing constraints. These models and tools were extended and used in this work.

Experiments using these tools revealed certain properties of such graphs that require further study. Specifically, the transient behavior at the beginning of the execution of a graph can have a significant effect on the steady state performance. Transformation and retiming of the application algorithm and its initial conditions can produce a different transient behavior and consequently different steady state performance. The effect of such transformations on the resource requirements or under resource constraints requires extensive study. Task scheduling to obtain maximum performance (based on user-defined criteria), or to satisfy a set of resource constraints, can also be significantly affected by a transformation of the application algorithm. Since task scheduling is performed by heuristic algorithms, further research is needed to determine if new scheduling heuristics can be developed that can exploit such transformations. This work has provided the initial development for further long-term research efforts.

A simulation tool was completed to provide insight into the transient and steady state execution of a dataflow graph. A set of scheduling algorithms was completed which can operate in conjuction with the modelling and performance tools previously developed. Initial studies on the performance of these algorithms were done to examine the effects of application algorithm transformations as measured by such quantities as number of processors, time between outputs, time between input and output, communication time and memory size.