Algorithm-Based Fault Tolerant Systems Based on Graph-Theoretic Error Occurrence/Propagation Models

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Abstract

High performance parallel computer systems become feasible solution of computationally intensive problems by the advent of cost-effective VLSI components in the past few years. Since the probability of one or more processors to become faulty in such multiple processor systems is quite large, it is desirable for improving the reliability of them to build some on-line fault tolerance features into them. However, the requirements for high performance and fault tolerance are seemingly contradictory: parallel architectures and algorithms have been developed to achieve maximum utilization of each of processors, while fault tolerance requires redundant computations and checking operations to ensure that the computation results are correct. To incorporate fault tolerance into multiprocessor systems at lower cost, several ABFT techniques have been proposed. However, most of these discussions are target dependent and less effort has been made at the generalization.

The objective of this research is to construct some general model which can be used for both analysis and synthesis of ABFT systems. Fault detectability/locatability under some practical error occurrence/propagation models and formal design methods of checking scheme of ABFT systems are also discussed on this general model. The essentials of ABFT technique are to encode data at system level and to modify the target algorithm to operate on the encoded data. To analyze and to control fault detectability/locatability of such a system, the error occurrence/propagation model at the algorithm level plays an important role. The model for ABFT system considered here can fully utilize a specified error occurrence/propagation model by using data dependency, and it can give us tighter conditions for fault detectability/locatability than previous models do. In the turn for synthesis, these properties contribute to the cost-effective checking scheme by reducing redundant checking operations.

In the result, the analysis/synthesis model and some relevant discussions done in this research will provide important bases for reliable parallel computing systems.

Key Words: **algorithm-based fault tolerance, checking scheme, data dependency, error occurrence, error propagation, fault detection, fault location, reliable parallel computing system**