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高效的部分冗余容错编译:复制错误流关键子图

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Abstract
Traditional fault tolerance compilations replicate all computations and registers to guarantee fault tolerance. But this brought great overhead in both storage utilization and performance. This paper suggestes a new concept of critical subgraph of error flow graph based on error flow analyses. Methods are given to generate critical subgraphs from critical nodes or from critical paths, and partial redundancy algorithm is suggested to replicate only critical subgraph. Partial redundancy algorithm guarantees effective fault tolerance, and greatly improves performance, reduces power dissipations and reduces storage usage. Experimental results show that, compared with full redundancy which replicates full error flow graph, partial redundancy can reduce register usage by 6.25%, reduce power dissipation by over 17%, reduces total execution cycles by nearly 26%, and improves performance by over 22%, at the cost of 6.25% lower nodes coverage.

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摘要
传统的容错编译通常复制所有的计算并且使用完全冗余的存储单元来保证容错.这种完全冗余在存储空间和性能上的开销都是相当大的.在错误流分析的基础上提出错误流图的关键子图的概念以及通过关键结点和关键路径生成关键子图的方法,并设计了通过复制错误流关键子图实现部分冗余的算法.在保证有效容错能力的同时,部分冗余明显减小了经过容错编译的程序在存储空间和性能上的开销.实验显示,与复制全部错误流图的完全冗余相比,在结点覆盖率降低6.25%的情况下,部分冗余算法最多能够减少寄存器的使用数量6.25%,减少功耗超过17%,减少执行时间接近26%,同时提高性能超过22%.

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