EFFICIENT VLSI NETWORKS

AND

PARALLEL ALGORITHMS BASED ON THEM

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CERTIFICATE

This is to certify that the thesis entitled 'Efficient VLSI Networks And Parallel Algorithms Based On Them', being submitted by Dhruva Nath to the Indian Institute of Technology, Delhi for the award of the degree of Doctor of Philosophy, is a record of bonafide research work carried out under our supervision. The results contained in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma.

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ABSTRACT

This thesis describes two interconnection networks for parallel processing, namely the Orthogonal Trees Network (OTN) and the Orthogonal Tree Cycles (OTC). Both networks are suitable for VLSI implementation, and are simple to program - visualising algorithms on them is straightforward. While these networks have time performances similar to fast networks such as the Perfect Shuffle Network (PSN) and the Cube Connected Cycles (CCC), they have substantially better Area * time^2 (AT^2) performances for a number of matrix and graph problems. For instance, two NxN Boolean matrices can be multiplied in $O(\log^2 N)$ time on both the OTN and OTC with AT^2 figures of $O(N^4 \log^2 N)$ on both. Both the CCC and PSN require an AT^2 of about $O(N^5)$ for this problem. The connected components of an undirected N-vertex graph can be found in $O(\log^3 N \log\log N)$ time on the OTN and OTC, for AT^2 figures of $O(N^2 \log^8 N \log\log^2 N)$ and $O(N^2 \log^6 N \log\log^2 N)$ respectively. Interestingly, for this problem the time taken is the same as the 'fast-but-large' networks like the PSN and CCC, but the chip area used up is only about as much as the 'slow-but-small' networks like the Mesh. As a result, the AT^2 figures for the OTN and OTC are substantially better than both: The Mesh, PSN and CCC all require an AT^2 of about $O(N^4)$ for this problem.

The same is true of the minimal spanning tree problem. A number of other problems such as sorting and the Discrete Fourier Transform can be solved on the OTN and OTC with AT^2 figures comparable to those of other networks. Therefore, they can be used as general purpose parallel processors. Alternatively, they may be used as special purpose VLSI chips.

CONTENTS