Heuristic Synthesis of MTBDDs
Based on Local Width Minimization

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Design of digital systems is based on various specifications of Boolean functions, most often in a form of Boolean expressions or in cube notation. Another popular machine representation of single-output Boolean functions uses binary decision diagrams (BDDs), which can have many forms.

Conversion of a single Boolean function into a BDD and related optimization problems were studied intensively. As the variable ordering influences the cost and shape of the diagram, we should find one ordering of variables among all possible, that produces a diagram optimal in a certain sense (e.g. minimum cost, width or average path length).

Generalization of BDDs to multiple-output Boolean functions are so called word-level BDDs, among them e.g. multi-terminal BDDs (MTBDDs) or BDDs for characteristic function BDD_for_CF. The latter diagrams use both input and output variables at decision nodes what makes them more complex; their width can be minimized in some cases by the known algorithm. On the other hand, optimum MTBDD synthesis, basically optimum ordering of variables with respect to a certain goal, is covered very little in the literature; and yet, tools for BDDs synthesis and manipulation cannot be used for MTBDDs, nor can be a MTBDD obtained from BDDs of component Boolean functions. Given the ordering of variables, the diagram may be obtained by decomposing the original function repeatedly, i.e. removing a group of 1 or more variables at each step.

In the presentation we will present an improved algorithm of MTBDD synthesis aiming at minimum MTBDD width or cost. The presented algorithm is a core of the upgraded version of a synthesis tool that accepts incompletely specified integer-valued functions of Boolean variables specified by possibly compatible cubes. The suggested technique is suitable for hardware (LUT cascades) or firmware implementation (branching microprograms).

The presentation will be based on a paper we have presented recently at DSD 2009 [1]. This research has been carried out under the financial support of the research grants GA102/07/0850, GD102/09/H042 and MSM0021630528.

References

1. Mikušek, P., Dvořák, V.: Heuristic Synthesis of Multi-Terminal BDDs Based on Local Width/Cost Minimization. In: 12th EUROMICRO Conference on Digital System Design DSD 2009, August 27–29, Patras, GR, IEEE CS, 2009, pages 605–608, ISBN 978-0-7695-3782-5