VLSI Standard Cell Design Using Genetic Algorithms

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Abstract We introduce the idea and a proof of concept of automated standard cell design for Very Large Scale Integrated Circuits (VLSI) using GADO - a genetic algorithm for design optimization.

1 Introduction

Standard cells are the lowest-level building blocks in VLSI design. Since most chip designs are composed of many standard cells, optimization of these cells is very important. Traditionally, standard cell libraries have been designed by humans. Recently, however, there has been a movement toward automated standard cell design [1, 2].

The advantages of automated standard cell design are low cost and custom tailoring. On the other hand, current automatically generated libraries are less efficient than hand designed ones.

2 Our work

Our work addresses the problem of inefficiency in automated standard cell design. We apply a genetic algorithm [3] to find standard cells, which are more efficient than hand designed ones. Genetic algorithms (GAs) are used to find more fit solutions from a diverse pool in a process similar to natural selection. The GA used in this work (GADO) is a GA that was designed to be suitable for engineering design optimization domains. These domains usually envolve expensive fitness evaluations and search spaces that are very difficult to search.

2.1 Representation

We used integers to represent the different components on the chip. We use a repair method to reduce the effects of aliasing. When genetic operators such as crossover and mutation are done, we sort the components of the chromosome in a way that maps the order of components on the board.

2.2 Fitness

A number of metrics were taken into account in our fitness function. These included area, power, speed, number of correct outputs, and design rule errors. The fitness function was hierarchical so that time would not be wasted evaluating incorrect designs for efficiency. The fitness function was also extended to check that inputs influence the proper output nodes.

2.3 Diversity

The distance between two designs was computed as the Euclidean distance between their integer representations. We are planning to create a more meaningful diversity function by taking into account the circuit structure.

3 Preliminary Results

Figure 1 shows the current results of our work. This is an attempt to build an inverter. You can see that the input node drives the gate of a transistor influencing the output node. Unfortunately, the other node of the transistor is not connected because the fitness function did not encourage this. We are planning to extend the fitness function to ensure that no transistor nodes are unconnected.

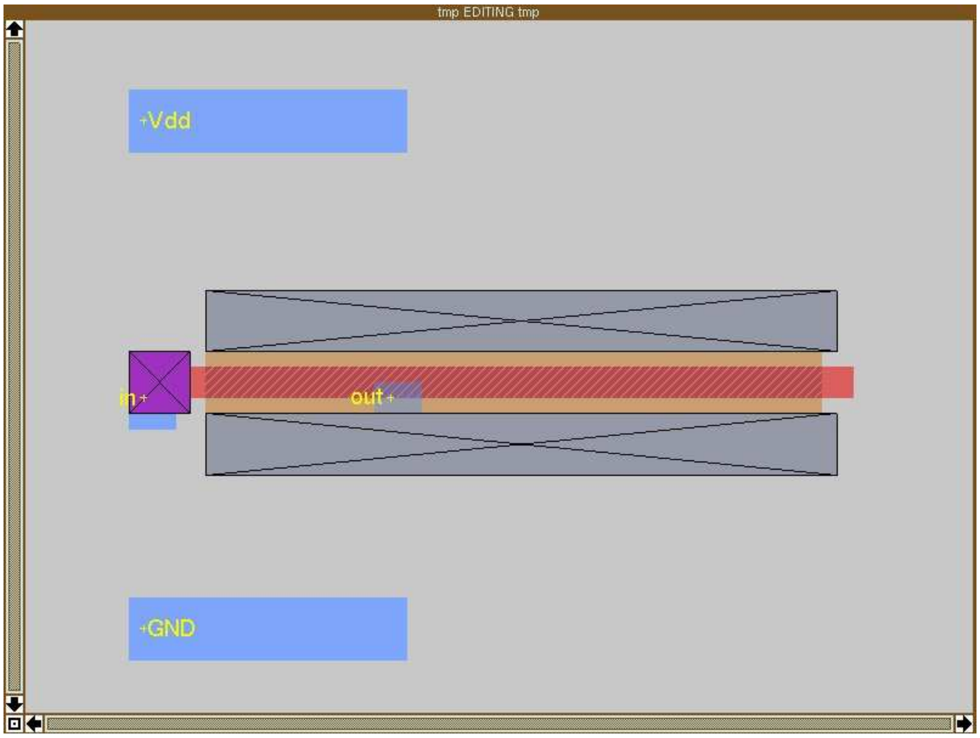

Figure 1: Current attempt to design an inverter.

4 Conclusions

We have presented a novel scheme for automated standard cell generation. We currently have not generated any complete circuits. However, we believe that this technique shows great promise with further development.

References

[1] C. Edwards, *EDA Vendors Rethink Standard-Cell Libraries*, Electronics Times, June 2000.

[2] D. Pietromonaco, *Automating Cost-Effective Library Creation*, Integrated System Design, November 2000.

[3] K. Rasheed and H. Hirsh, *Learning to be Selective in Genetic-Algorithm-Based Design Optimization*, Artificial Intelligence in Engineering, Design, Analysis and Manufacturing, 1999.