

Parallel Cell Placement Experimental System

ABSTRACT

This experimental system has been constructed to examine the efficiency of the parallel algorithm when applied to cell placement problems in LSI-CAD ,i.e., the combinatorial optimization problem.

This problem requires the circuit data and cell data as input, and decides the placement of each cell so as to minimize the wiring area.

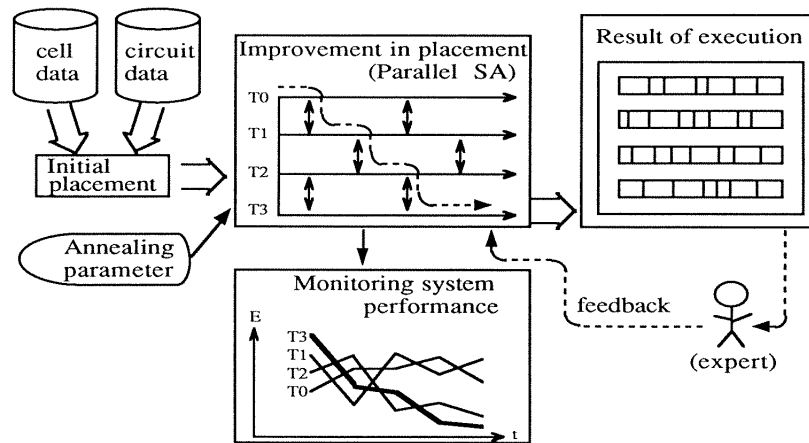
FEATURES

Parallel Simulated Annealing (PSA) is proposed.

- Plural SA processes execute iterative improvement under various values in the parameter (temperature).
 - Global searching at higher temperatures, and local searching at lower temperatures.
- The probabilistical and periodical exchange of solutions between adjacent temperatures automates the cooling schedules.

Improvements in placement are monitored with the expert being allowed to interact with the system.

- Displaying the estimated values of solutions on a line graph in real-time.
- Suspension and Re-execution are allowed to let the expert modify the cell placements.



Construction of parallel cell placement experimental system

ABSTRACT

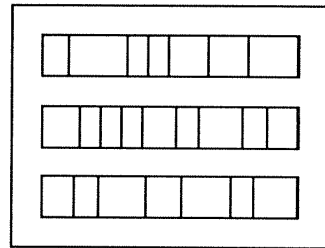
The placement problem is one of the processes in LSI layout design. It decides the placement of each cell so as to minimize the wiring area from the given circuit data and cell data. The number of cells in a chip is very large. Thus it a vast solution space must be searched to minimize the wiring area.

The Simulated Annealing (SA) sequential algorithm is well-known and is an efficient technique to solve this kind of combinatorial optimization problem. Parallel SA (PSA) is a new algorithm proposed for parallel computing machines. It automatically decides the value of a control parameter called 'temperature'. This is a difficult problem when applied to the sequential SA algorithm. This experimental system applies PSA, and solves the placement problem in LSI layout design on a Parallel Inference Machine.

The LSI design objective

The objective of this system is to form a standard poly-cell type cells.

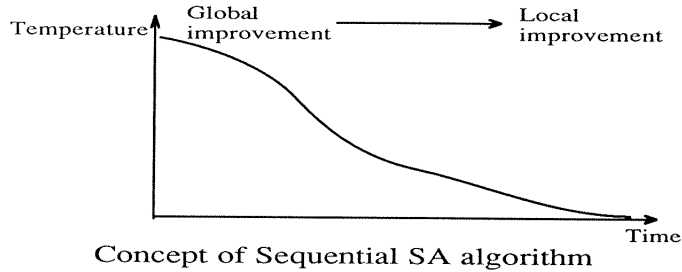
The elements of the circuit are cells with various width and uniform height. A standard cell consists of plural cell blocks constructed from a line of cells. The object of this system is to minimize the total wiring length used to connect each cell and terminal in the LSI.



Example of standard cell

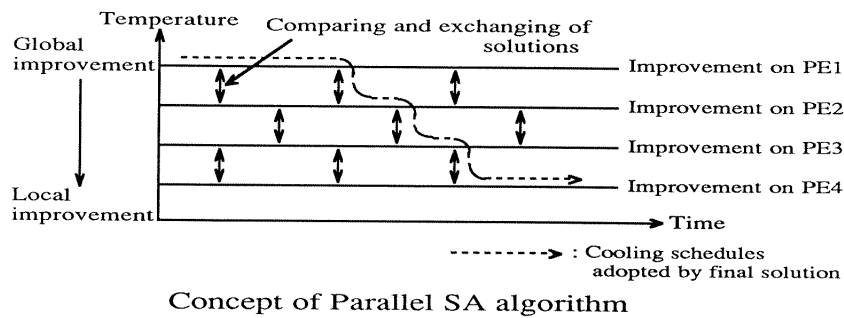
Sequential Simulated Annealing algorithm

Sequential SA is a kind of probabilistical algorithm. It iteratively improves the solution using pseudo random numbers. When applied to the cell placement problem, the placement is iteratively improved by randomly changing arbitrary cell positions. The temperature parameter is used to control the system as described below. Global improvements in the initial stage of execution, and local improvements in the latter. The lower the temperature, the greater the emphasis on local improvement. The fine control of the temperature depends on the objective problem. Individual adjustment is required to apply the sequential SA algorithm to specify problems.



Parallel Simulated Annealing algorithm

Parallel SA(PSA) automates in temperature control which is difficult in sequential SA. In PSA, unique and fixed values of the temperature are given to each processor. Improvements in placement using random numbers are executed individually. Periodic comparison and exchange of solutions is conducted between processors with adjacent temperatures. If the estimated value of the higher temperature is lower than that of the lower one or if two values are closed, the solutions of adjacent temperatures are exchanged. As a result, global improvement and local improvement are selected suitably as the execution proceeds, and the automatic in temperature control is realized. Finally the most improved solution appears in the processor with the lowest temperature.



Abstract of demonstration

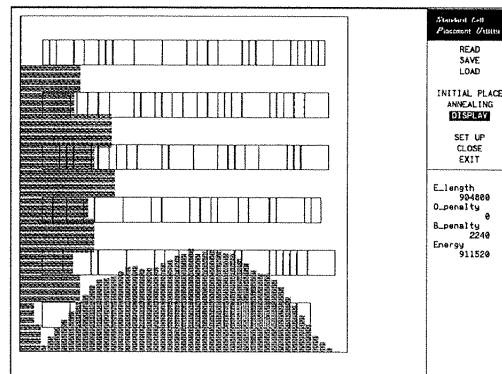
We demonstrate the following two topics on Multi-PSI(64PE). Sixty three processor elements(PEs) are used to execute PSA under unique and fixed temperature values. Iterative improvements are executed simultaneously on these PEs. One PE is used to monitor the process of improvements.

(1) Use artificial data which is small and has a known optimum solution.

- The data consists of 25 cells and 40 nets.
- The execution states are shown until the optimum solution is reached.
- The optimum solution is reached when the cells are placed in a 5×5 square.

(2) Use real data with an unknown optimum solution.

- The data consists of 125 cells, #147 nets and 24 I/O's.
- At first, random initial placement is executed, and the estimated value and channel density of the state are shown. The channel density is shown on a bar chart in the figure titled "Initial Placement".
- The process of improvement is monitored by estimated values that are displayed in real-time.
- After executing improvements in placement for a period of time, a result is obtained. Check the improvement in estimated value and the uniform expansion and flatness of the channel density.



Initial Placement