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ABSTRACT

Parallel distributed processing is considered a revolutionary new approach for solving certain type of problems, such as stock cutting that posed difficulty for engineers in the past. The problem of allocating irregular patterns arises frequently in applications where it has to be determined how a set of two-dimensional shapes will fit onto a stock sheet of finite dimensions with minimum waste. This study describes the use of simulated annealing approach for the solution of the problem.

INTRODUCTION

Ever since 1950's, there has been a growing interest in two-dimensional allocation problems [1,2,3]. This is partly due to the important role these problems play in computer aided design applications particularly those related to sheet-metal fabrication, garment making, plant and circuit layout. The problem is NP-complete and geometric combinatorial in nature [4]. Various heuristic algorithms proposed for solution explore a discrete space of admissible configurations in a sequential manner until a satisfactory one is found. On the other hand, randomized search algorithms such as simulated annealing [5] accepts solutions that are inferior to current solution configuration in the process of finding the optimal solution. Parallel architecture proposed in this study uses this approach for allocating irregular patterns.

GENERAL OUTLINE OF THE PROPOSED APPROACH

The approach uses an energy function which considers area of the rectangle enclosing all figures, level of similarities between pattern pairs and degree of overlap of patterns in evaluating the configurations generated. Patterns and configuration of pattern within stock sheet are represented using unimodular matrices.

Simulated annealing is used to minimize a function representing values of different allocation configurations. The cost or energy function to be minimized have three components;

$$f = \beta_A f_A + \beta_W f_W + \beta_O f_O$$

where fA denotes the area of the enveloping rectangle for all patterns, and f_O represents the amount of overlap in a given placement, and f_W is equal to $\Sigma\Sigma W_{ij}\, d_{ij}$ where, d_{ij} is the distance between the center of gravities of the patterns i and j in a given configuration, and W_{ij} represents the attractiveness weight of patterns. β_A, β_W and β_O are all positive terms determining the relative weights of the three different terms used in the energy function based on given set of patterns.

REMARKS

Currently, the validity of the approach is being tested. Fifty irregular random patterns are generated to be used as a test pattern pool. Parameters of the energy function are calculated based on these patterns. Attractiveness parameter for the pattern pairs are calculated according to pattern features.

Computer code is being developed to minimize the energy function using simulated annealing approach. Annealing schedule to be used in the code includes initial temperature, temperature decrement, equilibrium condition and stopping criteria. Results obtained so far on toy problems are promising.

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