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Spatial Scheduling in Shipbuilding Industry

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ABSTRACT

In any large heavy industry like that of ship building, there exist a lot of complications for the arrangement of building blocks optimally for the minimal space consumption.

The major problem arises at yard because of laxity in space for arranging the building blocks of ship under construction. A standardized erection sequence diagram is generally available to provide the prioritised erection sequence. This erection sequence diagram serves as the frame work. In order to make a timely erection of the blocks a post plan has to be developed so that the blocks lie in the nearest possible vicinity of the material handling devices while keeping the priority of erection. Therefore, the blocks are arranged in the pre-erection area. This kind of readiness of blocks leads to a very complex problem of space. This arises due to the least available space leading to an urgent need of an availability of intelligent spatial schedule without compromising the rate of production. There exists two critical problems ahead namely, the spatial occupation layout of pre-erection area and the emptying pattern in the spatial vicinity. The block shape is assumed be rectangular. The related input data's are the dates of erection (earliest as well as the latest), geometrical parameters of block available on pre-erection area, slack time and the like.

Keyword: Genetic Algorithm, Scheduling, Pre-Erection Area.

1.0 Introduction

There is always a requirement for better decision support system in any industrial operation. World over industrial engineers and decision makers are thriving to find an innovative ideal solution for their unique problems. Every scheduling and decisional problems end up in complicated iterative loop system. This kind of situation brings forth the urgent attention towards effective scheduling problems. An efficient spatial schedule rewards considerable improvement in profitability in terms of time, man and machine productivity all culminating to monetary aspects.

2.0 Major Shipyard Problems

The shipbuilding industry is a large production unit with multilevel probability of bottleneck formation during regular work flow pattern. In order to exemplify the problem in engineering modules, a cross work has to be done for introducing mathematical numerology so as to precipitate into a generalised optimisation problem with

well defined objective function and subjective constraints.
More commonly addressed problems are the identification of erection sequence, the manpower work flow management, load balancing over man and machine, the spatial scheduling, look ahead policy by the system to anticipate the flow blockade, productivity analysis, resource utilisation aspects, and the like.

3.0 Spatial Scheduling

The problems of spatial scheduling are approached with different techniques. In fact spatial scheduling problem addresses the requirement of optimal and best arrangement pattern of blocks so that it occupies minimum possible area in the pre-erection (PE) space. Along with spatial occupancy criteria, a consideration has to be made in such a way that the blocks are arranged in the easily accessible position to man and other material handling devices operating in the PE and at dock premises.

An efficient spatial schedule should match the stipulated dates of erection of blocks designated by erection sequence diagram. There are many co-related tasks to be considered, especially the maximum usage of spatial and other non spatial resources and elimination of waiting time for progressing tasks or inventories. There exists various stringent constraints of time frame, priority of the erection of blocks, man and machine performance abilities.

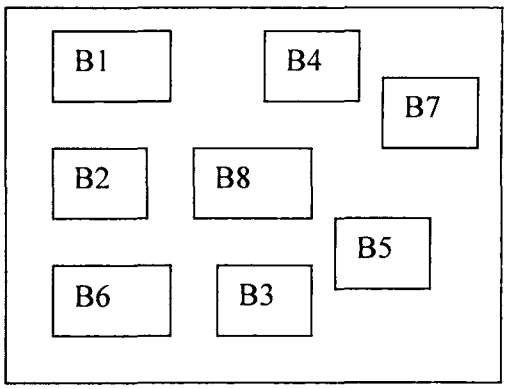

Fig. 1 Haphazard block layout in the Pre Erection Area

There are various methods adopted while dealing with these kinds of problems. In this paper, the genetic algorithm approach of optimisation is discussed.

4.0 A Genetic Algorithm Approach

Genetic algorithms are general-purpose search algorithms based upon the principles of evolution observed in nature. Genetic algorithms combine the genetic operators such as selection, crossover, and mutation operators with the goal of finding best solution to a problem. A genetic algorithm searches for the optimal solution until a specified termination criterion is met.

The solution to a problem is called a chromosome and a chromosome is made up of a collection of genes which are simply the parameters to be optimized. A genetic algorithm creates an initial population (a collection of chromosomes), evaluates the population, and then evolves the population through multiple generations (using the genetic operators discussed above) in the search for a good solution for the problem in hand.

Genetic algorithms can be applied to a wide variety of optimization problems such as scheduling, computer games, stock market trading, medical, adaptive control, transportation, the traveling salesmen problem, etc.

This approach generally embeds itself in such a way that a concept of machine learning is invoked and system makes its own decisional moves in order to terminate to an optimal solution.

5.0 Heuristics Background

The generally accepted heuristics of bottom left first selection concept is kept prevailing when an assumption of rectangular global (Pre Erection area) and the local layout (block plan area) is made. This concept is kept in mind as the background for the development of spatial scheduling system for the present problem. There are predominantly used various spatial search techniques namely, maximal remnant space utilisation strategy, maximal free rectangular space strategy, initial positioning strategy, and edging strategy.

6.0 Spatial Layout Problem Using Genetic Algorithm

In the present problem, an optimal spatial schedule has to be generated in the Pre Erection Area for the ship building blocks for optimal space consumption as well as taking care of erection order.

Lets us encode the various requisite parameters to Genetic algorithm designations. The data structure concept of object oriented programming is taken to consideration for the working of this program. In this algorithm chromosome stands for block data, which includes geometric parameters like length and breadth, dates of erection and priority ranking. A gene comprises of various chromosomes to create individual strands. The number of chromosomes in a gene is decided based on the total blocks available and thus attempt is made to derive the chromosome length.

6.1 Encoding

The blocks are considered with the accumulation of the block data parameters where associated database are stacked using data structures into predefined memory space and builds up into arrays.

Name of Block	B1	B2	B3	B4	B5
Length	5	7	10	19	12
Breadth	3	4	5	8	7

Fig. 2. A typical chromosome

(1) Firstly, the initialisation of population is done based on a random fashion depending upon the number of blocks. The chromosomes in the gene are determined based on the potential optima say, in this case based on geometrical data of pre erection area and the blocks.

(2) This iteration proceeds and offspring generations are created till the termination criterion is satisfied.

(A) Each program in the population is executed for the random selection to

continue in a bit by bit sequence and assign it a fitness value using the problem's fitness measure of 0.3.

(B) A new population of genes are created by applying the following operations to program(s) selected from the population with a probability based on fitness (with reselection allowed).

6.2 Reproduction

The selected chromosome is copied to the new population. This copying facilitates the addition of the populations in to agile group to improve the system to develop maximum possible random combinations.

6.3 Crossover

In this step new offsprings are created by the system for the new population by recombining randomly chosen parts of two selected genes. Thus enormous samples are created.

6.4 Mutation

New offspring program for the new population is developed by randomly mutating a randomly chosen part of the selected program.

B1	B2	B3	B4	B5
5	7	10	19	12
3	4	5	8	7

B7	B9	B8	B11	B10
5	7	10	19	12
3	4	5	8	7

Fig. 3 A typical Crossover operations

(3) Now the evolved offsprings are designated by the individual operation that is identified by result designation (the individual with the best fitness) as the run's result.

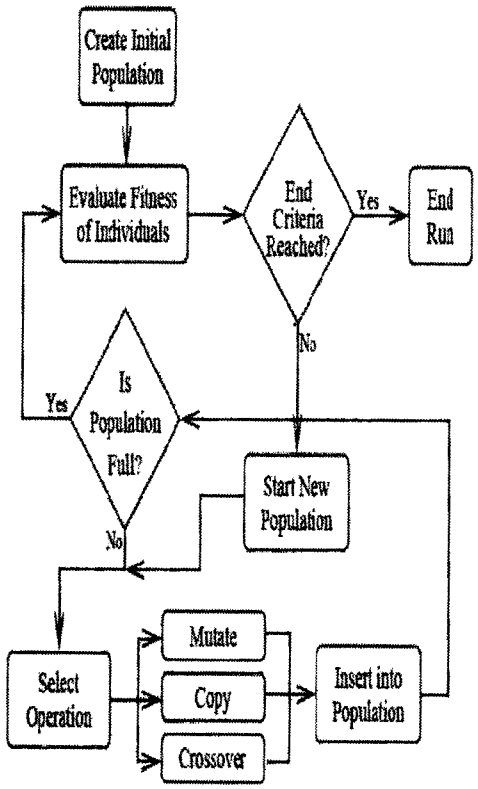

Fig. 4 Modified Genetic Algorithm Flow Chart for the problem

6.5 Terminations Conditions

In this paper the termination condition for per GA run is defined as follows:

1. The termination conditions met when the system finds a duplicate sample in the allocated result space.
2. The system finds no further healthier genes in the allocated memory space.

7.0 Result

The generated results are obtained as graphical waveform in the scatter diagram pattern. These results are decoded to achieve finding the optimal path. This optimal wave gives the best possible spatial layout for the corresponding shipyard.

8.0 Conclusion

The developed spatial scheduler program is capable of handling any desired number of blocks required for ship building, inter file handling systems, database modifications facilities for customising and producing the network related solutions. Here enormous usage of data structures has been done to handle the huge working database and random operator's work space. This could produce self explained graphical colour output of the spatial layout of pre-erection area, which helps in reconsidering and giving proper MIS to take concerned corrective actions. The main advantage of such efforts is that without any additional investment in man and machine, an eventually superfluous working strategy is evolved.

9.0 Acknowledgements

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