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A novel approach for parallel disassembly design based on a hybrid fuzzy-time model

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INTRODUCTION

Over the decades, the issue on disassembly path planning has attracted many researchers' attention due to not only the environmental factors but also the efficient use of natural resources.

- A number of researches have proposed disassembly sequencing approaches.
- Researches have great achievement with the optimal time and cost of disassembly.

Picture Credit: http://www.ethosboats.com/content/eco-friendly

ISSUE

❑ The Lacking of Present Research

Existing researches mainly focus on the sequential disassembly problem. There is little consideration about parallel disassembly, which usually exists over productive processes.

❑ Our Research Work

we propose a novel approach of parallel disassembly based on a hybrid fuzzy-time model. The parallel disassembly path planning method dispatches all workstations synergistically, which shortens the disassembly time and reduces the cost. The disassembly process is influenced by several uncertain factors and the time is not accurate in every process. We express the removal time of each component with triangular fuzzy numbers. Also, we encode components and available stations together within a chromosome sequence to simplify the algorithm. With introducing Gaussian function into genetic algorithm, the rate of convergence is improved, which contributes to an optimal result.

Problem Statement

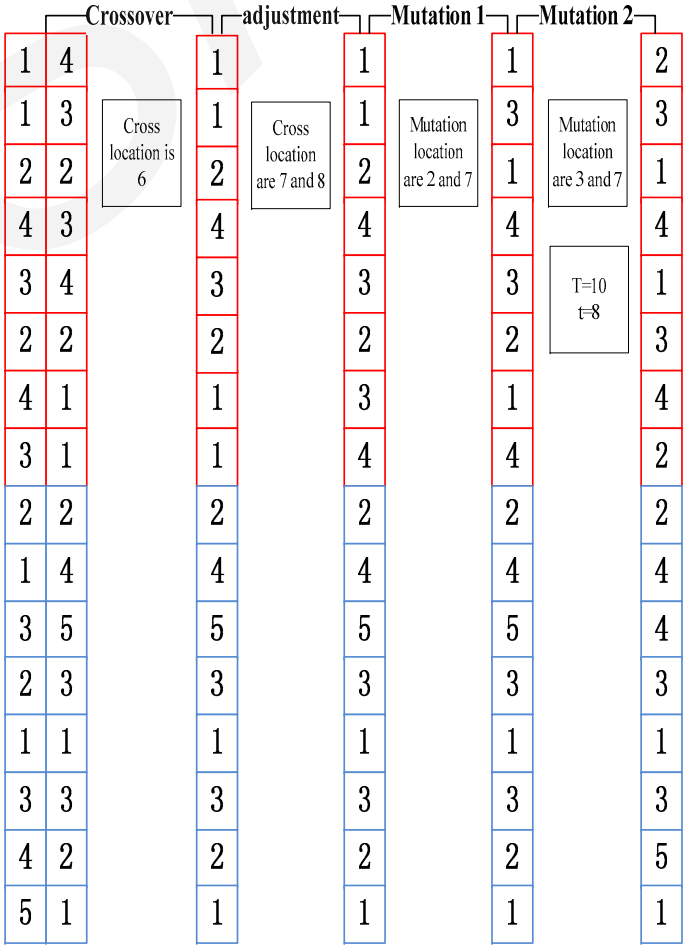
❑ The Proposed Fuzzy-Time Model

Notations	Descriptions
$AP = \{ap_1 \dots ap_i \dots ap_L\}$	The set of components, where ap_i is the ith component
$OP = \{op_1 \dots op_i \dots op_L\}$	The set of process orders
$OP_i = \{op_{i,1} \dots op_{i,j} \dots op_{i,W(i)}\}$	The process order of certain component ap_i
$ST = \{st_1 \dots st_k \dots st_N\}$	The set of stations, where st_k is the kth station
$SO_k = \{so_{k,1} \dots so_{k,h} \dots so_{k,NU(k)}\}$	$so_{k,h}$ is the total processes finished in the certain station st_k, and the fiction NU(k) is the total number of the processes
$f = t(st_k, so_{k,h})$	The fiction to represent the time that each process needs in each station
$g = c(st_k, so_{k,h})$	The fiction to represent the cost that each process needs in each station

The Optimization

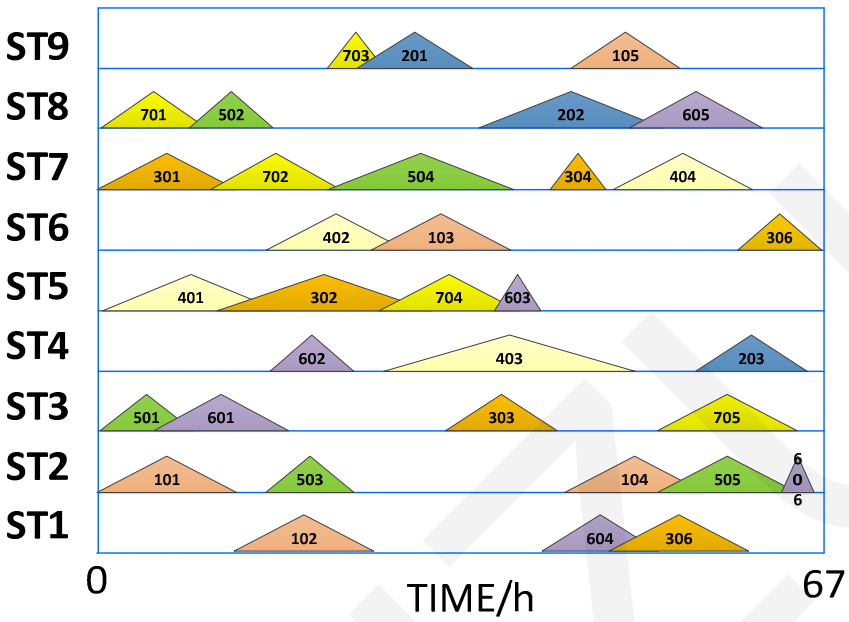
❑ The information interpreted from the chromosome

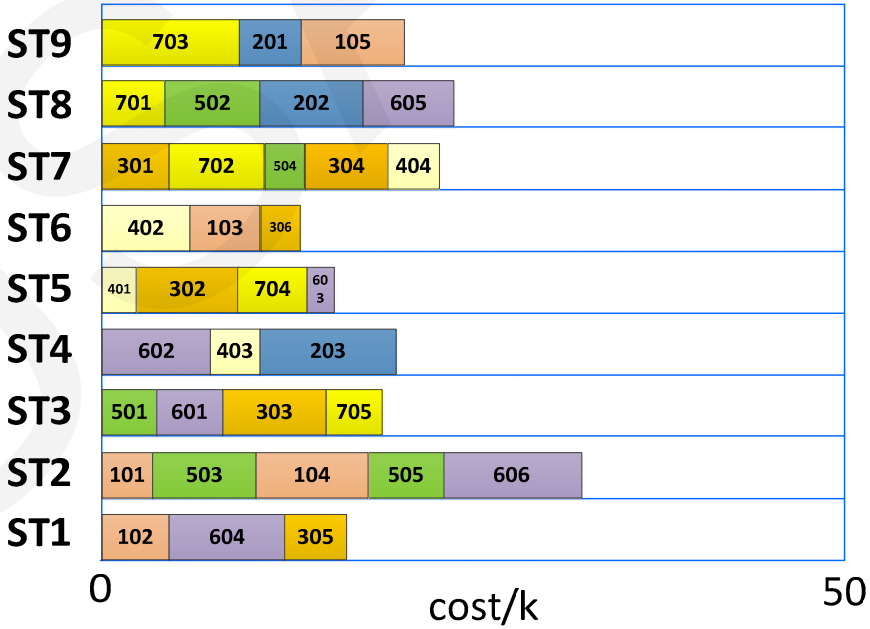
Chromosome	1,3,4,2,4,1,3,2,1,4,1,2 | 2,5,3,3,1,4 ,2,5,4,2,1,5
disassembly sequence	Component 1→Component 3→Component 4→Component 2→Component 4→Component 1→Component 3→Component 2→Component 1→Component 4→Component 1→Component 2
Station sequence	Station 2→Station 5→Station 3→Station 3→Station 1→Station 4→Station 2→Station 5→Station 4→Station 2→Station 1→Station 5
Component 1	4 processes in total
Component 2	3 processes in total
Component 3	2 processes in total
Component 4	3 processes in total



Case Study

❑ Simulation Results

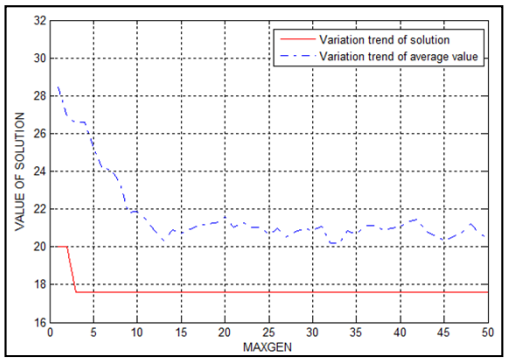


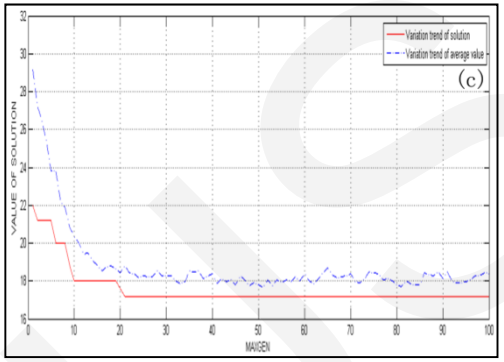


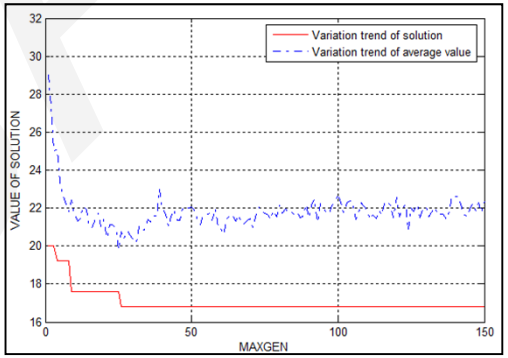
	Maxgen	Fitness	Computing time
Genetic Algorithm in this paper	50	17.5	6.3
	100	17.3	12.8
	150	16.8	16.9
RRT Algorithm	50	19.6	6.8
	100	20.4	13.7
	150	23.3	18.1

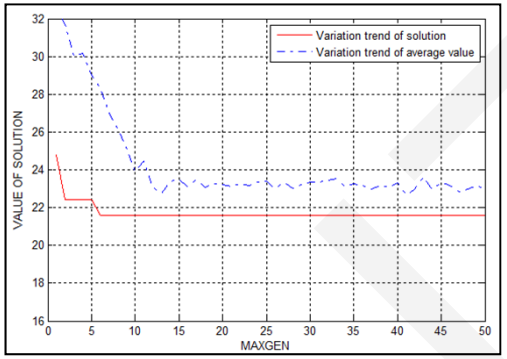
Case Study

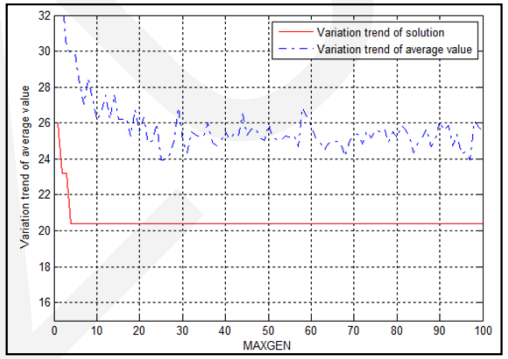
❑ Simulation Results

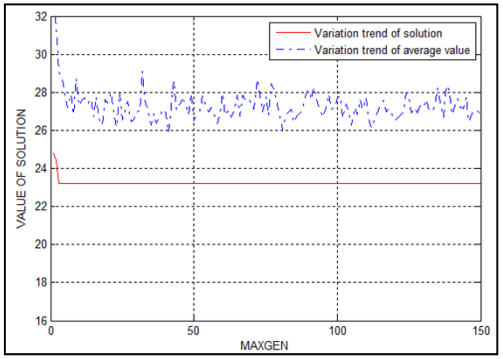












We make a conclusion that algorithm proposed this paper can usually get a better solution. Furthermore, the running time of the new algorithm is shorter.

Conclusions

In this research, we consider a parallel disassembly path planning problem with fuzzy-time focus on minimum overall operation time and cost. In order to represent disassembly path planning and fuzzy time of processes, we describe a disassembly path planning problem with N stations and L components. Then fuzzy time-based dispatching disassembly process model is proposed and constraints were deduced base on the model. Gauss mutation operator is introduced to GA to optimize the result, for better solution and shorter time.

An application of the proposed approach is illustrated with disassembly of a hydro-press. The result shows that the problem can be solved perfectly within a reasonable amount of computing time and cost.

This research can be extended in several ways. First, the proposed approach is needed to be applied to more case studies so as to show the effectiveness. Also, it is a necessary to improve the algorithm to suit large-size products. And a coding method for large-scale data to GA is useful when the problem has a large number of components.