Optimizing Automated Stacking Crane Dispatching Strategy Using an MOEA for an Automated Container Terminal

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ABSTRACT : *The problem of automated stacking cranes (ASC) dispatching in container terminals is addressed in this paper. We propose a heuristic-based ASC dispatching approach which adopts multi-criteria decision strategy. By aggregating different criteria the proposed strategy can consider multiple aspects of the dispatching situation and make robust decision in various situations. A multi-objective evolutionary algorithm (MOEA) is adopted to tune the weights associated to each criteria to minimize both the quay crane delay and external truck delay. The proposed approach is validated by comparison with different dispatching heuristics and simulation results obtained confirms its effectiveness*

KEY WORDS : *automated container terminal; automated stacking crane; dispatching strategy; optimization; multi-objective evolutionary algorithm*

1. Introduction

Container terminals consists of many blocks an each block contains a number of container stacks and two non-overlapping automated stacking cranes (ASCs). There are four main jobs and two preparatory jobs for associated container, named loading, discharging, carry-in, carry-out, re-handling and repositioning. To maximize the productivity of a container terminal, it is important for quay cranes (QCs) to process jobs without any delay and the ASCs should be able to stack or retrieve the containers rapidly. This paper proposes an effective combination of a rule-based dispatching algorithm with an evolutionary optimization method to optimize the weights associated with each criteria and other free parameters.

2. ASC Dispatching Problem

There are several difficulties in ASC dispatching. The first difficulty is how to decide the candidate jobs that can be done at the time of an ASC becomes idle. The second difficulty is that of preparatory jobs. Such preparatory jobs are the main cause of delay of crane operation, and they result in undesirable extended waiting of QC or ET. Discriminate the main jobs and the preparatory jobs become important that means in which condition that the idle ASC decide to help the other ASC by doing his preparatory jobs or just consider own business. Because if the landside ASC want to help the seaside ASC by performing the preparatory of seaside jobs since considering seaside jobs are more important, there is a trade-off between the make span and ET delay and so does seaside ASC

3. Heuristic Based ASC Dispatching

This part describes a method of determining the job requested in a real time situation. First we select the jobs whose associated container has no above containers as candidate jobs. Then evaluate each candidate job by using heuristic based ASC dispatching strategy to select the most valuable job to perform. TABLE I shows the dispatching rules that we proposed. The dispatching strategy we

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proposed is a weighted sum of single dispatching rule that we show in Table 1. By using fuzzy decision algorithm to normalize the attributes we can get a more intelligent decision and balance each rules in strategy. By using MOEA to optimize the associated value we can to take into account the seaside performance and landside performance simultaneously.

Table 1 Dispatching rules

규칙	규칙 설명
E	Empty travel time
P	Processing time
D	Expected deadline
W	Workload
S	Expected saving time
IM	Interference make probability
IC	Interference caused.

4. Experiment Result

The yard simulation system and NSGA-II (Deb 2002) are used for optimizing the dispatching strategy. The experiment results show the effectiveness of dispatching strategy. Fig.1 and Fig.2 shows the result we got considering different distribution of container in stacking yard and the computation cost is significantly lower than local-search approach.

As the results show, our approach can improve both the seaside and the landside performance.

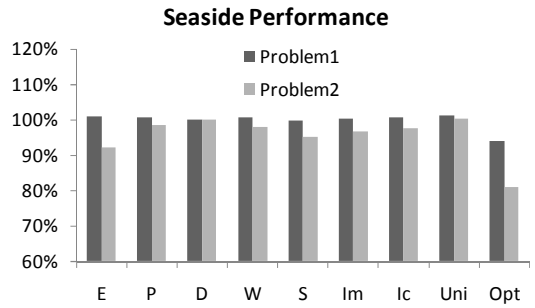

Fig.1 Seaside Performance

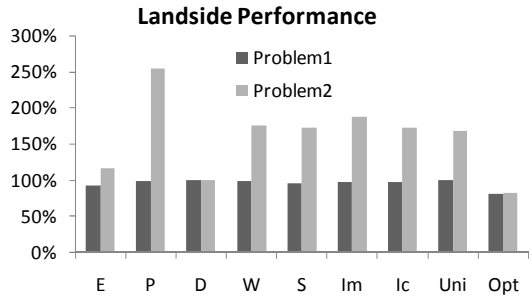

Fig.2 Landside Performance

5. Conclusion

The problem of automated stacking cranes (ASC) dispatching in container terminals is addressed in this paper. We propose a heuristic-based ASC dispatching approach which adopts multi-criteria decision strategy. By aggregating different criteria the proposed strategy can consider multiple aspects of the dispatching situation and make robust decision in various situations. A multi-objective evolutionary algorithm (MOEA) is adopted to tune the weights associated to each criteria to minimize both the quay crane delay and external truck delay. The proposed approach is validated by comparison with different dispatching heuristics and simulation results obtained confirms its effectiveness.

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