SIMULATION ANALYSIS OF SHUTTLE BASED STORAGE AND RETRIEVAL SYSTEMS

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Abstract

In this paper, a simulation-based performance evaluation of shuttle-based storage and retrieval system (SBS/RS) is presented. In comparison with well-known automated storage and retrieval systems, SBS/RSs can substantially increase the throughput capacity of the system. The objective of this study is to exploit the benefits of SBS/RS system design for reducing the mean cycle time of transactions and consequently increasing the throughput capacity of the system. Performance comparison of the studied SBS/RS is contrasted with alternative storage rack configurations, velocity profiles of the shuttle carriers and velocity profiles of the elevators’ lifting tables in the system. The results show that SBS/RSs are effective in reducing the mean cycle time and also show large improvement by increasing throughput capacity.

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Key Words: Automated Warehouse, Shuttle Based Storage and Retrieval System, Discrete Event Simulation, Performance Analysis

1. INTRODUCTION

Automated Storage and Retrieval Systems (AS/RSs) have been widely used in warehouses since 1950s to store and retrieve unit-loads without interference of an operator. The main advantages of AS/RSs are savings in labour costs and floor space, increased reliability, and reduced error rates.

The main disadvantages are high investment costs, less flexibility, and higher investments in control systems [1]. The early version of an AS/RS is also known as Crane Based Automated Storage and Retrieval Systems (CBAS/RS) which has one Storage and Retrieval (S/R) machine in each aisle that cannot leave its designated aisle (aisle-captive system). It can transport only one load at a time. There is large number of system design options for AS/RS in the literature [2, 3].

Due to increasingly small order sizes with large product variety and faster deliveries, material handling providers are developing new solutions. To meet this demand in throughput and constraints with regard to delivery times in warehouses, SBS/RS is developed in automated material handling industry.

This new technology is developed as an alternative to mini-load CBAS/RS where it cannot handle the required throughput capacity. In this technology, mostly two elevators lifting tables capable of vertical movement of loads (totes) share a single mast to transport totes from horizontally operating shuttle carriers to input/output (I/O) locations and vice versa. Shuttle carriers are usually tier-captive, however some other designs with shuttle carriers traveling between tiers and aisles may also be considered. In this study, we consider an SBS/RS with the tier-captive shuttle carriers.

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