

PARAMETRIC STUDY OF THROUGHPUT PERFORMANCE IN SBS/RS BASED ON SIMULATION

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Abstract

This paper presents an analysis of cycle times and throughput performances of Shuttle-Based Storage and Retrieval Systems (SBS/RSs), a relatively new technology that is becoming an important part of automated warehouses. A parametric simulation model was developed for the purposes of this research. The model enables calculation of Single Command (SC) and Dual Command (DC) cycle times and throughput performances of SBS/RS. The model was tested on a case study, which is based on a real type of SBS/RS. Experiments were designed to evaluate the following factors, such as number of bays n_x and minimum warehouse volume Q . Our research uses Design of Experiment (DOE) analysis and helps to achieve the proper dimension of the SBS/RS, which gives us the best possible performance of the SBS/RS. The simulation based on the presented model delivers the best SBS/RS designs.

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Key Words: Logistics, Warehouses, Shuttle-Based Storage and Retrieval Systems, Simulation, Design of Experiments, Performance Analysis

1. INTRODUCTION

The Internet based technologies have enabled the possibility to have better control of virtually all processes and to be able to customize mass produced goods. Customers accepted these new possibilities very well which, in turn, caused the reduction of production series` sizes and increased the number of different products. The need for management of a large number of variants, in smaller quantities, has arisen. All activities which support manufacturing processes have to follow this trend, including the activities of warehousing, logistics and transport. If, in the first phase, the computerization of warehouses was the sufficient answer to new demands, in the next phase, the changed supplier and customer needs demand construction of new types of warehouses. The need for storage and retrieval equipment has also changed because of the change of technologies. One of the answers to these challenges are SBS/RS, which are rather new and, therefore, need to be researched with various approaches.

An SBS/RS consists of shuttle carriers, elevators with a lifting table and storage racks. The most important difference between an SBS/RS and an Automated Storage and Retrieval System (AS/RS) is the way storage and retrieval devices move [1]. In an AS/RS cranes that move simultaneously in horizontal and vertical directions handle the unit loads. In an SBS/RS the unit loads are handled by autonomous vehicles (shuttle carriers) moving horizontally, and by an elevator (with lifting table) moving vertically [2]. Autonomous vehicles enable simultaneous operating of many shuttle carriers at the same time, therefore, theoretically, doubling the throughput performance. One shuttle carrier can operate at extreme conditions at each tier. Of course, in this way, we get a bottleneck at the lifting table, since it has to serve for vertical movement for all the used shuttles. SBS/RSs have more design variables, which need to be taken into account at design. In addition to the common AS/RS variables such as rack width and height, we have variables such as the number of shuttles, number of elevator lifting tables, the elevator position, and the buffer position.