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Research Article

Automatic Storage and Retrieval System (AS/RS) Design for Manufacturing System

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Abstract:

In this article, the Automatic Storage and Retrieval System (AS/RS) desing used in automatic production systems and the AS/RS simulation technique were studied in this design. Part 1, which was created by simulating with computer code, was composed of two types of cells according to the dimensions of the space. Thanks to the prepared simulation, it offers the performance of AGVs, robots and collection-deposit stations. The simulation created has tested how long the warehouse can withstand periods of recession and depression. The simulation was run in two modes as single command mode and dual command mode. According to the obtained data, it has been obtained that the binary mode gives better performance compared to the single instruction. At the same time, this study; He proved that when the input speed is greater than the output speed, the binary instruction allows more items to be translated in a given time frame compared to a single instruction.

1. Introduction

In AS/RS; materials under a certain degree of automation; A combination of precision, accuracy and speed, storing or receiving, equipment control is created. AS/RS has a series of storage aisles which are served one or more (S/R) usually using one S/R machine per aisle (Figure 1). These stations have one or more inputs/outputs. In the terminology of AS/RS systems, I/O stations are often referred to as receive and drop (P/D) stations. Pick/Drop is operated manually or connected to some type of automated processing system, such as a conveyor system (or AGVS) [1]. If different categories of the automatic storage/retrieval system are examined;

• **Unit load in the AS/RS system:** A automated system is designed to handle loads stored on pallets and this system is computer controlled and S/R machines are automatic [2].

• **Mini-load in AS/RS system:** This storage system is used to transport small loads in boxes or drawers.

• **Man-on-board in AS/RS system:** This is an alternative method for the problem of storing and retrieving individual items in the created system [Table 1].

• **Automatic product (parts) picking system:** It is designed for picking up products. The flow of products is ensured. In this way, it is suitable for first-in/first-out inventory and control (Table 2).

• **Deep lane AS/RS:** Deep lane AS/RS is used where large quantities are to be stored. However, it is a high-density unit load storage system used in cases where product types and numbers are low. Each shelf section is designed with an inlet on one side and an outlet on the other. The loads are taken by the S/R type machine, which is specially designed to be taken from one side of the rack system.

Table 1. *System Performance*

Description	**Result**
Single Command	76.465 min. (53 Working Days)
Dual Command	95.389 min. (66 Working Days)

Table 2. *Small and large items retrieved and stored [3]*

	SC		**DC**	
	Stored	**Retrieved**	**Stored**	**Retrieved**
Small	344	264	411	332
Large	348	270	423	343
Total	692	534	834	675

Table 3. *Delay and Rise Times [3]*

Description	SC	DC	SC/DC
td The delay time	76.000	95.000	0,80
tr The rise time	48.000	47.000	1,02
tr/td	0,63	0,50	

Table 4. *Equipment Utilization*

Description	Result
AGV	36%
Robot	42%
Output P/D	35%

2. Material and Methods

A warehouse area was designed with a sufficient number of AGVs and robots (Table 3). Dual signal automatic and recovery system is used. They all have technical features such as speeds, loading and unloading times. While designing, as many P/O stations were kept as necessary. A method has been proposed to model large-scale AS/RS-AGV systems that would accurately and flexibly describe AS/RS where many products are stored and retrieved.
There are two important steps to run simulation; while first stage; is to create a code by placing the number of AS/RS levels and the number of AGVs (Table 4). For the second stage, in the designed model; Each part number placed on each shelf. The arrival and departure times from the warehouse were recorded. We can quickly simulate/animate the findings using the module-based modelling method developed in this study.
There are specific modules that work to simulate situations (robots, unload signals, AGVs, load signals). Each module detects the next event time. A scheduling procedure is created and ranks the times of these events. Users are determined to be dealers located in very different geographical points throughout the country, including abroad.

2.1 System Performance

The simulation was run in two modes. These are single and double command loops. As the results of the performance analysis in both cycles. Flow time refers to the time interval between the point when a task is ready to be processed and the point at which it is completed. Flow time is measured as follows:
Single workflow; It is concluded with storage by designing that a storage cycle starts with the L/U station, the AGV receives the product, goes to the P/O station, and finally the robot receives the product. Similarly, if it is an undo loop; The robot is defined as starting at the P/O station, traveling empty to the retrieve location, picking up the product, going to the P/O station, dropping the product, AGV picking up the product, going to the L/U station, and finally leaving the L/U station. The dual workflow starts with the L/U station of a storage loop, the AGV picks up the product, goes to the P/D station, and finally, the robot is assumed to pick up the product and go to the storage location and store it.
In the undo loop, however, the robot goes to the receive location empty, picks up the object from there, goes back to the P/D station and drops the object, then the AGV picks up the object, goes to the L/U station, and finally releases the L/U.
These two workflow times are measured and presented in Table 1. A working day includes 3 shifts and is designed in such a way that each shift consists of 8 hours.

3. Results and Discussions

The items stored in the binary command is 20% and the items retrieved in the binary command is 26%.
Therefore, with these conveniences and operating conditions, the binary command works better.
The simulation works in two modes; single command mode provides an extra stream of inputs in 53 business days, while dual command mode provides 66 business days. The results confirm that the dual mode gives better performance compared to the single instruction.

4. Conclusions

It was seen from this work that when the input speed is greater than the output speed, the binary instruction allows more items to be translated in a given time frame compared to the single instruction.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
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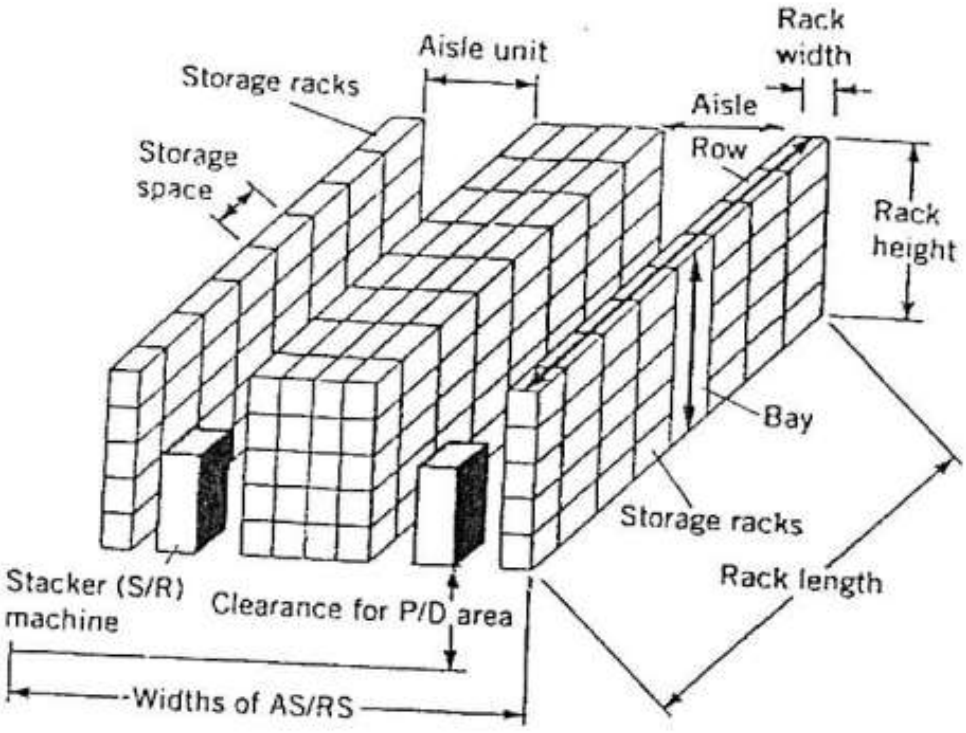

Figure 1. *Generic Structure of an AS/RS [3]*

- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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