DEVELOPMENT OF MODULAR AUTOMATED STORAGE AND RETRIEVAL SYSTEMS

Submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Hons.)

by

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APPROVAL

I hereby declare that I have read this dissertation/report and in my opinion this dissertation/report is sufficient in terms of scope and quality as a partial fulfilment of Bachelor Degree of Manufacturing Engineering.

Signature : . . . .

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ABSTRAK

Sistem penyimpanan dan pengambilan automatik (ASRS) adalah salah satu sistem pengendalian bahan utama, yang banyak digunakan di pusat-pusat penyimpanan dan persekitaran pengeluaran automatik. Sistem ini telah digunakan bukan sahaja sebagai alternatif kepada gudang penyimpanan tetapi juga sebagai sebahagian daripada sistem perkilangan. Projek ini membincangkan sistem ASRS yang memfokuskan kepada sistem penyimpanan ASRS. Sesetengah masalah dan perkara boleh didapati dengan mengenal pasti ASRS yang ada di pasaran, sistem kerangka dan operasi prinsip ASRS. Pada masa ini, rekabentuk penyimpanan automatik dan pengambilan semula tetap tidak dapat disesuaikan dengan jenis atau saiz penyimpanan yang berbeza. Sesetengah inisiatif perlu dilakukan untuk mengatasi perkara ini dalam meningkatkan teknologi ASRS dalam industri perkilangan. Kajian ini bermula dengan penyiasatan reka bentuk sistem simpanan dan pengambilan automatik dalam industri automatik. Penyelidikan reka bentuk ASRS diperolehi melalui beberapa jurnal, artikel, dan buku. Selain itu, cadangan reka bentuk sistem penyimpanan dan modular automatik modular akan dibincangkan dalam laporan ini. ASRS yang mempunyai konsep modular menekankan kepada rak ASRS yang boleh menyesuaikan diri dengan pelbagai saiz beban. Rak ASRS dengan konsep modular akan direka bentuk dengan menggunakan perisian CAD. Analisis reka bentuk akan diuji dengan menggunakan kekuatan daya untuk memastikan reka bentuk selamat direka. Ujian kebolehpercayaan akan dijalankan untuk memastikan reka bentuk memenuhi objektif terakhir dalam laporan ini. Ujian ini akan dianalisis dengan menggunakan beban yang berbeza. Dengan adanya penyimpanan automatik dan sistem pengambilan semula yang modular, diharapkan dapat meningkatkan proses penyimpanan dan pengambilan dalam industri perkilangan.

ABSTRACT

Automated storage and retrieval system (ASRS) is one of the major material handling systems, which is widely used in storage centers and automated production environments. This system had been utilized not only as alternatives to traditional warehouses but also as a part of advanced manufacturing systems. This project discusses about the ASRS system which focusing on the racking system of ASRS. Some problems and matters can be identified by doing research of the available ASRS in the market, the racking system and the principle operation of the ASRS. Currently, the design of the automated storage and retrieval is fixed which cannot be adapted in different type or size of the storage. Some initiative need to be done to overcome this matter in enhancing the technology of ASRS in manufacturing industry. The work starts with the investigation of the current design of automated storage and retrieval system in automated industry. The research of the design of ASRS investigated through some journals, articles, and books. Besides, the proposal of the modular automated storage and retrieval systems design will be discussed in this report. The modular ASRS focused on the rack of the ASRS which can adapt with the variety size of loads. ASRS rack with the modular concept will be designed by using CAD software. The analysis of the design will be tested by applying force in order to ensure the design is safe to be fabricated. The reliability test will be conducted to ensure the design is satisfy with the last objective in this report. The test will be analyzed by using different size of loads. With the modular of the automated storage and retrieval systems, storing and retrieving process will be enhanced within the manufacturing industry.

DEDICATION

Dedicated to my greatest mother, Wan Nafisah Binti Wan Ali,
my late father Mahamed Rasidi bin Mat Sulaiman, my siblings,
my appreciated families and all my friends and colleagues
for giving me moral support, cooperation,
encouragement and also understanding.

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Last but not least, I am sincerely thanks to my beloved family especially my understand the importance of this final year project and support me through the hectic times. All of my hard works will be nothing without the motivational, inspirational and supportive from all of them.

Finally, I would like to thanks everybody who was important to this FYP report, as well as expressing my apology that I could not mention personally each one of you.

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LIST OF ABBREVIATIONS

ASRS   - Automated Storage and Retrieval System

S/R   -Storage and Retrieval

LIST OF SYMBOL

L	-	Length
W	-	Width
H	-	Height
Mm	-	millimeter
GPa	-	Giga Pascal
n_y	-	Number of slot along the height of the aisle
n_x	-	Number of slot along the length of the aisle
$\int$	-	Length of individual compartment
b	-	Width of individual compartment
h	-	Height of individual compartment
x	-	allowances along length
y	-	Allowances along width
z	-	Allowances along height
u	-	Storage intensity
Vh	-	average value of horizontal speed of S/R machine
Vv	-	average value of vertical speed of S/R machine
Tsc	-	single-command cycle time,
Tdc	-	dual command cycle time
Tpd	-	store and retrieve load time

CHAPTER 1
INTRODUCTION

1.1   Research Background

An Automated Storage and Retrieval System (ASRS) is a mix of hardware and controls that handle, store, and retrieve materials as required with exactness, precision, and speed under a characterized level of mechanization. Frameworks change from moderately basic, physically controlled request picking machines working in little stockpiling structures to a great degree extensive, PC controlled capacity/recovery frameworks completely coordinated into an assembling and dissemination process.

Basically, ASRS alludes to an assortment of computer controlled techniques for naturally keeping and recovering burdens to and from characterized capacity areas. Inside an ASRS condition one would discover at least one of the accompanying advancements: Horizontal Carousels, Vertical Carousels, Vertical Lift Modules, and additionally Fixed Aisle Storage and Retrieval Systems, the last using exceptional capacity recovery machines to take the necessary steps expected to embed, separate, and convey burdens to assigned information yield areas inside the walkways being served.

The usage of the ASRS give a numerous impact to industry of manufacturing. In enhancing the business conditions accommodation, the users were provided with the increased inventory control and tracking. These ASRS systems are consists of modular subsystems that can be easily substituted to prolong the service life of the overall system and reduce downtime. The effect of ASRS usage are the workforce requirement and labor costs can be reduced for a longer term of time. Besides, the productivity of works is high, and the workplace is much safer

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by using ASRS rather than using human power which can exposed to harm. Maybe most fundamentally, in any case, ASRS frameworks can deliver real reserve funds in stock stockpiling costs, as inconceivably enhanced distribution center space used both vertically and on a level plane makes more prominent stockpiling thickness.

1.2 Problem statement

Automated storage and retrieval systems (ASRS) is widely used in manufacturing industry that can enhance the productivity of works. Somehow the current ASRS which is available in the market do have few limitations. Some factors that caused the limitations have been identified. The first issue is the Space constraints. This is one of the factors that limits the function and usage of the ASRS. The design of the ASRS is not flexible which it cannot changed to varies type of sizes. The pattern of the storage and retrieval machine is not universal whereas it cannot compatible with the size of storage.
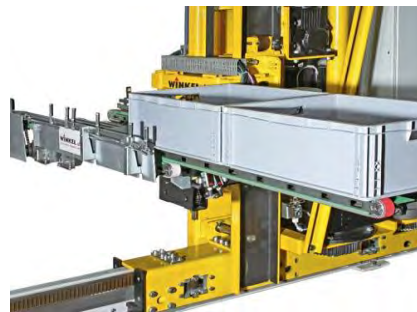
Figure 1. 1 Automated Storage and Retrieval Systems

Moreover, if the loads of items stored is smaller or have various kind of sizes, the changes of the storage size cannot be done. Currently, the storage size is fixed with the load size. Thus, the storage occupied less space when the ASRS is fixed in terms of design if there are some different size of loads. The storage need more space if the load size is bigger than before. Figure 1.2 shows that the size of the storage rack of ASRS.

Figure 1. 2 Storage Size

Cost also affected the usage of ASRS in manufacturing industry which high cost will be needed if the industry wants to change the type of ASRS to suit up with the changes size of load. In addition, someti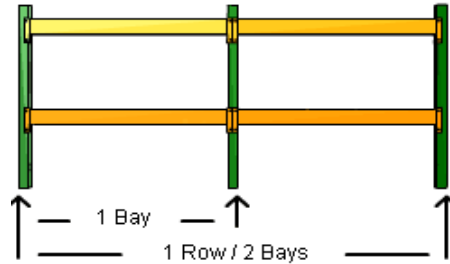mes the type or the size of the load is changing annually affected the usage of ASRS which is also needed to be changed. This kind of aspect need to be focused because of the expenditure of the cost will be high to change the ASRS machine.

This report is proposed is to identify the current design of automated storage and retrieval system to know on how to enhance the ASRS usage in manufacturing industry. In addition, the design for the modular automated storage and retrieval system will be developed which can adapt with variety of size of storage. Then, the problems faced by industry can be reduced and the cost usage can be minimized.

1.3   Objectives

The objectives of this project are as follows:

   i.   To investigate the current design of automated storage and retrieval system in automated industry

  ii.   To propose the design of modular automated storage and retrieval systems which can enhance the current available ASRS

 iii.   To conduct the reliability test for the model of modular ASRS which can be used in any type or size of the storage in manufacturing industry.

1.4   Scopes

The scopes of this project are as follows:

i.   Research on the current design of automated storage and retrieval systems (ASRS) that available in market. In this research it is more focus on type, rack design and the principal operation of ASRS.

ii.   Identify the advantages that enhance the productivity and the constraints of the available ASRS that limits its' ability in industry. The solution can be determined throughout this research.

iii.   Design the rack of ASRS as a modular prototype in enhancing the development of ASRS usage in manufacturing industry. The pattern of the model will be designed by using the CAD software which is Solidworks.

iv.   Reliability test will be conducted on the prototype of modular ASRS rack to ensure the function and ability of the model. This part will show the advantage and the different between the model and the current ASRS. If there are any occurrence of problem and error, the modification will be done.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter will cover about the previous studies or research about the automated storage and retrieval systems that has been used in this application. All information was collected from on the journal, books, and other printed sources. Main topic of this chapter is discussion about all features that have been used in current ASRS which widely applied in manufacturing industry. All the information will be combined to be analyzed and make some improvement to make the project more function.

As the main objective of this dissertation is on the ASRS problems, in this chapter, we focus on reviewing the existing literature of ASRS problems from different perspectives. First, we review the physical design problems discussed in the literature, as one of the main focuses in this project is to determine the appropriate design for the system.

2.2 Automated storage and retrieval systems

Automated storage and retrieval systems (ASRS) are not new innovations which are widely used in manufacturing industry. They really got economically accessible since 1950 by organizations in Europe and Japan. Since then, there need been limitless upgrades done PC systems, electrical controls. The usage of ASRS have helped easier expense supplies and lower the cost of manufacturing industry.

Aslam, Gardezi, & Hayat (2009) identify that an automated storage and retrieval system is a storage system that performs pick and deposit operations with speed and accuracy under a defined degree of automation. The performance of any manufacturing firm depends largely on its material handling and storage system. The important of the vertical storage systems can be seen because less floor space is required to keep a high quantity of goods. Material storage can be performed manually but the automated methods for storing and retrieving materials are more efficient and these are integral part of computer integrated manufacturing (CIM).

Automated Storage and Retrieval Systems are warehousing systems that are used for the storage and retrieval of products in both distribution and production environments. An automated storage and retrieval system ASRS usually consists of racks served by cranes running through aisles between the racks. An ASRS is capable of handling pallets without the interference of an operator, thus the system is fully automated. Both in production and distribution environments ASRS are used for putting products in storage and for retrieving those products from storage to fulfill an order (Roodbergen, 2009).

According to Rashid, Kasemi, & Rahman (2011) an incorporated, computer-managed, computerized product shifting gadget such as the garage shelves system, the garage retrieval device, and the input and output points. ASRS is an incorporated engineering system that requires the knowledge of mechanicals, electrical, electronics and computer engineering in its design. The storage retrieval device consists of a unique mechanism responsible for moving the products from input or output to some extent inside the cabinets, a gadget for recording and arranging the goods, a machine for reading and executing an order.
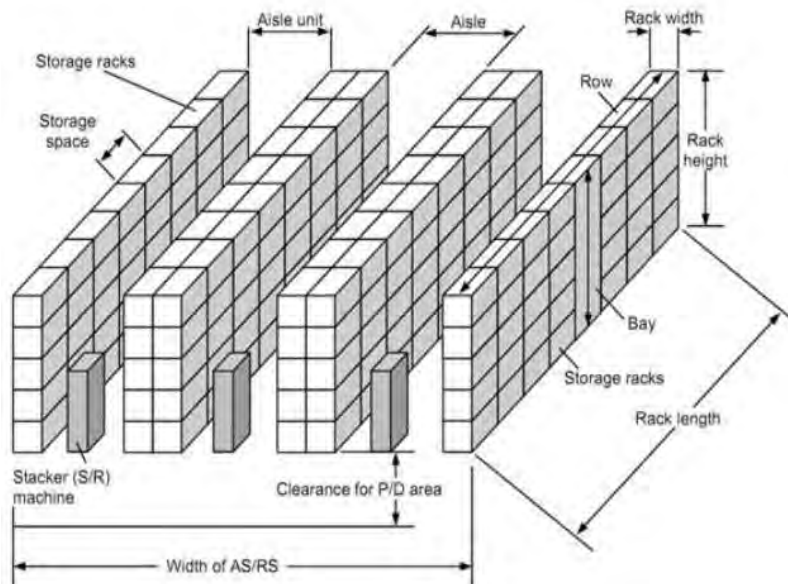
Figure 2. 1Example of ASRS

Figure 2. 2 ASRS Structure

2.3   Principle operation

Automated storage and retrieval system structures are computer-controlled systems that shop and retrieve product in distribution centers, warehouse and manufacturing facilities. This storage systems have been developing since the 1960's and is the best and maximum state-of-the-art fabric dealing with gadget available. Loads are strategically brought via automation upon demand without the use of manual labor.

Kuo, Krishnamurthy, & Malmborg (2007) studied that the principle ASRS control matter is positioning the ASRS machine within an acceptable tolerance at a storage compartment in the storage rack to deposit or retrieve a load. The locations of materials stored within the machine need to be decided to instruct the storage and retrieval machine to a selected garage compartment. Inside a given aisle in the ASRS, each compartment is recognized by means of its horizontal and vertical positions and whether it's miles on the proper side or left aspect of the aisle. A scheme based on alpha-numeric codes may be used for this purpose. The use of this place identification scheme, every unit of fabricated stored within the device can be refenced to a selected place inside the aisle. The file of these place is referred to as the 'item place stored'. Each time a storage transaction is completed the transaction must be recorded into object place file.

An ASRS gadget commonly operates in one among two modes: unmarried cycle (SC) or dual cycle (DC) also called Interleaving. For every of the modes the S/R gadget starts off evolved at the P&D station, shops and/or retrieves a load, and returns to the P&D station to complete a cycle. In a SC the S/R system both stores and retrieves, even as in a DC it each store and retrieves in a single cycle. In a DC, the S/R device picks up a load from a P/D station, travels to a storage location to store it, travels to another vicinity to retrieve a load and then returns to the P&D station to supply it (Salah, Wasiullah, & Noche, 2011).