Development of Robotic Automated Storage and Retrieval System (AS/RS)

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Abstract

The automated storage and retrieval systems (AS/RS) are major material handling support systems that are commonly used in the automated factories, distribution centers, warehousing, and non manufacturing environments. Their applications vary widely from a simple storage and retrieval system for small parts to central systems where production, assembly, and manufacturing operations are concentrically located around them. This paper summarizes the literature study of a Robotic automated storage and retrieval system and development of a dedicated automated storage and retrieval system for YCCE Flexible manufacturing system laboratory. The prototype model of automated storage and retrieval system developed consist of the control hardware and software communicating over a field bus network. This also includes study of literature for types of automated storage and retrieval system, study of literature for suitable environment for automated storage and retrieval system, order processing for automated storage and retrieval system. This study of automated storage and retrieval system and the physical model of automated storage and retrieval system will ensure better understanding of automated storage and retrieval system for student. The development of physical prototype is highly beneficial to acquisition of tactic knowledge and greatly benefits the development of students by understanding the automated storage and retrieval system. This model will contribute to the ongoing development of dedicated FMS. And this prototype model for AS/RS will be the foot step ahead to achieve the goal.

Keywords :AS/RS, Dwell point analysis, FEM, Network system, Robotic

1. Introduction

An automated storage/retrieval system (AS/RS) can be defined as a storage system under which a defined degree of automation is to be implemented to ensure precision accuracy and speed in performing storage and retrieval operations.This dedicated robotic automated storage and retrieval system will be foot step ahead to contribute to flexible manufacturing system. Development of integrated manufacturing environment has been going on in YCCE mechanical engineering department from last few batches of PG projects. The continuous efforts are going on towards the flexible manufacturing system for mechanical department FMS laboratory he term flexible manufacturing cell is commonly used to refer to machine grouping that consists of either manually operated or automated material handling, and it may or may not be computer controlled. The term flexible manufacturing system generally means a fully automated system consisting of automated workstations, automated material handling and computer control. Storage is an essential function in an automation system. The material storage system allows materials to be stocked for a specified period of time, before they are re-introduced, or are introduced for the first time, into the automation system. The sorts of stored material are related to the product (e.g. raw materials, purchased parts, work-in-process, finished products, and scrap and rework), the process (e.g. process refuse, such as process waste products; and tooling), and the overall support functions in the factory (e.g. maintenance spare parts, office supplies, and plant records). Each of these material types is typically stored under different conditions and controls. Robotic AS/RS is designed to pick and palletize goods onto a mixed pallet which allow retrieving orders in a ready to ship sequence. Robots have frequently been used to palletize these specialized loads. The first Robotic ASRS system has been developed by Bastian in the world which helps to create store ready pallet.

2. Literature Review

Jeroen P Vanden Berg explains Analytical expression for the optimal dwell point in an AS/RS" he was concentrates on deciding the dwell point in an AS/RS, to minimize the expected travel time to the position of next operation. Report that on the basis of a simulation study the nearest-neighbor rule gives the best results for selecting an open location within the storage area for randomized storage or within a class-region for class-based storage. When an incoming load cannot be stored within its dedicated region it is better to assign it to a location further away from the input and output station, than to a location that is nearer than its dedicated region. The latter is likely to fill up the storage space for fast moving products, which may result in increased mean travel times. They also considered three criteria when evaluating good due date performance; mean response

time, maximum response time or the number of late requests and report that these criteria were satisfied better when using a FCFS sequence for the retrievals than by applying specific urgency rules (giving priority to retrievals with long waiting times). Hausman et al (1976) deal with optimal storage assignment. Results are obtained which compare the operating performance of three storage assignment rules: random assignment, which is similar to the closest-open-location rule used by many currently operating systems; full turnover-based assignment; and class-based turnover assignment. It is shown that significant reductions in crane travel time (and distance) are obtainable from class-based turnover-based rules rather than closest-open-location (essentially random) policies. These improvements can, under certain circumstances, be directly translated into increased throughput capacity for existing systems and may be used to alter the design (e.g. size and number of racks, speed of cranes, etc.) of proposed systems in order to achieve a more desirable system balance between throughput and storage capacity. According to Moon & Kim (2001) were explain shuffling or relocations are helpful to maintain stable throughputs with all the three types of ASRS operation policies (random, 2 class-based and 3-class-based). They are also helpful to avoid losses caused by crane travel distance increase and lack of storage with a system under unstable production plans. Relocation does not cause any crane operation problems since the time to re-locate items in an ASRS is too minor to affect the crane utilization. With class-based storage policies, better throughputs and lower rack and crane utilizations are achieved. An applicable operation policy can be selected based on the production plan variation, or a necessary variation point for relocation to the current policy can be determined using the simulation results. Bozer & White (1990) have developed travel-time models for ASRS machines. The S/R machine is taken to travel simultaneously horizontally and vertically as it moves along a storage aisle. For randomized storage conditions expected travel times are determined for both single and dual command cycles. Alternative input/output locations are considered and various dwell-point strategies for the storage/retrieval machine are examined.

3. Concepts

The objective of this project is to develop a dedicated prototype model of Robotic automated storage and retrieval system to facilitate study of automated storage and retrieval system for students in flexible manufacturing system laboratory. And will be the test bed for the ongoing project for the extension for FMS laboratory with ongoing projects in PG CAD/CAM course. And will allow for analysis of control strategies for knowledge acquisition, knowledge development, knowledge extension, knowledge spiraling. As the lab model are also available in the market, but they are available in standard sizes. Standard controllers they are using which are very costly. They mostly use pneumatic controllers.As they are using pneumatic controllers the maintenance is high due to leakages. These will be avoided as we are generating fully mechanical controls. And it is drafted and designed according to FMS lab layout and the sizes of the work parts that will be processed on the CNC machine tools available with YCCE FMS lab.

3.1 FLEXIBLE MANUFACTURING SYSTEM

The term flexible manufacturing cell is commonly used to refer to machine grouping that consists of either manually operated or automated material handling, and it may or may not be computer controlled. The term flexible manufacturing system generally means a fully automated system consisting of automated workstations, automated material handling and computer control. In contrast to this defines a FMS as an automated computer controlled cell and a FMC with the addition of automated storage and the retrieval as FMS.
The four basic elements of any FMS are
Robot
Workstations,
Material transport and storage system,
Computer controlled system.

3.2 AUTOMATED STORAGE AND RETRIEVAL SYSTEM

Storage is an essential function in an automation system. The material storage system allows materials to be stocked for a specified period of time, before they are re-introduced, or are introduced for the first time, into the automation system. The sorts of stored material are related to the product (e.g. raw materials, purchased parts, work-in-process, finished products, and scrap and rework), the process (e.g. process refuse, such as process waste products; and tooling), and the overall support functions in the factory (e.g. maintenance spare parts, office supplies, and plant records). Each of these material types is typically stored under different conditions and controls.

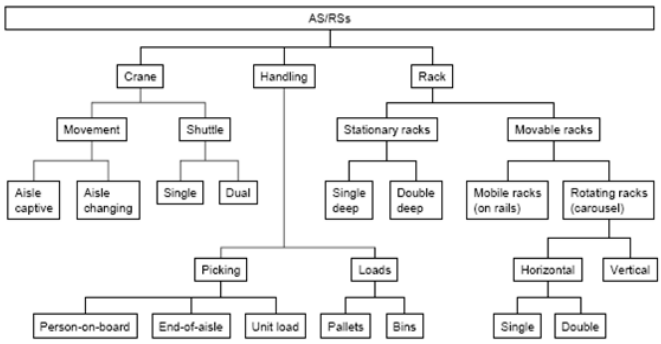

Figure 1:- different types for automated storage and retrieval system

3.3Layout Development for robotic AS/RS system

The objective of this project is to develop a dedicated prototype model of robotic automated storage and retrieval system to facilitate study of automated storage and retrieval system in flexible manufacturing system laboratory.

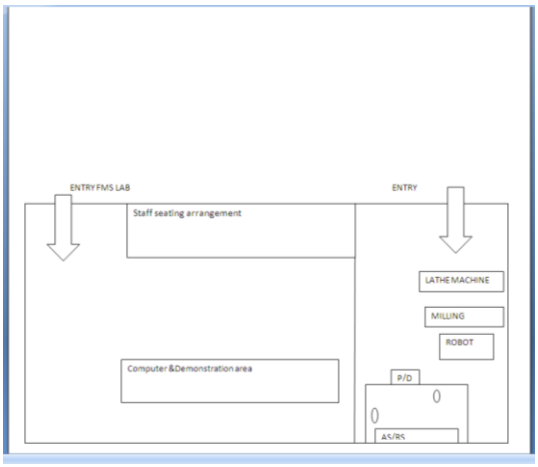

Fig:-2 block dig. For FMS lab layout

This work done concentrates on development of robotic automated storage and retrieval system. The components for robotic automated storage and retrieval system are storage structure, automated storage and retrieval machine i.e. robot and pick and deposit station. The system is grid following system means robot is follow the grid system and decided its path by which it can travel the minimum distance. This system consists of IR sensor system and use the interfacing for remote control. System receives the unit load part from Lathe and milling machine which are present in the FMS lab. Then sensor provided all this information to the robots then robot check the two conditions i.e. load/unload means robot is already with work part or ready to accept the work part from pick and drop station. Second condition is that it check the nearest one condition means those Robot is near from pick and drop station or rack that robot performs storage and retrieval according to the requirements.

Controller should be checking the two conditions and then decided which perform the given task.

1) Load/unload condition
2) Nearest one condition

Dimension of layout 3'*4'

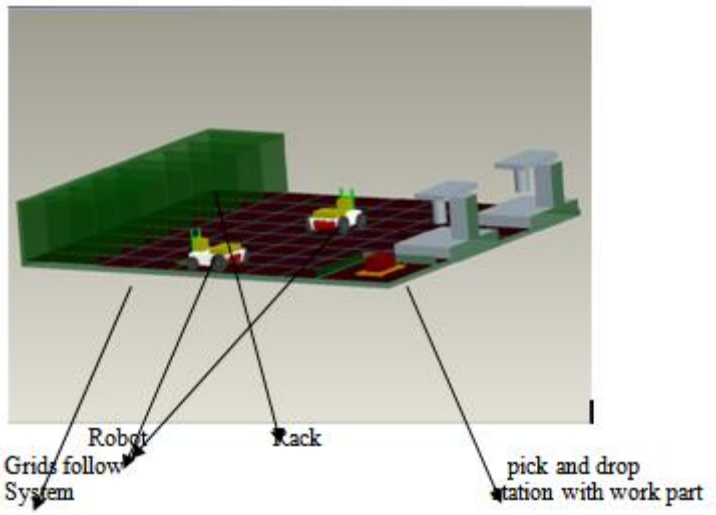

Fig 3:- layout of the robotic AS/RS system

3.4 Robotic AS/RS Rack structure

The total storage capacity of one storage aisle depends on how many storage compartments are arranged horizontally and vertically in the aisle. There are one row and six columns are present with the single rack. total length of rack is 3'

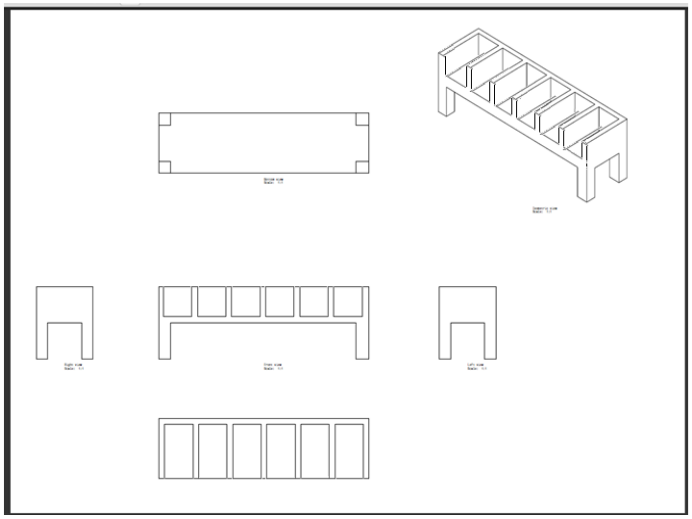

Fig 4:-Rack structure

3.5 Robot with Fork Lift Mechanism

In this system two robots will be used with fork lift mechanism. Most of us probably have a general idea of what a forklift is, but there are a number of different classifications, power sources, sizes, uses and new technologies that make up these useful machines. Some are used on rugged construction sites and lift heavy materials and equipment while other forklifts drive themselves inside modernized warehouses. Whether indoors or out, forklifts are a necessary tool in most warehouses and an integral part of our industries.Forklifts might seem more industrial than inventive, but consider that they're typically the size of a small car yet they can lift loads that are thousands of pounds, often several stories into the air, all without tipping over. These machines work long hours each day lifting and moving heavy loads to keep our manufacturing, automotive, aerospace and other industries humming along.Forklifts have been around for nearly 100 years and they continue to make our jobs more efficient just as much as they did when they were invented. Whether they're forklifts that use batteries, liquid propane, hydrogen fuel cells or another power source, without these machines we wouldn't be able to build ship or move manufactured goods efficiently.

3.6 Function

A forklift has two forks that are located on the front of the machine. These two forks only move up and down, but they can also tilt upward and downward. The operator controls these movements, and uses a Battery system to move the forks. The battery system applies pressure to a bar with rolling chains that is located in the forklift. Forklifts can get their power from many different sources, including electricity, gasoline, diesel or propane. In this system it shall get power from battery. Height of fork lift =15 cm.

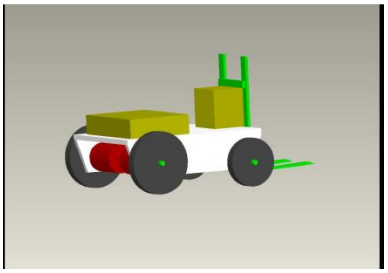

Fig 5: - Robot with fork lift mechanism

Dimensions for unit load

Dimension of unit load 100*100*10 mm and weight one kg

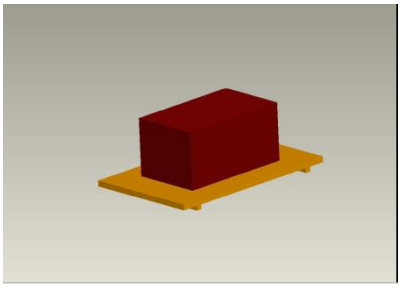

Fig 6:-unit load

4. Conclustion:-

Automated storage and retrieval system (AS/RS) is complex in design and fabrication which needs exclusive study of transmitting devices, motors to control movements of the various axes, positioning techniques and feedback control system, power circuitry, behavior of electronics devices it support first user microcontroller system. Automated storage and retrieval system development is divide in layers i.e. fabrication of the mechanical components and their assembly, the electrical circuitry, the electronic circuitry, microcontroller programming and interfacing.

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