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USE OF ELECTROMAGNET TO DEVELOP ROBOTIC AUTOMATED STORAGE AND RETRIEVAL SYSTEM (AS/RS)

S.U.Chakole[1], G.H. Waghmare[2],S.T.Bagde[3]
[1]P.G student,
[2,3]Associate Professor
Mechanical Department
1, 2,3Yeshwantrao Chavan College of Engineering, Hingna Road, Wanadongri, Nagpur-441110(India)

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

INTRODUCTION

In today's manufacturing environments, inventories are maintained at lower levels than in the past. These reduced inventories have led to smaller storage systems, which, in turn, have created the need for quick access to the material being held in storage. Hence, automated storage/retrieval systems used in manufacturing, warehousing, and distribution applications must be designed to provide quick response times to service requests in order to keep the system operating efficiently. One important operational aspect of the AS/RS, which contributes to the system response time, is the dwell point location of the S/R machine. The dwell point is the location where the S/R machine is positioned when the AS/RS is idle and awaiting the next service request

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.

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

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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

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.

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.

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

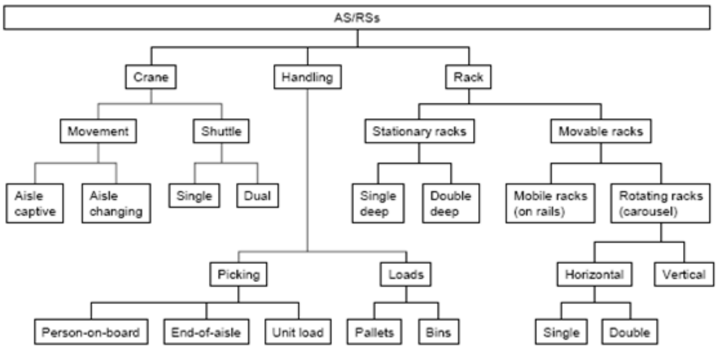


Figure 1:- different types for automated storage and retrieval system

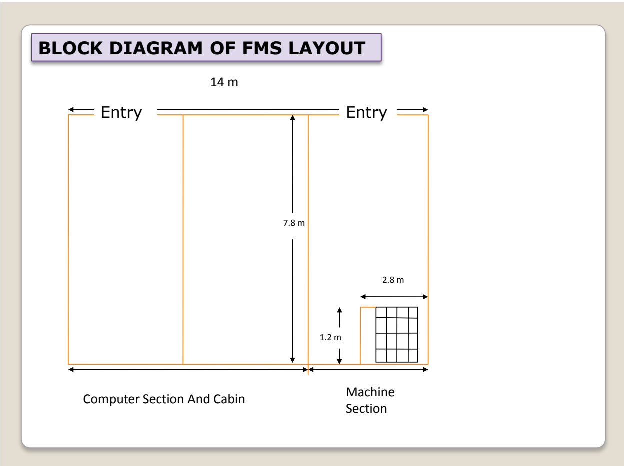
Layout Development for robotic AS/RS system:-

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.

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 checks the nearest one condition means those Robots is near from pick and drop station or rack that robot performs storage and retrieval according to the requirements. In this system Two robots are use with electromagnetic lift mechanisms.



System Component-

- Robot
- Rack
- Pick and drop station
- Work part
- Layout

In this system two robots are use with electromagnetic lift mechanism. Racks stored are use the work part. Robots receive the work part from pick and drop station. In layout grid following system is use for this black and white colors are required.

Robot Component

- IR sensor
- Motor driver
- Controller
- DC motor
- Battery
- Electromagnet
- Wireless receiver

IR sensor is useful to identified black and white strip. Voltage maintains take place by using motor driver.7V supply is provide by using DC motor. Battery is use to provide power. Electromagnet is use to lift the work part. Wireless receivers are present on both the Robot.

- **Calculation for weight carrying capacity of electromagnet :-**
- 32 gauges
- 2500 turns
- voltage 12 v
- Resistance 20 Ohm

Then I=V/R

=12/20

=0.6 Amp

Electromagnetic force F

= ((N*I) ^2*K*A)/(2*g^2)

N = No. of turns

A = Cross section area

g = Distance between magnet and piece of metal in meter

K (constant) = 4*PI*10^-7

F= Electromagnetic force F

F=((2500*0.6)^2*4*3.14*10^-7*3.14*(0.1)^2)/(2*25*10^-3)

F=0.4383N

Load Lifting = 0.4383/9.8

=0.0421Kg

= 40 gm

Determination of Single- and Dual-command Cycle Times for Unit Load AS/RS

- **Single-command Cycle**

  It performs either storage or a retrieval operation. There are certain steps that are followed in storage or retrieval cycle to determine the cycle time. In case of storage cycle, machine picks up a load, travels to the storage location, deposits the load, and returns empty to the P/D station. Similarly, in a retrieval cycle, the S/R machine begins at the P/D station and travels empty to the retrieval location. Thereafter, it picks up the load, travels to the P/D station, and deposits the load.

- **Dual-command Cycle**

  Cycle time is determined in case of dual-command cycle when it starts its operation with the S/R machine at the P/D station. The machine picks up the load and travel to the storage location to put down the load. Thereafter, the machine travels to the retrieval location to recover the load. Finally, it travels back to the P/D station to deposit the load. Bozer and White (1984) derived an expression for cycle time based on following assumptions:

- Randomized storage of loads in the AS/RS

- Horizontal and vertical velocities of the S/R machines are constant

- Rack openings are of single-size
- P/D station is located at the base and at the end of the aisle
- Simultaneous horizontal and vertical travel of S/R machine
- The storage space dimensions help to determine the length (*L*1) and height (*H*1) of an AS/RS aisle and it is given as follows :
- $L1 = n\,(l + x)$ =6 inch
- $H1 = m\,(h + z)$ =6 inch

Where *n* and *m* are the number of bays and storage spaces per system height.

Velocity of the Robot
Vh=Vv=V=πDN/60
D=70mm (dia of the wheel)
N=75 rpm (rpm of dc geared motor)
V=0.275m/s

- Time required travelling full horizontal length and vertical height of an aisle is given by
  Th=L1/Vh
  = 6/0.275=6/10.82
  =0.55 min
  And
  Tv =H1/Vv
  =6/10.82

- Where *Vh* and *Vv* are the average horizontal and vertical speeds of S/R machines.
- For single-command cycle, cycle time is given as :

  Tsc=T (M^2/3+1)+2Tpd
  =0.55(1/3+1)2*0.15
  =1.033

- For dual-command cycle, cycle time is :
  Tdc=T/30(40+15M^2-M^3)+4Tpd
  =0.55/30(40+15*1-1)+4*0.15
  =1.59 min

Where
Tsc = single-command cycle time,
Tdc = dual-command cycle time,
T = max (*Th*, *Tv*),
M = min (*Th* / *T*, *Tv* / *T*),
Tpd = time to perform either a pick up or deposit,
Th = time taken to traverse full horizontal aisle distance, and
Tv = time taken to traverse full vertical aisle distance.

Conclusion:-this prototype has made to understand the student about the concept of AS/RS system.

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