

# Design and Development of Prototype for Automated Storage and Retrieval System

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**Abstract**— The purpose of this paper is to overview the proposed design and development of automated storage and retrieval system. Goods like spare parts and small inventories cause significant issues in handling them. Due to more space utilization and to get rid of sorting out, this system is proposed which handles goods efficiently by storing them at defined locations safely and retrieves them quickly without being damaged. A three-dimensional solid modeling of proposed system is developed using the computer-aided drawing software. A program is written and microcontroller is used to control stepper motor for driving storage and retrieving vehicle in three dimensions. Furthermore, different aspects of future work are also specified.

**Keywords**—Automated Storage; Automated Retrieval; inventory;

## I. INTRODUCTION

Automated storage and retrieval system (AS-RS) is a system to handle materials by applying automation in storage and retrieval processes. In today's world of automation, they play a vital role in handling raw materials and places where work is in process. For managing control of inventories in various facilities, AS-RS is a reliable option indeed. Usually, AS-RS refers automated controlled systems for performing storage and retrieving functions from specified locations. Owing to increased trends, companies and industries need automation to improve their throughput level. From the time raw materials or inventories go into the industries and comes out from the gate in form of finished product, it is handled at all stages in between, no matter it is in stores or on the shop floor. So AS-RS handles them efficiently and let the user get rid of sorting out their products.

Automated storage and retrieval systems are being widely used in industries, distribution centers and warehouses as well. It performs its action without human interference and supervision. They reduce error rates and hence it has more reliability. Material handling was carried out manually before automation but automated operation increases efficiency. Generally all of these systems have some features in common including storing and retrieving machine commonly called as cranes, racks and bins.

### A. History of Automated Storage and Retrieval System

Over the years there have been many modifications in systems including storage and retrieval operations. Behind these modifications, there were same factors of easy operations, high production rate and less error chance. Initially, bunch of labors used to handle materials manually with their supervisor ordering storage and retrieval operations. With the increase in production, storage of goods became difficult. This leads to introduction of machinery for the purpose of storage and ease of retrieval.

In early days material handling was done using animals and carts but later with the advancement of science it was improved using forklifts and conveyor belts. Automated storage and retrieval of materials was introduced in 1940. For this purpose automated storage and retrieval systems have been used in industries and distribution centers since 1950 [1]. Out of these Automated guided vehicles (AGV) are in use after 1950 and is considered as the first implemented step towards automation in material handling [2]. Carousels storage systems are also employed for this purpose and are widely used to store and pick small, light and commonly used items [3]. Automated storage and retrieval systems are serving with improved efficiency and reliability since they are first used. Scope of this paper is to present that how this system is designed and developed.

### B. Objectives and Aims

Our primary objective of this project is to design and fabricate a prototype for automated storage and retrieval system. Our aim is to fabricate it in a way that it can automatically store and retrieve goods. Initially an understanding is developed about microcontrollers and other software which are required for our system. Microcontroller gives commands to stepper motors which leads to motion in three dimensions. An efficient and cost saving system for resolving material handling issues is to be developed. Finally designed prototype is to be assembled and fabricated keeping in view all the constraints.

### C. Benefits of Using AS-RS

AS-RS is beneficial in number of aspects. Successful manufacturing of this project will yield a number of benefits. Proposed system along with its benefits can lead to high

throughput. It provides user with more convenience. System will be helpful in storing and retrieving good in stores without human interference. Things can easily be stored and retrieved over unreachable cells as well. By using controller, efficiency is increased and accurate decisions are made with minimum picking errors.

Its advantages are as follows:

- Reliable
- Specific storage/retrieving location of each material does not require sorting out
- Provides reduction in labor cost
- Minimum errors
- Better space utilization
- Products are made more secure without being damaged
- Better inventory control

This paper gives an overview of our design and development of prototype for automated storage and retrieval system. It is organized as follows.

## II. DESIGN OF AS-RS

AS-RS design is based on structure and its controlling scheme employed for this project. Layout for programming is also designed to accomplish successful implementation. Success and failure of any system depends upon its design. Design consists of structure, controlling scheme and programming layout.

### A. Structure

This prototype consists of two racks in between which there is a storing and retrieving vehicle (SRV). SRV moves along the path between racks. SRV as a whole is a combination of three selectors.

- Column Selector
- Row Selector
- Rack Selector

For storage and retrieval racks are used having cells of same dimensions. Number of cells depends upon number of rows and columns, which are equal in both racks.

A pick and drop point is set which is basically home position of SRV. SRV will start its motion from this point and after storing/retrieving, it will come back at its home position. Model of structure for AS-RS is shown in fig 1.

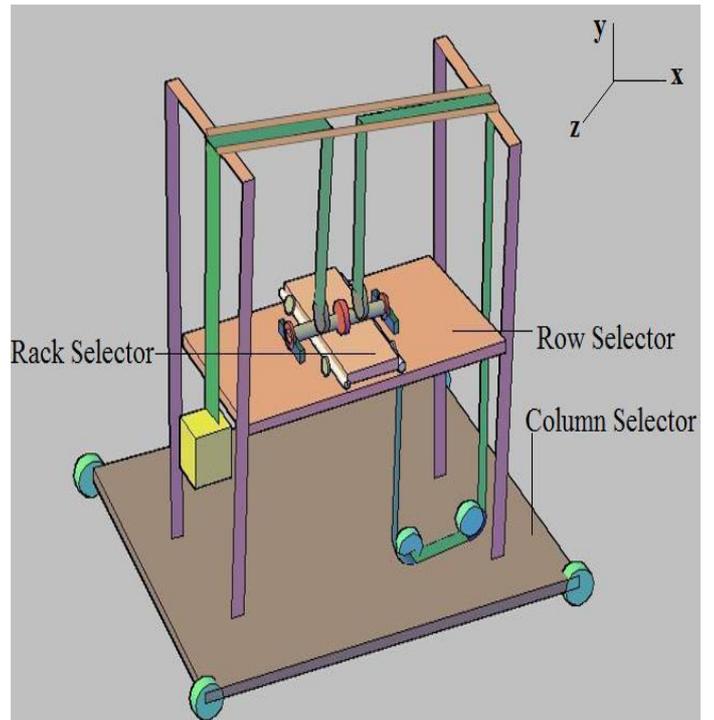


Fig. 1. Structure of ASRS

### B. Controlling Scheme

Basic component behind stepper motors is microcontroller. We have employed it with master slave controlling scheme. One microcontroller reserved for column selector motor is set as master microcontroller while the other two are slave ones. It gives command to slave microcontrollers for rotation of row and column selectors motors respectively. This controlling scheme can be seen from fig 2.

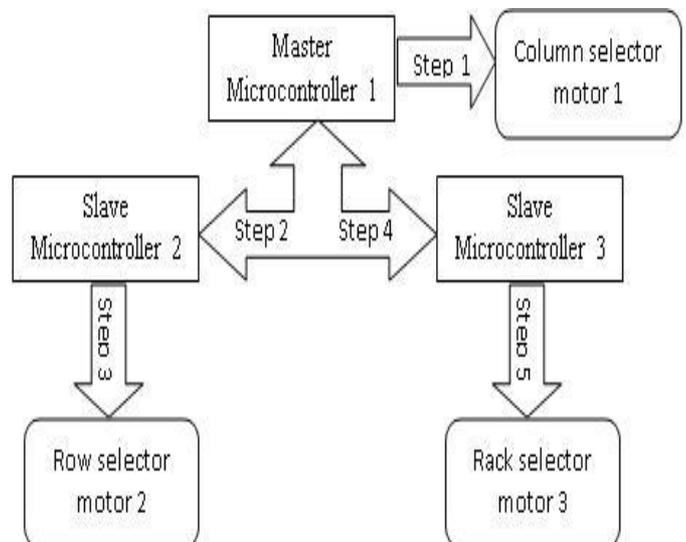


Fig. 2. Controlling Scheme

C. Programming layout

This system includes keypad as input device. The input is translated in to motor rotations inside microcontroller. Home position (pick and drop point) is at one end of assembly and by default trolley remains there when no user attempt is made. Coding includes three digit address entered from the user. Validity of address is defined by each digit. 1st digit is associated with column address, 2nd digit with row address and 3rd digit with rack address. Valid user input is one that follows the limitation imposed on each digit. Only correct input is processed for storage and retrieval operation. Digits processing is executed on first come first serve basis when input termination indicator is submitted appropriately. Each address is linked with distinct combination of three square waves and direction outputs. These outputs guide three motors in hardware to reach specific location mentioned by user. After performing the requested function, vehicle is guided in program to return to home position. Fig. 3 shows the flowchart of programming layout.

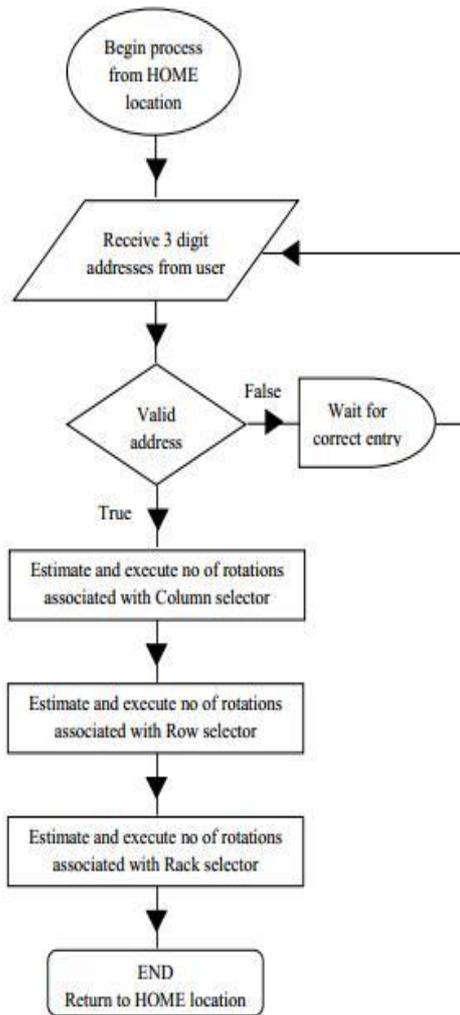


Fig. 3. Programming Layout

III. METHODOLOGY

AS-RS is proposed to solve issues in material handling process. Goods can be stored and retrieved in a specified location in a cell of a particular rack as defined by the user. A storage and retrieval vehicle (SRV) is designed that performs storage and retrieval of items. The whole system relies on microcontroller and stepper motor correct functioning. Microcontroller is selected on the basis of sufficient input output ports for this system. After selection it is programmed using MikroC software and code is burned into microcontroller memory. Once it is programmed, it works according to the code feed in it. Stepper motor is selected based on weight and torque requirements. Stepper motor driving circuitry is used to drive motor in three dimensions (x, y and z). Motor works followed by commands of microcontroller which fulfils motions of column (x-axis horizontal), row (y-axis vertical) and rack selectors (z-axis inward/outward).

A. Storage and Retrieval

An address (entered by user) of particular cell of specified rack is provided in order to store or retrieve an item. Address corresponds to particular column, row number and rack. Microcontroller give commands to stepper motor and it drives SRV by following the address. Fixed no of rotations programmed according to each cell, will let the stepper motors to move in all three dimensions.

Storage and retrieval operation has basically three steps.

- First of all column selector will move in x-direction and stops in front of particular column of rack as addressed by user.
- Secondly in order to reach that address specified by user, row selector moves in vertical y-direction and stops in front of entered row. Now SRV will be in front of that particular cell of rack.
- Thirdly Rack selector will move inward/outward for that specified rack as defined by user.

Finally after storing/ retrieving items into or out of rack, SRV reverses all of its steps and moves back to pick and drop point of items near user. Hence in this way storage/retrieval is done automatically without human interference.

IV. APPLICATION OF PROJECT

The accurate application of AS-RS affords an extensive list of user benefits. They can be employed in all those places where there is requirement of handling materials by storing them at defined locations. It can be seen that automated storage and retrieval systems are capable of effective material handling. They handle raw materials, products where work is in process, control inventories, finished goods of all kinds and makes it possible to retrieve them where placed.

Our project can be applied for storage and retrieval of spare parts in various industries. Its application includes controlling

of small inventories by automated storing and retrieving them when required.

#### V. FUTURE WORK

So far we have designed a prototype for storage or retrieval of spare parts and for inventory control. Later we will develop it for storage of books in libraries. It will be served with a scanner which will scan for particular barcode of that particular book and will retrieve it back to pick and drop point. Similarly books belonging to specific category of racks will be stored automatically in defined locations.

Furthermore this system can be extended in a way that goods should be able to be stored at first unoccupied place. For this purpose, data has to be updated every time about current location of that item so that it's retrieval can be made possible.

#### VI. CONCLUSION

In this paper all the details of proposed system have been discussed. The problem of handling spare parts and inventories can be solved by using automated storage and retrieval system (AS-RS). As a result of implementing this system storage and retrieval of goods can be made possible, which yields better space utilization and saves time from sorting out without any damage of products. This system

eradicates manual work and can easily be controlled by any common man.

It is certainly a good way to make storage secure and reliable and allows quick retrieval of goods. Many factors favor AS-RS as it is beneficial in number of ways.

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