

PLC Based Automated Storage and Retrieval System for Multiple Racks



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ABSTRACT

Automated Storage and Retrieval systems (ASRS) are proving keywords in the flexible manufacturing setups. As the optimized storage and minimum retrieval time are significant components of the manufacturing cost. The designated ASRS 3-axes, stepper motor driven, PLC controlled system, which has Z axis to deal with height of storage rack 100 mm, X axis to negotiate length of shelves 600 mm and Y axis to negotiate multiple racks 800 mm. The PLC with 48 i/o's is selected which has retentive memory. For storing the proposed system picks the object from in feed location, and places it to the computed destination as per algorithm & for Retrieval the systems picks the required object from bin & places it on desired location. The control panel is equipped with occupation details, provision to command the destination location, execute command button, emergency stop. The PLC program offers the user to command storage or retrieval, informs about the occupation, follows the command. The pick and place is electromagnetic. The retentive memory of PLC is employed to store the occupation status of the shelves.

Keywords— Retentive Memory, ASRS, PLC.

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I. INTRODUCTION

This Automated Storage and Retrieval systems are one of the primary subsystem of the Flexible Manufacturing setup. When the automated production is implemented the raw material, bought out items, or subassemblies are usually stored in any manufacturing set up. The inventory is required to be maintained minimum so as to lower the WIP cost and help the process reach the Just in Time philosophy. The ASRS systems are taught to not allow any of the store component in the system for a long while as well as it effectively maintains the cycle time possible low.

The setups available in the educational equipment so as to demonstrate the students the working principle, programming PLC, are not that competent and provide only one rack. This weakline of the present state of art, detour to the development of the demonstrative setup of the ASRS so that the students are possible to demonstrate the subsystem ASRS of the FMS unit.

II. OBJECTIVES

The proposed ASRS was designed for following objectives.

- To allow multi rack operation.
- To be able to operate in AUTO and MANUAL mode.
- To enable the user to command desired location either to store or to retrieve.
- To be able to accommodate the 50 cu. mm. objects

The proposed ASRS is designed and implemented with the main objective of demonstration. Therefore no much of the research publications were consulted. The basic theme was adopted from the standard texts and some brochures were referred to define the system details.

III. THE AUTOMATED STORAGE AND RETRIEVAL SYSTEM

The Fig. 1 shows the complete setup of proposed ASRS. This system is to store the product/ components in category format in the zone allocated by algorithm. This is to give high priority to high class components & optimised the storage space with high yield items, thus getting maximum benefits from storage space. Also the higher running items are stored near the out feed area so the retrieval time will be minimised, boosting the productivity. Repositioning of non moving C class components will be done in storage space & also will be moved out to accommodate incoming A class item. The stepper motors are used to programme & position the slides. Operator will place the component on In feed area, will select the category / class component & press cycle start switch. Conveyor will move component to picking area. Depending on space availability & component class, PLC program will decide where to place the component. Slides will move accordingly. Z slide will move down, Electromagnet will made on, Job picked by electro magnet , now X & Y slide will move to program selected position, Z slide will move down. Electro magnet will be made off. Job will be release in position. Z slide move up.

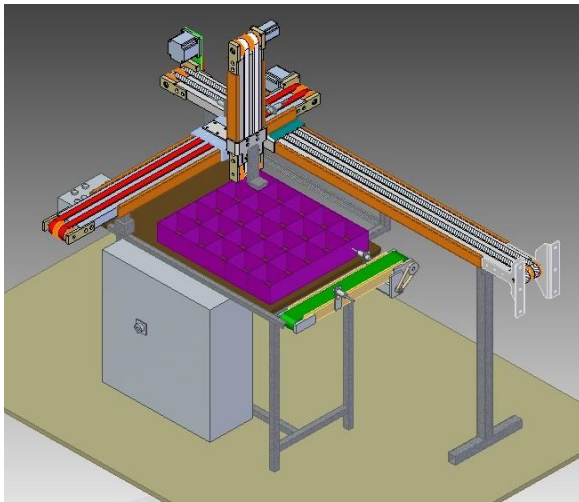


Figure 1 : The ASRS setup

A. Motion X

The X motion is basically to negotiate length of shelves. This is stepper motor (Torque:- 34 Kg.cm & Current:-3Amp) driven slide. The timer belt and pulleys are used for precise power transmission and moving the slide to the desired position. The subassembly is mounted on Aluminium Extrusion which provides the base to slide. The roller ball cage slide as guide element with it, as shown in Fig. 2

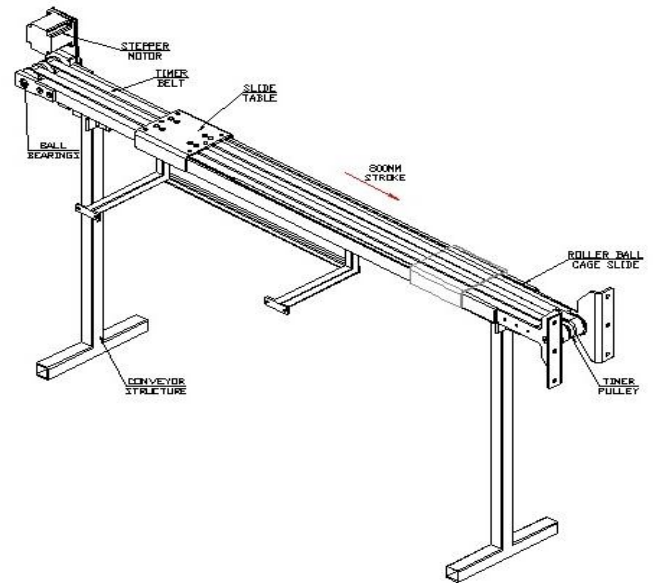
The full stroke of slide is 600 mm & maximum speed of slide travel is 10 m/min. One proximity sensor is used to

confirm home position of slide, which also serves as parking position of slide when idle.

B. Motion Y

The Fig. 3 shows motion Y. This motion moves the axis so as to address multiple Racks. This is again stepper motor with Torque 34 Kg.cm & Current 3Amp, driven slide. In this motion also the timer belt and pulley are used for desired positional accuracy. The roller ball cage slide act as

guide element, wherein this entiresubassembly is mounted on Aluminium extrusion as base of slide. The full stroke of slide is 800 mm & maximum speed of slide travel is 5 m/min. One proximity sensor is used to confirm home



position of slide , That is also parking position of slide when idle.

Figure 2.The X Axis.

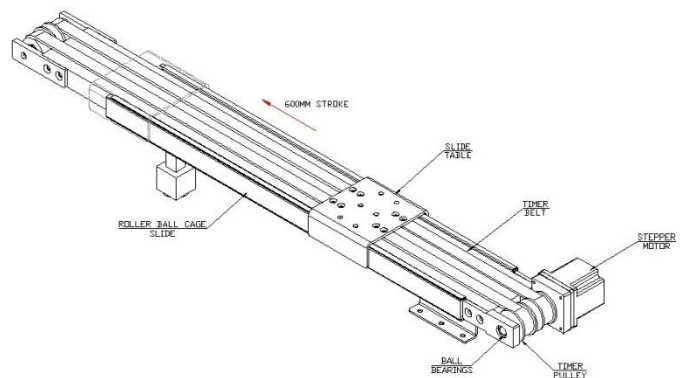


Figure 3 : The Y Axis.

C. Motion Z :

1) This motion enables the ASRS to negotiate the height so as to serve to shelves of the rack. This is stepper motor with significant specifications as Torque 20 Kg.cm & Current 2.8Amp, driven slide, with timer belt and pulley, The Roller ball cage slide as guide element & Aluminium extrusion as base of slide ensures the fully supported structure for rigidity as positional accuracy is very significant here as the object is being placed.

2) Full stroke of slide is 100 mm & maximum speed of slide travel is 5 m/min. Here again a proximity sensor is used to confirm home position of slide, which serves as parking position of slide when idle.

The power of demonstration was tested on the polytechnic student and all the students experimented this ASRS were satisfied for the function and understanding. The proposed ASRS is of very much use for grapes cold storage and subassemblies having more than 20 subcomponents.

IV. THE PLC PROGRAMMING

3) The PLC is main heart of This system. The DELTA make PLC, Model DVP-28SV is selected as it has the required specifications as discussed. It has on-board 16 inputs & 12 outputs in which 4 outputs are high-speed outputs. These high speed outputs are used for giving pulsed command to stepper motor drive. 9 pin D connector Port is used for connecting laptop or programming device to PLC for uploading or downloading the program.

The system has a control panel. The panel is designed to facilitate the user to operate the ASRS for the desired function. The START button puts the ASRS in operation till the STOP button is pressed, and both the buttons are push to ON. The PLC has a retentive memory, which stores the occupancy of the each location. The ASRS is designed for multi rack operation while only one rack is symbolically provided in the assembly.

The push buttons STORE and RETRIEVE enables the operator to command the ASRS to take the object from the conveyor to the desired location and collect the object from the commanded location to the conveyor respectively.

The priority wise locations are categorized. The first two racks are intended for high priority A items, next two for B priority items and finally last two are for C category items.

The PLC works out the which location is nearest when it is instructed to decide the storing location on its own while in AUTO mode. Similarly in AUTO mode it retrieves the object which is nearest. The three push buttons A, B and C allows the user to select the category of objects in AUTO mode. The AUTO mode button is latching ON-OFF type.

In manual mode, the operator has to command the location from which the object is to be retrieved or stored. This is implemented by thumb wheel switches locations ranging from 0 to 99. The four shelves and four location each shelf amounts to 16 locations a rack. Thus 1, 16 is first rack, 17 to 32 is second rack and so on. The thumb wheel are set to any number from 1 to 16 in the present case, to either STORE or RETRIEVE objects.

While implementing the position commanded the PLC moves one axis at a time at the storing column has to move across shelves of each rack. While going to next rack it is required to come to the extreme left position so that it comes out of rack length so as to reach to the desired rack. The storing column is attached with an electromagnet so that objects could be gripped magnetically.

V. IMPORTANT DEDUCTIONS

The ASRS thus implemented has proved the purpose. All the objectives set forth are positively implemented. Total cycle time of storing an object in manual mode is minimum 4 minutes and maximum 7 minutes.