Plc Based Automated Storage And Retrieval System With A Robotic End Effector

Mr. Goutham Mareeswaran.B[#1], Mr. Kishore Kumar. U[#2], Mr. Karthik.A[#3], Mr. G. Prakash Ram[#4]

[#1]*Assistant Professor, Dept. of Mechatronics Engineering, SRM Institute of science and technology, SRM Nagar, Kattankulathur - 603 203, Kancheepuram District, Tamil Nadu.*
[#2,#3]*Student, Dept. of Mechatronics Engineering, SRM Institute of science and technology, SRM Nagar, Kattankulathur - 603 203, Kancheepuram District, Tamil Nadu.*
[#4]*Student, Dept. of ECE, SRM Institute of science and technology, SRM Nagar, Kattankulathur - 603 203, Kancheepuram District, Tamil Nadu.*

Abstract

This paper aims to develop an ASRS that has a three DOF robotic arm attached to it. Initially, the common ASRS focused on heavy pallets loads but with the evolution of the technology, handled loads have become smaller. Our objective is to lift even lighter objects in the field of pharmacy as a tablet dispensing machine. The whole system is controlled and monitored using PLC and SCADA. This system can be of important use in holding a small object and storing it in a very small confined area. Conventional ASRS is bigger and can hold bigger object but when it comes to small tiny objects this same ASRS fails to retrieve the object so we have proposed a system that can hold, store and retrieve small and soft objects without any damage to it. The proposed idea provides both monitoring and control of all the above parameters using PLC. It gets the input from the HMI. According to the ladder logic diagram, it issues the necessary control automatically. and then the entire operation is monitored using SCADA.

Keywords *– ASRS – Autonomous storage and retrieval system, PLC – Programmable Logic Controller, SCADA – Supervisory Control and Data Acquisition, HMI – Human Machine Interface.*

I. INTRODUCTION

Storage and Retrieval Systems have been widely used in the distribution and production environment since their introduction in the 1960s. An Automated Storage and Retrieval system usually consists of racks served by cranes running through aisles between the racks. Generally, Automated Storage and Retrieval systems refer to a variety of computer-controlled methods for automatically depositing and retrieving loads to and from defined storage locations. Automated Storage and Retrieval Systems have many benefits including savings in labor cost, improved material flow and inventory control, high floor space utilization, increased safety, and stock rotation. Automated Storage and Retrieval System, carousels/rotary racks, automated guided vehicles and robotics systems are some of the most common material handling systems in manufacturing industries. The right application of Automated Storage and Retrieval System provides a long list of user benefits. It has been demonstrated time and time again that automated storage and retrieval systems are proven technologies capable of effectively and consistently handling and buffering raw materials, work in process inventories aid finished goods of all kinds and making it possible to integrate material handling storage.

II. LITERARY SURVEY

A. EXISTING SYSTEM

The Material Handling Institute defines an Automated Storage and Retrieval System (ASRS) as a combination of equipment and controls which handles stores and retrieves materials with precision, speed, and accuracy under a defined degree of operation. For the project, the ASRS is a specifically designed system that transports loads on specifically designed bins or pallets, with efficiency and speed. This entire system is controlled by an Arduino Mega processor and is fully automated. In the particular design for the project, the ASRS is a 3-axis manipulator, with a storage rack. The storage structure is fabricated with lightweight aluminum L angled channels and the SR machine or the Storage Retrieval machine is fabricated with V slotted aluminum channels. The designing of the SR machine was the major task in system design. The SR machine should be able to conduct swift, hassle-free vertical and horizontal motion. Many mechanisms could be implemented for the system, of which a simple belt-driven slider mechanism was the most efficient and space-saving.

B. PROPOSED SYSTEM

The proposed ASRS has a consists of a self-acting PLC system which works round the clock to avert the problem with the system this enhances the safety of the system form a normal ASRS

The whole ASRS and the arm are completely operated using PLC and the full system is monitored by SCADA so that no interrupts of failure may occur during this process. A rack according to the system is made to store the material or objects. The program is done according to the storage system.

III. DESIGN OF THE PROPOSED SYSTEM

There are a few economic models available to design material handling systems. Noble et al. (1992) reviewed a number of the approaches which have been taken to model the design of material handling systems. The common approach is to structure models of the various types of material handling systems, using desired performance parameters, available resources of space and funds, and then to compare the relative merits of each system. The models created are usually empirically determined from existing systems, with certain key inputs which, to a large extent, determine the design of the system, by factoring in size, cost and performance. The advantage of this approach is that a system can be quickly modeled using existing material handling solutions, and estimated costs, sizes and performance parameters can be quickly evaluated for the alternatives. The method is better suited for application by equipment vendors, for tenders on frequently used designs, utilizing their decision knowledge base.

The engineering approach to designing a material handling system typically follows a conventional product design practice. One such approach is illustrated by Dieter (1983), arid can be adapted for use in the design, process for the installation of an ASRS is a flexible manufacturing environment. The success of the engineering approach depends largely on the analysis carried out in formulating the problem. Problem definition includes assessment of the engineering objectives; correctly applying the constraints on possible solutions; and defining the criteria by which the design will be evaluated.

Table 1: DH parameters of the proposed Model

Link	a_n	α	d_n	Θ_n
1	0	0	d_1	0
2	0	0	d_2	0
3	0	90^0	0	Θ_3
4	L_4	0	0	Θ_4
5	L_5	0	0	Θ_5

Application of creative techniques to generate alternative solutions gives designers the freedom to look for new solutions to problems that have been solved previously. While it is important to use existing knowledge to make design decisions, the process should not be constrained to only reproducing modified versions of old designs.

The concurrent approach to the design process is of value to any materials handling system, and especially to the ASRS. Sale (1994), explains integration as incorporating the interfacing and coordination of functions, the linkages of physical components, and the information hand-offs that occur throughout the organization. 11 As mentioned previously, the design of an ASRS will often include the information system which handles inventory or other handling transactions. While the integration of the ASRS into the existing FMAS is important, there was little teamwork required in this particular sign process, and the additional complexity of the concurrent approach was therefore not justifiable for this design process.

Noble et al. (1992) propose an a.de-sign justification approach that requires economic justification at each design decision to ensure that a functionally and economically viable system design results from the process. This method was intended to be applied to large systems design and concurrent engineering, but the principle is well suited for this design. The cost of each component of the design was evaluated concurrently with the design process, and its inclusion or rejection was decided at an early stage of the process.

A. DESIGN OF THE MANIPULATOR

It is an arm-like mechanism that consists of a series of segments, usually sliding or jointed, which grasp and move objects with some degrees of freedom. The degree of freedom (DOF) of a mechanical system is the number of independent parameters that define its configuration. It is the number of parameters that determine the state of a physical system and is important to the analysis of systems of bodies in mechanical engineering, aeronautical engineering, robotics, and structural engineering. For a manipulator, each degree of freedom is a joint on the arm, a place where it can bend or rotate or translate.

The Denavit-Hartenberg (DH) Convention is the most commonly used method for calculating kinematics of any robotic model. A DH parameter gives us the most complete and minimal solution to our robotic model. The whole design was modeled in solid works software

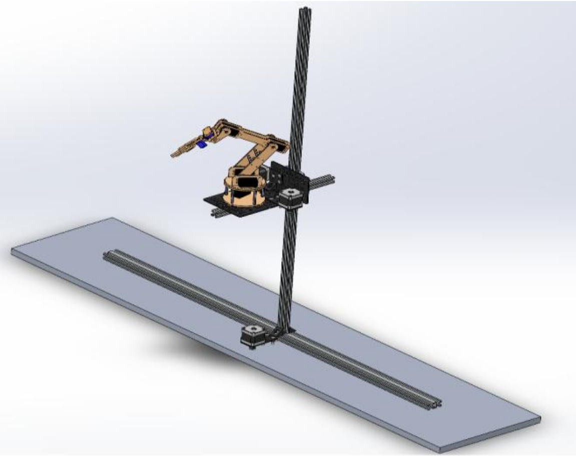

Fig.1: Design of the proposed ASRS

Fig.2: Design of the proposed 4X3 Rack

The PLC is connected to the Boolnath stepper motor driver which is an intern connected to the stepper motor this will help the motor to actuate more accurately and a precious manner similarly the robotic arm driver is connected to the PLC that is connected to the motor used in 3 DOF manipulator.

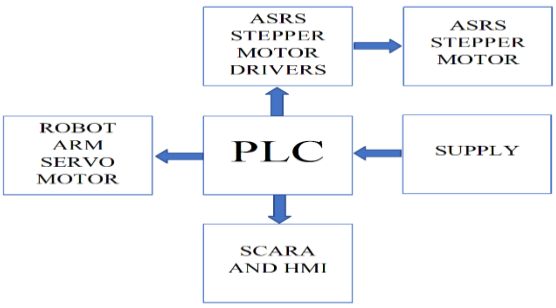

Fig.3: Basic circuit

IV. COMMUNICATION BETWEEN SCADA & PLC

RS Logix programming packages are compatible with programs created with Rockwell Software DOS-based programming packages for the SLC and MicroLogix families of processors thus making the program to maintain both hardware and software platforms more conveniently and in an easy manner. The RS Logix 500 benefits include:

- Cross-reference information Drag-and-drop editing Diagnostics
- Dependable communications Database editing Reporting

V. SOFTWARE DESIGN

This is the basic command used in our model. The K1000 command allows the motor to actuate forward direction. Then the K-1000 command allows the motor to actuate in reverse direction. By using the simple logic, the whole system is controlled. So that the motor can stop in a correct position to grab the object and then retrieve to the initial position with any fuss in the control system.
Simultaneously the whole system is monitored in the SCADA system so that if there is any problem in the system or the model. The supervisory system help the user to troubleshoot the problem by notifying it in the system.

VI. FLOW CHART

The system is fully set then the object is placed accordingly in their respective position. Now considering that the rack is of 4X4 with 16 racks in total, if the user wants to take an object form the nth rack then the system will directly go to the nth according to the instruction given and picks the object and delivers it to the user.

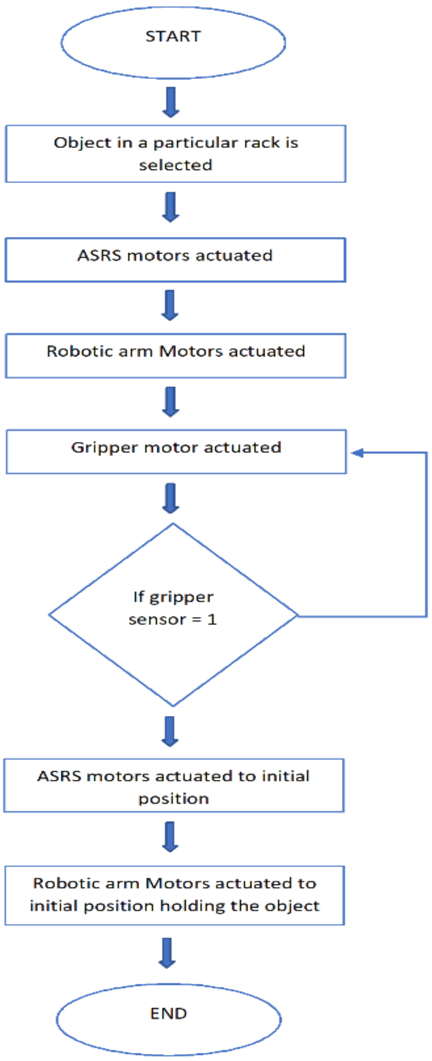

Fig.4: Flowchart of the model

VII.SPECIFICATIONS OF PLC

Manufacturer: Delta **DVP-14SS211R Programmable Logic Controller**

Types: Fixed – fix no of Inputs & outputs.

Modular-Variable no of inputs & outputs.
Power: 20.4 to 28.8 VDC
Digital Inputs: 8 inputs, 24 VDC sink or source
Digital Outputs: 6 relay outputs
Communication Port: RS-232 and RS-485, Modbus ASCII/RTU master or slave
Program Capacity: 8 k steps

VIII. CONCLUSION

ASRS is the most convenient system for storage in industries but when coming to small application the most sufficient system fails to fulfil that necessity to overcome that we have proposed and developed a full system that can hold the small object of different shapes and sizes.

Since this is more user-friendly there is no need for a person to monitor it regularly the user or a customer can directly come to choose whatever she wants and get the things easily with the help of any other. This system is also very much compact that it can accommodate in a very small area. Using this system in a supermarket or pharmacy might help people to consume their valuable time. Invariantly there is no need for a person to wait for a long time in a queue.

This system can perform all the operations without the involvement of humans. This system can detect a minor change in the system so that the troubleshooting is done effectively beforehand. This also saves a lot of power and time for the user.

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