Advanced Technology of Automated Storage and Retrieval System Using PLC Integration

Ashna Joy[1], B.Padmanabhan[2], A.Abinaya[3]

[1,3]UG Student, [2]Assistant Professor

[1,2,3]Department of Electrical &Electronics Engineering, Sathyabama University, Chennai, Tamil Nadu, India

Abstract— **This article proposes an highly developed fully automatic ASRS (automatic storage and retrieval system). This main material management support system is generally used for storing and retrieving the unprocessed materials in the manufacturing unit. The necessities of ASRS are increasingly of a more dynamic nature for which new models will need to be developed to overcome the time consumption. ASRS consists of a range of controlled systems for automatically retrieving and storing loads from preferred storage spaces. It is usually used in applications where there is a very high quantity of loads being moved into and out of storage. This system is mainly used for storing and retrieving the unprocessed materials in a manufacturing unit. The main aim of this paper is to build up an automatic system from the present system. The original idea of the article is to help public those who work as operators by designing a system where it is capable of managing the drawer without interference of an operator. The performance of the present system is enhanced by using PLC integration where it coordinates the operation and control of ASRS.**

Keywords*— *Programmable logic controller, Supervisory Control and Data Acquisition, Elevator Conveyor Setup

I. INTRODUCTION

In a dynamic industrial location the collection of unprocessed materials or completed products is done by automated guided vehicles, which has an important role in the improvement of these competitive conditions. The control and speed of production storage delivery systems by means of a classic human operated forklifts and hence the stock data management are more difficult. Therefore a fully automated storage and retrieval system (ASRS) is implemented in order to find the solutions for all these problems. Recent advances in this technology offer the possibility of drastically reducing the cost of the current system with accurate and fast positioning under a defined degree of automation.

The ASRS is an important key part of the rapid logistic system along with the consideration of limited space, high labour cost, requirement of flexibility, expandability, quality, reliability, management control. It consists of mechanical equipment, automation control equipment using PLC integration, computer system and it operates under computerised control maintaining an inventory of the stored items for handling the materials which is at a height. Retrieval of items is accomplished by specifying the item type and quantity to be retrieved [1]-[3]. The computer determines where in the storage area the item can be retrieved from and schedules the retrieval. It directs the proper automated storage and retrieval machine (SRM) to the location where the item is stored and directs the machine to deposit the item at a location where it is to be picked up. The MES takes loads into and out of the storage area and move them to the manufacturing floor or loading docks. To store items, the pallet is placed at an input station for the system, the information for inventory is entered into a computer terminal and the AS/RS system moves the load to the storage area, determines a suitable location for the item, and stores the load[[4]-[6]. This paper aims to develop the functionality of a manually controlled SRM using PLC integration.

II. PROPOSED SYSTEM

In the proposed system the manual operators are not required either to store or retrieve.A Tri-axis Functional ECS is constructed to store and retrieve the materials to/from the storage chambers. The ECS can move in X, Y & Z axis to perform the functions of storage and retrieval as shown in Fig1.The storage chambers are designed in such a way that they can detect the presence or absence of materials and correspondingly instruct the PLC. The ECS has a base plate to provide the base for the pallets where sensors are provided.

Fig 1: Elevator Conveyor System

SCADA is designed to provide the desired human-machine interface to the operator. Through this design one can easily supervise, control and have data acquisition anytime. PLC is used to provide the necessary control functions for the entire process [7]-[9]. The desired logic is programmed and loaded into the PLC's memory to initiate its action.

III. BLOCK DIAGRAM

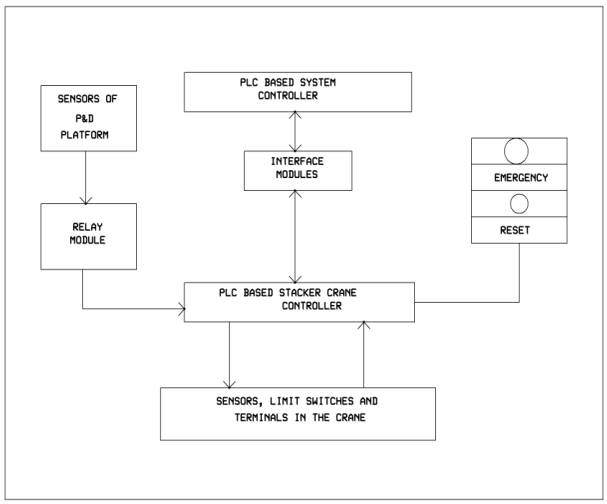

Fig 2: Block Diagram of the proposed system

The basic block diagram of ASRS is given in Fig2. Here two controllers are used, that is, the PLC based system controller and the PLC based stacker crane controller. The PLC based system controller is interfaced with PLC based stacker crane controller through interface modules. These two controllers communicate through Profibus. Here Profibus is used so that all the inputs and outputs can be connected in single cable for easier and faster communication. The stacker crane controller is connected to several sensors, limit switches to get physical inputs.

The PLC based system controller is nothing but the HMI (Human Machine Interface) screen. Once when the sever enters the rack number for storing or retrieving operation the stacker crane controller senses the row and column to which it has to perform the operation. The end limits of travel in all the axes of movement are detected by heavy duty limit switches.The position of fork at centre is also detected by limit switch. The digital inputs are given to PLC through relays. The sensors of P&D platform is used to sense the presence or absence of pallet. The emergency switch is provided for any emergency purpose like power failure and shuts down the whole system. The Reset option is used to stop the crane at any position and return to its homing position.

IV. CIRCUIT DIAGRAM

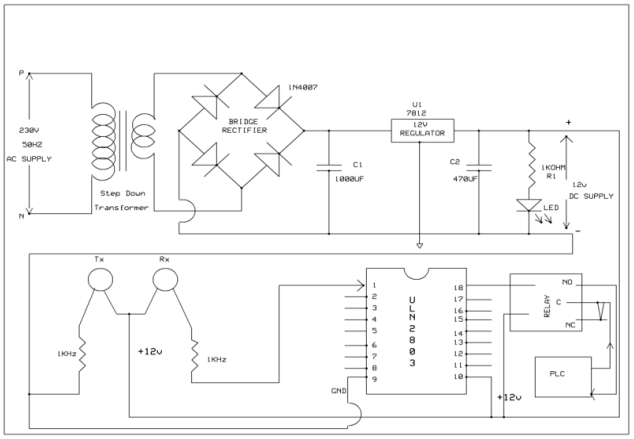

Fig 3: Circuit Diagram of regulated supply

The circuit diagram consists of power supply and programming part. It contains a step down transformer, bridge rectifier, filtering capacitor, voltage regulator, IR pair, ULN circuit, relays and PLC. In the power supply circuit 230 volt 50 Hz AC supply is given to the transformer which acts as a step down transformer. This stepped down AC voltage is given to bridge rectifier which is converted into DC voltage. Further this filtered DC voltage is given to a 7812 regulator that gives a constant 12 volt DC supply which is given to the IR pair in Fig3.

IR pair consists of a transmitter and a receiver which is protected by means of resistors. Whenever there is an obstacle in the spacing of transmitter and receiver it will sense the object and send signals to the ULN circuit. ULN is an IC chip which will be acting a NOT operation. Therefore the supply will be reversed in the ULN and is given to the relay which activates it. Relay has three terminals namely normally open, normally closed and common. Normally the common terminal of the relay will be in contact with normally closed terminal. Whenever the relay gets actuated by the negative supply the common terminal comes in contact with the normally open terminal. Thus the relay operates and it transmits the signals to the PLC. Hence the operation is performed.

V. MOTOR OPERATION

The motor operation is performed using PLC and relays. Triaxial operation is performed here that is, X axis, Y axis and Z axis. Hence three motors are used to perform the operation. Here we have two relays for each axis of direction. If we consider the X axis operation, common terminal of R1 is connected to the positive terminal of the motor and common terminal of R2 is connected to negative of the motor. The normally closed terminals of the both relays are short circuited and the normally open terminals of both relays are also short circuited. The positive terminal of the power supply from the PLC is given to the normally open terminal and the negative terminal of the power supply is given to the normally closed as in Fig5.

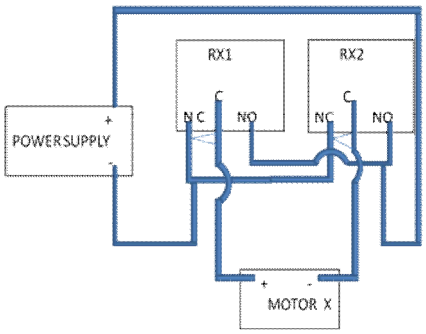

Fig 4: Motor Operation For X Axis

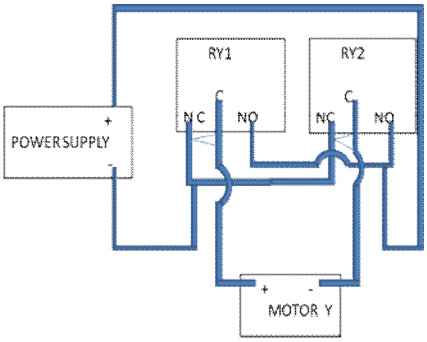

Fig 5: Motor Operation For Y Axis

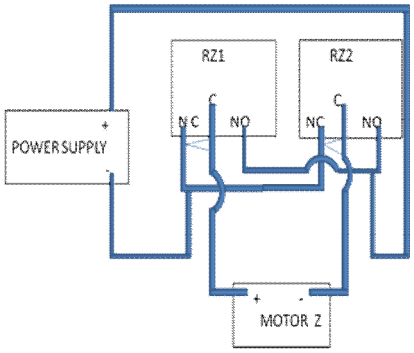

Fig 6: Motor Operating For Z axis

Table1: Truth Table for the Operation of Motor

R1	R2	MOTOR
0	0	No Oprn
0	1	Rev
1	0	Fwd
1	1	No Oprn

When 0 and 0 or 1 and 1 is given to both the relays there will not be any operation performed as the common terminal will be in contact with normally closed terminal. Then motor will not perform any operation. When 0 is given to R1 and 1 is given to R2, the common terminal of R2 will come in contact to normally open terminal and since the common terminal is connected to negative of the motor, the motor will rotate in reverse direction. When 1 is given to R1 and 0 is given to R2, the common terminal of R1 will come in contact to normally open terminal and since the common terminal is connected to positive of the motor, the motor will rotate in forward direction. Likewise the same operation is done for Y axis and Z axis as in Fig6 & Fig7.

VI. SOFTWARE USED

PLC and SCADA are the software used along with their link software.

SCADA DESIGN

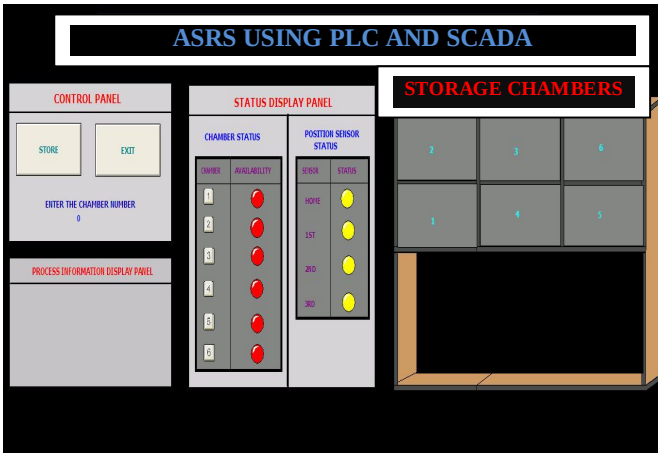

Fig 7: SCADA Design of the Proposed System

This is the HMI screen which is developed using Wonderware Intouch software. In Fig 7 we have designed a control panel for store and retrieve command. When the chamber number is entered and store or exit option is clicked the crane operates automatically and reaches that particular

chamber and performs the operation given. In the status display the availability of pallets in each chamber will be indicated. When the crane stops in a particular position that will be indicated in position sensor display. Whatever process is happening will be indicated in the process information display panel.

PROGRAMMABLE LOGIC CONTROLLER

A **Programmable Logic Controller**, is a digital computer used for automation of electromechanical processes. Here we use OMRON CP1E

VII. SIMULATION RESULT

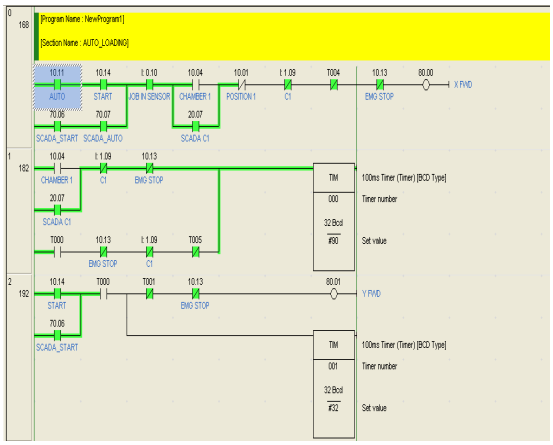

Fig 8: Loading process

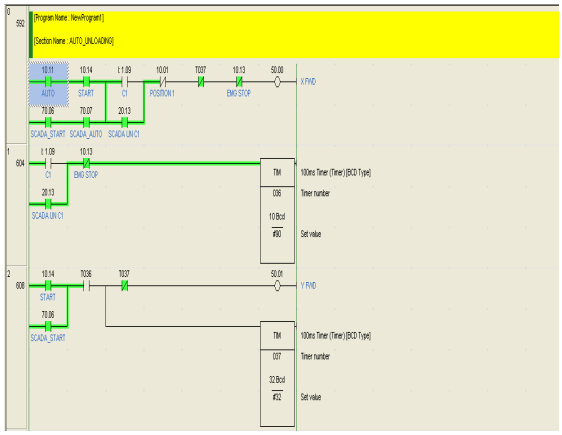

Fig 9: Unloading process

Figure 8 shows the simulation of loading and figure 9 shows the simulation of unloading operation. Once the input is given in the SCADA screen the auto and start gets activated and the crane starts operating.

VIII. HARDWARE IMPLEMENTATION

In the fully automatic ASRS the time consumption is lesser than the manually operated ASRS. Automatic ASRS takes 35 sec and manually controlled ASRS takes 60 sec approximately. In the proposed system the miscalculations can be detected and it is more reliable. It eliminates the product damage and labour cost.

Fig 9: Whole setup of Hardware

IX. CONCLUSION

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. Automated storage and retrieval system development is divided in layers i.e. fabrication of the mechanical components and their assembly, the electrical circuitry, the electronic circuitry, programming and interfacing.

X. REFERENCE

[1] Rashid, M.M; Kasemi, B; Rahman, M., 2001, "New ASRS using wireless communication", International conference on Mechatronics IEEE. pp 1-7

[2] Swathi S P , M G Vasundhra, Dr B Yogesha, 2013"PLC based Automatic Racking System" in International Journel of Engineering Research Technology. pp 805-810

[3] Kees JanRoodbergen, 2009 "A survey of literature on ASRS" in European Journal Of Operational Research. pp 343-362

[4] Dotoli, M. Fanti, M.P, 2002 "Modeling of an ASRS by rail guided vehicles with colored petri nets". International conference on Systems,Man and Cybernetics(Vol 3), IEEE,

[5] Sriram ,T. Vishwanatha Rao, K. Biswas, B. Ahmed, B, 1996 "Applications of barcode technology in Automated Storage and Retrieval System", Proceedings of International conference on Industrial electronics, Control and Instrumentation ,IEEE.

[6] MasudMansuri, 1997"Cycle time computation, and dedicated storage assignments, for AS/RS system". Elsevier Science Ltd. pp307-310

[7] We-Min Chow, 1989" Development of an Automated Storage and Retrieval System for manufacturing assembly lines". Proceedings of international conference on Robotics and Automation. IEEE. pp 490-491

[8] Hu Yahong, Huang Shell Ying, Chen Chuanyu, Hsu Wen-Jing, 2003 "Travel time analysis for a new Automated Storage and Retrieval systems". Emerging technologies and factory automation, Proceedings ETFA'03. IEEE conference. pp 75-81

[9] Ajinkya C. Dawale, Chandrashekhar N. Sakhale,"Design and Fabrication of Automatic Storage and Retrieval System". IJITEE, International Journal of Innovative Technology and Exploring Engineering. pp 32-37