Automation of Warehouse

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Abstract— **The main idea behind an automated warehouse is to improvise the picking and handling of any object picturized on a large scale. This can be done with an automated process which would eventually lead to reduction and replacement to the tedious human efforts behind this process. The design includes a model-based approach to automate warehouse by controlling, analyzing the model of warehouse and autonomous transport in warehouse. It clearly objectifies the warehouse system which can deliver large number of packets from storage module to assigned location simultaneously within minimal time requirement along with careful handling of the goods, preventing them from any further damage. System performance is increased by developing an integrated warehouse control by designing a data capture technique along with automatic identification. This prototype is implemented using a ladder logic programming on PLC along with a control panel. This allows a wide range of benefits to the user with quick action rate. This automated warehouse has an efficient work which helps in satisfying the needs by cutting down the time and human efforts required for the work project. Along with all such benefits it all keeps and account of objects safety thereby leading to careful handling of all the objects that may be heavy or fragile.**

Keywords—TIA PORTAL, Factory IO, Wonderware AVEVA, PLC S7-1200, PLC Sim.

I. INTRODUCTION

The proposed research paper is based on development of an Automated storage and Retrieval System (AS/RS) which particularly focuses on pellet warehouse with bulk storage facilities. The first automated warehouse was introduced in some 50 years ago. The development process which underline on mechanical, electrical and electronic aspects will be done in various phases such as design, implement, integrate, validate, testing and analysis along with documentation and specification. Today, the modern Automated Warehouse Systems (AWS's) are continuously advancing thereby replacing traditional warehouse system. With certain adaptation in the order processing the batch, zoning and sorting system can meet large number of orders and are much more efficient and effective. The AS/RS prototype consists of hardware, software along with networking components which could communicate through each other. The system consists of cranes and racks which provides the retrieving activity along storing the products to their respective destination. This is then fully controlled by a supervisory computer control. The material storing and handling system consists of a conveyor, a loading/unloading station, a material stacking system. Most of the Automated Warehouse Systems are composed by vehicles which can move them along a mono-dimensional path. The problem is to control the interface system.

Most of automation industry are looking forward for an integrated automated workstation which provides an operation with no interference of an operator with rapid market variation. Factors such as productivity, connectivity and standardization which leads to manufacturing success. These factors basically help any warehouse to come out with its challenges. This is where AS/RS comes into picture, an AS/RS is a combination of control and automated equipment that not just handles and stores but also retrieves variety of objects with accuracy, speed and precision. It can be manually used as single alone unit but now a day the automated system is preferable. AS/RS systems are widely used in warehouse, production and automation industry due to its better and efficient performance. Moreover, to evaluate the process an automated model is generated, and algorithm is presented.
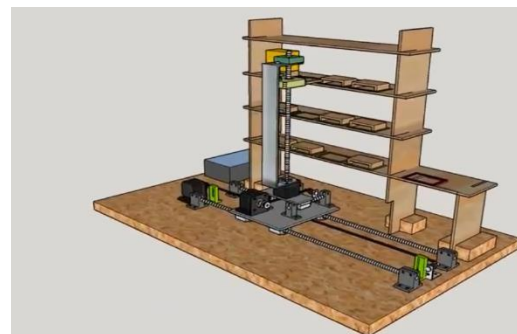

Fig (I) AS/RS Automated Warehouse

The above Fig (I) illustrates a AS/RS Automated Warehouse. This leads to better material handling in providing a better product to improve the overall function. Automated storage and retrieval systems (AS/RS) comes up in serving to optimize flow, space utilization, systems integration, and many such aspects.

II. LITERATURE REVIEW

Based on past paper presentation and the research papers on our topic of Automation Warehouse, we have handpicked some of the relevant topics that best described the working progress and the current scenarios. Automation Warehouse is a vast ongoing project that is frequently and constantly evolving, upgrading with new technologies. Based on those research paper we have concluded and have put forward our project to work and help the technology grow further for the betterment and easiness of the working environment.

A. Automated Storage and Retrieval System (AS/RS)

The mentioned paper gives us an overview of literature regarding *AS/RS*. The given explanation of the system provides us with various issues which include travel time, storage time, sequence assignment, etc. Whereas, it is observed that most of them are checked and provided with solutions that include scheduling and design problems only. But however, apart from static nature the models are increasing for dynamic ones which may include new models who can bring up a large development in time, planning and system performance. But this system required more customization since each system have their different supply chain it be tailored to account for unique variable. Modifying hardware like customizing program for the system and integrating it with other systems. For an AS/RS system to work correctly, everything must be installed with high accuracy. As a result, there is a very high labour efficiency for both installation and maintenance. [10]

B. Automated Guided Vehicles

The paper describes an auto transportation research project which the integral along with modular solution for the transportation as well as management in warehouse. The management automation includes a process that is based on identification of the warehouse based on RFID and PDAs. The supervision of such warehouse includes an internal access by SCADA system which includes even the remote areas. Whereas in other hand, the transport automation comprises of various implementation such as navigation, line tracking, path planning, teleoperation using a force-feedback device.

Modularity has been one of the main goals to achieve during the project. In this context, they have developed several modular applications in order to accomplish this task. For management automation, they have integrated the information system of an enterprise, based on an ERP, with different modules. On the other hand, a flexible identification system based on RFID systems and PDAs has been proposed for improving the communication flow between the manager and operators and expediting storage process. Warehouse supervision has been performed with a SCADA application, for remote control and monitoring vehicle positions and pallet locations thereby supervising the warehouse from any commercial internet web-browser. In particular, the industrial teleoperation has been described in detail in this paper. The application visualizes a 3D picture that represents the layout of the complete warehouse including a real image captured by the wireless camera fitted on vehicle. The low-level vehicle control is performed with a PLC, ensuring robustness requirements. The global automation of a warehouse is still a very difficult task, because of the high cost of its components as well as security which has not considered in this paper. [9]

C. Automnated and Robotic Warehouse

The paper was published in 2018 which stated the order picking systems from which individual packages can be picked. Storage systems for unit loads (bins and pallets). It discusses the different types of automated systems as well as several scientific results that are now known about such systems. They calculated the cycle time of the crane for single command cycles, for the situation in which any location within the rack is equally likely for the crane to travel to. It is assumed that the travel time to the farthest location is longer than the lifting time to the highest location and the fact that the crane drives and lifts simultaneously has been considered. If there are more classes and fewer products are stored per class, it is more complicated to share the space between products and more space is required per product. Research on automated warehouses are yet not under existence. With increasing technology and new advanced skills there are new questionnaire which needs to be justified. New models must be made to evaluate performance of the systems. However, even today there are quite a limitation that have arisen on automation of sequence picking as they are high investment which are earned only on long term. Further, the picking part of the process is still hard to automate and may need to be carried out manually. Manual warehouses will continue to exist for the time being, despite the new developments, even in economies with high labour costs. [8]

III. METHOD

The automated storage and retrieving system, stores and retrieve product with speed, accuracy as well as precision. It provides a storage density in a variety of areas such as:

1. A combination of conveyor and a voice picking to reduce the walk time and improve the efficiency to pick.

2. Quick response to minimize the cost and avoid lack in stocks.

3. Delivering the right product along with quantity to keep the process run smoothly and efficiently.

Below mentioned are methods on which AS/RS usually is operated to fulfil the above variety thereby providing a speedy, efficiency response.

A. Mono Series

The Mono series model are characterized by the exploitation of storage space and efficiency. They are further distinguished to have a height up to 49 meters. They are aislebound models with no buffers and provide end protection. It provides a lifting capacity of around 6 kgs.

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Fig (a) Mono Series

B. Multi Series

The design of the multi series AS/RS curve going stacker cranes is in such a way that it can directly access to every storage aisle, safely as well as quickly. It includes a patented rail geometry that reduces the wear. Integral stacker crane and point control with two driven wheels for better maneuvering.
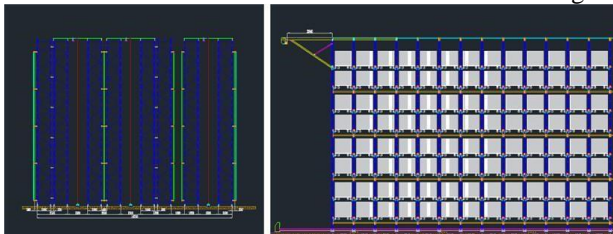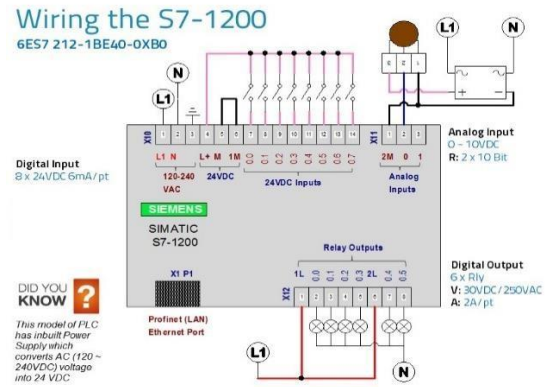

Fig (b) Multi Series

IV. HARDWARE SYSTEM

A. PLC S7-1200

The S7-1200 is a simple, flexible, ingenious for easy automated task in industries as well as in buildings. The controller gives access to wide variety of devices according to the automation needs. Various features which includes powerful instructions, perfect solutions, compact design, etc helps in wide variety of applications.
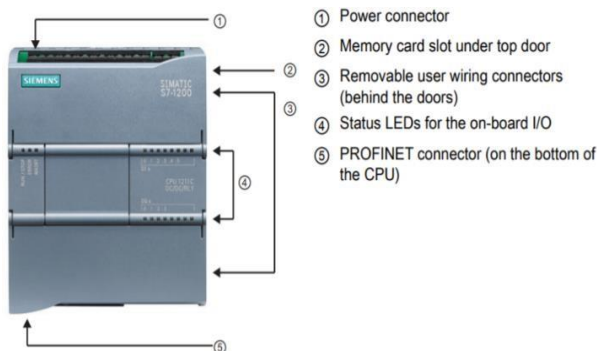

① Power connector
② Memory card slot under top door
③ Removable user wiring connectors (behind the doors)
④ Status LEDs for the on-board I/O
⑤ PROFINET connector (on the bottom of the CPU)

Fig (A.1) PLC S7-1200

Fig (A.2) Wiring of PLC S7-1200

B. Stepper Motor
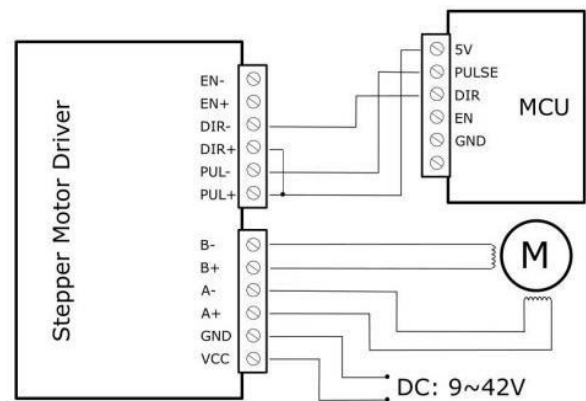
Fig (B) Stepper Motor Drive Configuration

The stepper motor are DC motors that move in distinct steps. They come in various style and sizes. They have different electrical characteristics. It comprises of multiple coils which are organized in groups called "phase". When energized, each phase will rotate one step at a time. This step can be controlled with a computer with positing and control.

Stepper motors have multiple toothed electromagnetic arrangement. These electromagnetic are energized by external circuits or controller. To move the shaft electromagnet is given power which attracts the teeth. Once the first one is turned off only then the second one comes into action. By this the process is in repeat. Each of this is called step.
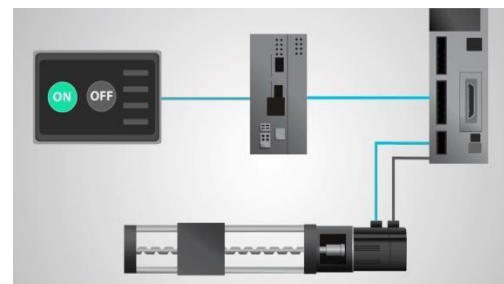
C. Linear Actuator

Fig (C) Linear Actuator

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It is a ball screw based mechanical linear actuator. It reduces backlash thereby translating rotational motion to linear motion with minimal or rather little friction. A threaded shaft provides a helical raceway for ball bearings. The threaded shaft is screw whereas the ball assembly act as the nut. In order to effectively eliminate the backlash between the input and output, the ball screw can operate with some preload.
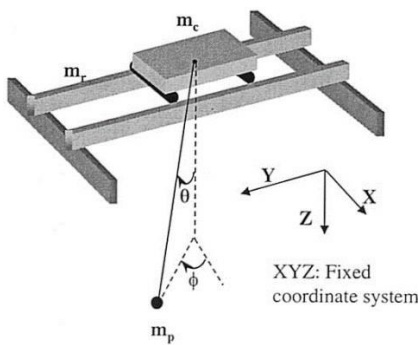
D. XYZ Crane

Fig (D) XYZ Crane

The crane will usually operate in three axes: X, Y, Z respectively. In accordance to the hoisted, the vertical movement will refer to as Z axis. The carriage moves in left/right direction which is encountered to be X-axis. Similarly, the movement of carriage in forward and reverse direction is said to be Y-axis.

V. CONCLUSION

With increasing technology and fast growing of the skills, warehouses are being benefited with the use of all the advanced skills and technique. Warehouse automation can help increase customer satisfaction by increasing efficiency of the work assigned which is not possible through humandirected work alone. Automation is the future of warehousing systems at large as well as small scale industries. The automation comes along in various forms, sizes, etc. The important thing is to select the right types of automation depending on individual needs.

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