Automatic Control Three-Dimensional Warehouse based on PLC

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Abstract - An automated system is increased in this globalized world. This paper is based upon use of PLC (Programmable Logic Controllers), 3-ph motor and sensors for the purpose of automatic goods handling inside the warehouse and the logistics industries. In many industries, found problem storage goods and flow tasks efficiency in warehouse because several kinds of products. Usage PLC system input line automation to helpful manufactured process accuracy and efficiency. In this research we proposed warehouse automation system which is easy to implement and cost effective. The implementation of this system improves the efficiency of labor and the quality of manufactured products and to create conditions for the optimum utilization of all production resources depends on the PLC program

Keywords: Automatic goods handling, Warehouse automation system, 3-ph motor and sensors, PLC,

I. INTRODUCTION

Automation is the use of control systems and information technologies systems (such as numerical control, inventory control, programmable logic control, and other industrial control systems) to reduce the need for human work in the production of goods and services. In the scope of industrialization, automation is a step beyond mechanization. Automation greatly decreases the need for human sensory, mental requirements and saves time as well [1]. The processes and Systems can also be automated. Specialized industrial computers, referred to as programmable logic controllers (PLCs), are frequently used to synchronize the flow of inputs from (physical) sensors and events with the flow of outputs to actuators and events. This leads to precisely controlled actions that permit a tight control of almost any industrial process [2].

Automatic segregation and directing of materials are controlled using PLCs. It makes use of limiting sensor, color sensor, proximity sensors for segregation and directing of the materials is controlled by using a motor and the conveyor belt depending on the instructions specified in the ladder logic in PLC. In food packaging industry PLC is mainly used for automation purpose which helps in reducing packaging time and increases the production rate as compared with the manual system [3].

Many useful researches have been done in the field of warehouse automation system. For example, Min S. Ko et al. [4] developed a case study to simulate and verify the PLC program for an automobile panel AS/RS. They suggested a PLC simulation using 3D models and PLC codes, which consists of real automobile manufacturing data. Senanayake and S. Veera Ragavan [5] used an optimization method to determine the optimum storage locations for the goods that will use AS/RS. They used fuzzy control system for the purpose of determining the best storage location. In this study, AS/RS’s working strategies, sensor, PLC and other control components are analyzed and automation techniques are discussed. System’s control structure is explained with detailed algorithms and AS/RS automation components’ functions are examined. AsaadMusaab Ali Yousif [2] design and developed control system of AS/RS by simulate through PLC. Sunderesh S. Heragu et al. [6] modeled the AVS/RS (Autonomous Vehicle Storage and Retrieval System) and used MPA (manufacturing system performance analyzer) to examine the performance of an AS/RS. They used experimental results to show if the OQN (Open Queueing Network) methodology can be applied to analyze an AS/RS and determined MPA is a better choice to quickly evaluate alternate configurations of the AVS/RS. Rashid et al. [7] proposed a new design of an Automated Storage and Retrieval System using wireless communication to improve existing warehouse management system (WMS). They made the communication between PIC controller and computer by wireless technology and the motion of the system is based on three DC motors for each direction of motion X, Y and Z that is controlled by PIC microcontroller.

The main objective of the project controls the three-dimensional warehouse in goods handling with help of PLCs. The whole process is done automatically based on input signals from the PLC to the respective devices

II. HARDWARE AND DESCRIPTION

A. PLC control

We have chosen SIEMENS S7-1200 CPU 1215c series. Programmable Logic Controllers with the following features

| Feature                          | CPU 1215c   |
|----------------------------------|-------------|
| Physical size (mm)               | 130 x 100 x 75 |
| User memory                      |             |
| Work                             | 125 Kbytes  |
| Load                             | 4 Mbytes    |
| Retentive                        | 10 Kbytes   |
| Local on-board I/O               |             |
| Digital                          | 14 inputs/10 output |
| Analog                           | 2 inputs/1 output |
| Process image size               |             |
| Input                            | 1024 bytes  |
| Output                           | 1024 bytes  |
| Bit memory (M)                   | 8192 bytes  |
| Signal module (SM) expansion     | 8           |
| Signal board (SB), Battery board (BB), or communication board (CB) | 1 |
| Communication module (CM)        | 3           |
B. Sensor

In this system, Proximity sensor detect an object input signal transmitter for the PLC without touching it and therefore do not cause abrasion or damage to the object.

C. DC motor

It is use to operate the directions of the stacker crane and the gripper. 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 this operation and one for the gripper movement.

III. SOFTWARE PLATFORM REQUIREMENT

Siemens PLC programming software Portal V13 (including SIMATIC STEP 7 Professional V13 and SIMATIC WinCC Comfort Advanced V13)

Table 2: The computer can support software

| Hardware requirement | The computer with STEP 7 Basic/Professional V13 must at least meet the following requirements: |
|----------------------|-----------------------------------------------------------------------------------------------|
|                      | ● CPU processor: CoreTM i5-3320m 3.3 GHz ● Memory: 8G or larger ● Hard disk: 300 GB SSD ● Graphics resolution: minimum, 1920 x 1080 ● Monitor: 15.6" widescreen display, 1920 x 1080( ● CD-ROM: DL MULTISTANDARD DVD - RW |

Table 3: Display configuration position devices of PLC program

| Input | Signal | Description | Input status |
|-------|--------|-------------|--------------|
| I0.0  | CEMG   | Emergency stop | effective invalid |
| I0.1  | PWR-ON | Power-on | effective invalid |
| I0.2  | EX-LIM | Palletizer overrun relay | effective invalid |
| I0.3  | 3ELP   | 3-axis positive limit. | effective invalid |
| I0.4  | 3ORG1  | 3 axis origin 1. | effective invalid |
| I0.5  | SEN1   | Workpiece detection photoelectric switch on fork | effective invalid |
| I0.6  | 3ORG3  | 3 axis origin 3. | effective invalid |
| I0.7  | 3EL-   | 3-axis negative limit. | effective invalid |
| I0.8  | 2EL-   | 2-axis negative limit. | effective invalid |
| I0.9  | 2EL+   | 2-axis positive limit. | effective invalid |
| I1.1  | 2DEC1  | 2-axis deceleration 1 point. | effective invalid |
| I1.2  | 2DEC2  | 2-axis deceleration 2 point. | effective invalid |
| I1.3  | 2DEC3  | 2-axis deceleration 3 point. | effective invalid |
| I1.4  | 2EL+   | 2-axis positive limit. | effective invalid |
| I1.5  | 1EL+   | 1-axis positive limit. | effective invalid |
| I1.6  | 1DEC1  | 1-axis deceleration 1 point. | effective invalid |
| I1.7  | 1DEC2  | 1-axis deceleration 2 point. | effective invalid |
V. ADVANTAGES AND DISADVANTAGES

A. Advantages
- This system reduces human intervention while increasing safety.
- Automatic Manufacturing process is efficiency and accuracy.
- Distance time work saving.

B. Disadvantages
- High cost investment installation
- Require engineers skilled knowledge, ability and experience
- Time in maintenance and improve are large

VI. APPLICATION

we have implemented a ladder code install at PLC software to control system. After that output commands to

| I5.1 SQ21 | Raw material warehouse position 21. Workpiece detection switch. | effective | invalid |
| I5.2 SQ22 | Raw material warehouse position 22. Workpiece detection switch. | effective | invalid |
| I5.3 SQ23 | Raw material warehouse position 23. Workpiece detection switch. | effective | invalid |
| I5.4 SQ24 | Raw material warehouse position 24. Workpiece detection switch. | effective | invalid |
| I5.5 SQ25 | Raw material warehouse position 25. Workpiece detection switch. | effective | invalid |
| I5.6 SQ26 | Raw material warehouse position 26. Workpiece detection switch. | effective | invalid |
| I5.7 SQ27 | Raw material warehouse position 27. Workpiece detection switch. | effective | invalid |
| I5.8 SQ28 | Raw material warehouse position 28. Workpiece detection switch. | effective | invalid |

| OUTPUT |
| Q0.0 RED | Tricolor lamp red | effective | invalid |
| Q0.1 YELLOW | Three color light yellow | effective | invalid |
| Q0.2 GREEN | Tricolor light green | effective | invalid |
| Q0.3 START | Start relay | effective | invalid |
| Q0.4 STOP | Stop relay | effective | invalid |
| Q0.5 DIS LIM | Over limit contact relay | effective | invalid |
| Q0.6 ALMHL | Alarm indicator | effective | invalid |
| Q0.7 CMGHL | Emergency stop indicator | effective | invalid |
| Q1.0 STOP_U | Inverter stop | effective | invalid |
configuration I/O devices. Complexity of automatic warehouse has been modeled, based on this paper purpose we achieved such as analysis, developed and control system

Figure 4: three-dimensional warehouse system

Figure 5: PLC control panel

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