

- Manual position control.
- Continuous operation.

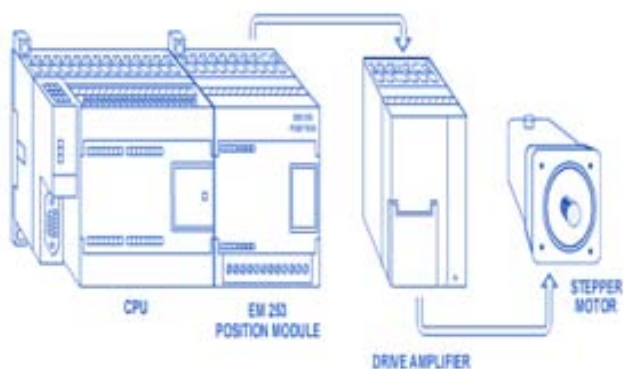


Figure 1: The EM 253 Position Module connected to PLC over the expansion I/O bus

3. PLC Hardware Specifications

A programmable logic controller is a digital computer used for automation of electromechanical processes. Industrial PLC describes the computing unit of any industrial automation system and therefore need to meet several challenging requirements such as high reliability, environmental noise and influence immunity and also enhanced protection classes (e.g. water-resistant and dust sealed).

PLCs also satisfy the needs of continuous 24 hours/7 days operation and availability over a wide environmental temperature range as well as real-time operation capability and security and safety enhancements.


The input/output arrangements may be built into a simple PLC, or the PLC may have external I/O modules attached to a computer network that plugs into the PLC. The communications interface is used to receive and transmit data on communication networks from or to other remote PLCs. It is concerned with such actions as device verification, data acquisition, synchronization between user applications and connection management.

Some of the advantages of using PLC include:

- Programming the PLC is easier than wiring the relay control panel.
- The PLC can be reprogrammed. Conventional Controls must be rewired and are often scrapped instead.
- PLC takes less floor space than relay control panels.
- Maintenance of the PLC is easier, and reliability is greater.
- PLC can be connected to the plant computer systems more easily than relays.

We have chosen **PLC_200** Series Programmable Logic Controllers with the following features.

Table 1: S7-200 CPU Model features [3].

| Feature | CPU 226 |
|-------------------------|---------------------------------------------------------------------------------------|
| Physical size (mm) | 190 x 80 x 62 |
| Program memory: | |
| with run mode edit | 16384 bytes |
| without run mode edit | 24576 bytes |
| Data memory | 10240 bytes |
| Memory backup | 100 hours typical |
| Local on-board I/O | |
| Digital | 24 In/16 Out |
| Analog | -- |
| Expansion modules | 7 modules1 |
| High-speed counters | |
| Single phase | 6 at 30 kHz |
| Two phase | 4 at 20 kHz |
| Pulse outputs (DC) | 2 at 20 kHz |
| Analog adjustments | 2 |
| Real-time clock | Built-in |
| Communications ports | 2 RS--485 |
| Floating-point math | Yes |
| Digital I/O image size | 256 (128 in, 128 out) |
| Boolean execution speed | 0.22 microseconds/instruction |
| Picture |  |

4. PLC-Software Specifications

PLC programs are typically written in a special application on a personal computer, and then downloaded by a direct-connection cable or over a network to the PLC. The program is stored in the PLC either in battery-backed-up RAM or some other non-volatile flash memory. Often, a single PLC can be programmed to replace thousands of relays.

The STEP 7--Micro/WIN programming package provides a user-friendly environment to develop, edit, and monitor the logic needed to control your application [4]. STEP 7--Micro/WIN provides three program editors for convenience and efficiency in developing the control program for your application. To help you find the information you need, STEP 7--Micro/WIN provides an extensive online help system and a documentation CD that contains an electronic version of this manual, application tips, and other useful information [5].

5. Basic Design of the System

Major applications of mechatronics include automation, robotics, sensing and control system, microcontrollers / PLCs, computer-machine controls and others. Mechatronics is a design process that includes a

combination of mechanical engineering, control engineering and computer engineering. Basically a mechatronic system comprises of a basic mechanical structure (to generate a certain carrying behavior or movement), sensors (to collect information on the system or the environment), processors (to evaluate the information and to generate correcting variables according to certain rules), and actuators (to convert correcting variables into forces, movements, electrical voltages or other quantities which act on the basic system or its environment).

This Automated material handling system is composed of an entry/exit bay of metallic parts, a three axis arm robots, actuators, sensors, drivers and an entry/exit bay of boxes.

Table 2: sensors and the functions

| No. | Type | Function |
|-----|------------------|-----------------------------------------------------|
| 1 | Limit switches | Arm robots detector at zero position (picking area) |
| 2 | “ | Top limit switch of the arm robots vertical axis |
| 3 | “ | Bottom limit switch of the arm robots vertical axis |
| 4 | Photo electronic | Part detector at the picking area |
| 5 | “ | Box detector at the placing area |
| 6 | Proximity sensor | Arm robots movement detector |
| 7 | “ | Magnetic gripper detector |

Table 3: actuators and functions

| No. | Type | Function |
|-----|---------------|-----------------------------------------------------|
| 1 | 3ph-motor | Parts conveyor table |
| 2 | “ | Boxes conveyor table |
| 3 | Stepper motor | Longitudinal axis movement of the arm robots |
| 4 | “ | Transversal axis movement of the arm robots |
| 5 | “ | Vertical axis descending movement of the arm robots |
| 6 | “ | Magnetic gripper |

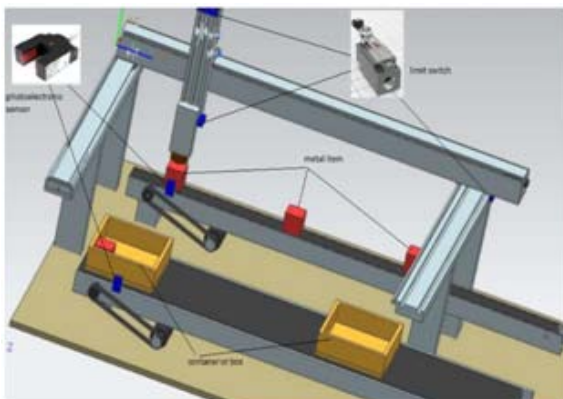


Figure 2: The sensors position into the system

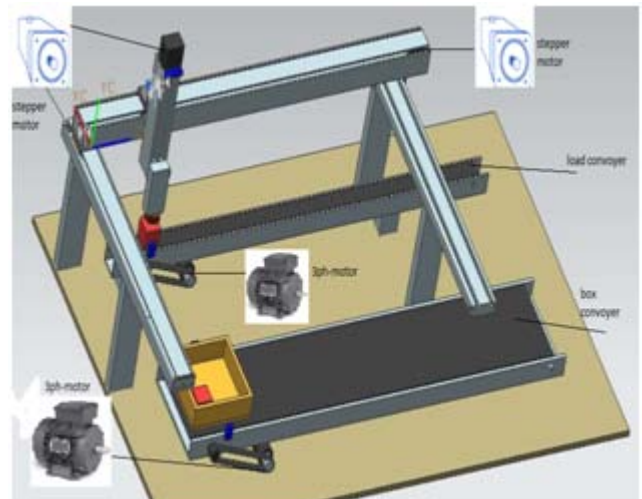


Figure 4: The actuators and their position in the System



Figure 5: Sample for the box

6. Working

When a PLC executes a program, it must know in real-time when external devices controlling a process are changing. During each operating cycle, the processor reads all the inputs, takes these values, and energizes or de-energizes the outputs according to the user program. This process is known as a program scan cycle.

6.1 Generally

Boxes are transported by a conveyor belt from the entry bay to the conveyor belt that positions the boxes in the placing area. The parts conveyor belt transports metallic supplied parts. The three axis arm robot picks the parts using a magnetic gripper and places them in the previously positioned box. The loaded boxes are then transported to the automatic exit conveyor belt for the boxes.

6.2 The boxes

The box is subdivided into 9 cells (part/cell) after the three axis arm robots picks the part then the PLC sends pluses out to control the stepper motor move FW/BW for specific distance according to cells position in the box. The required pluses for stepper motor for this distance it should be calculated and stored into the PLC memory the

program it can call it from the memory directly figure (6) shows the box cells and there distances.

The PLC will send pluses for stepper to move 1st time X1 distance, 2nd X2 distance, 3rd X3 distance, 4th X1&Y1 distance, 5th X2&Y1 distance, 6th X3&Y1 distance, 7th X1&Y2, 8th X2&Y2 and the last X3&Y2.

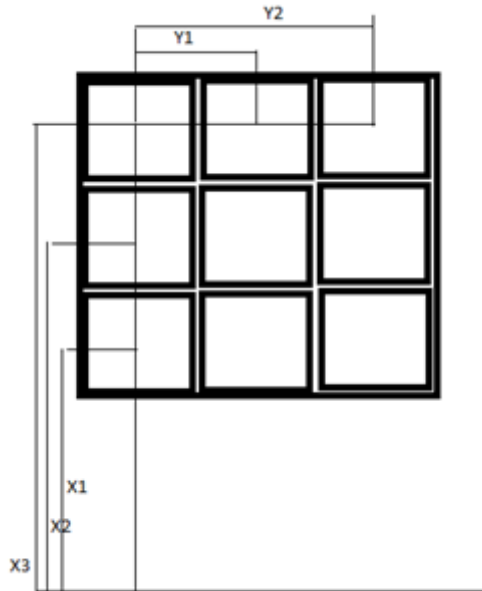


Figure 6: The box cells x1, x2 and x3 are the distance from the part conveyor belt, y1 and y2 the distance from the first Colum to second Colum and third Colum

6.3 Ladder Flowchart

This ladder flowchart shows how the control program looks like

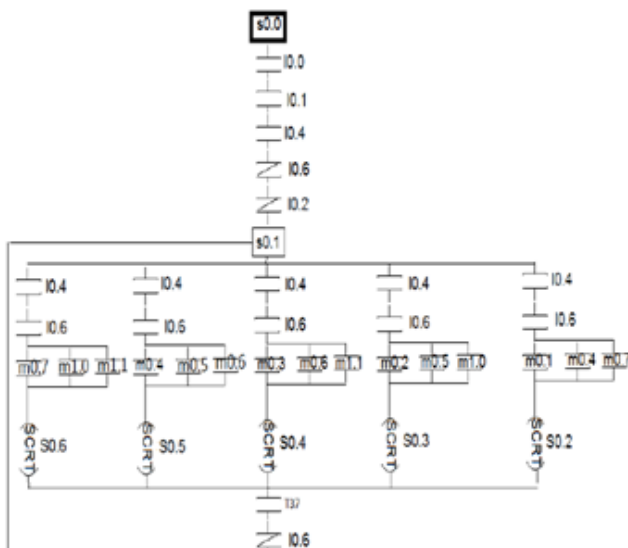


Figure 7: Shows the ladder flowchart.

In this ladder flowchart there are 7th states S0.0, S0.1, S0.2, S0.3, S0.4, S0.5 and S0.7. The S0.0 it will be active when the program start running and then the system will read the Part detector, Box detector, Arm robots movement

detector and Magnetic gripper detector to active S0.1 which guide the robots move to zero position (picking area) after pick apart then the program will active S0.2 which allow the robots move to placing area and place the first part into first cell of the box again the program will active S0.1 to pick the 2nd part and then the S0.3 will be active to allow the robots place the 2nd part into 2nd cell The program will repeat same sequence for other parts.

7. Result

After we download the program into the PLC-200 and finish the connection of the sensors, actuator, drivers, inverters, power supply converter, encoders, the EM 253 Position Module and then test the system we did some modification for the ladder after that the system was working stably figure (8), (9) and (10) show some connection of the final model of the system.

8. Conclusions

The whole system has good compatibility and compact structure. It is easy to install, and the line running is stable in the actual production. The labor intensity is greatly reduced for workers, so it has a high degree of automation. On the basis of ensuring the quality, it improves product efficiency, and brings great economic benefits to the production side.



Figure 8: Some connection of the final model of the system



Figure 9: Some connection of the final model of the system

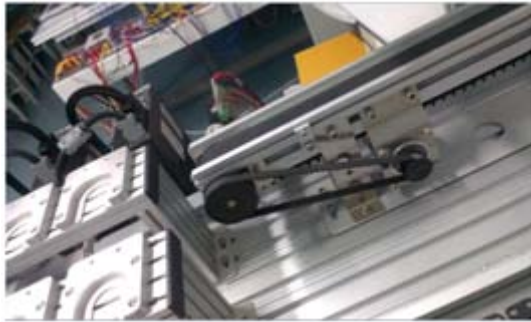


Figure 10: connection of actuator and drivers of the system

References

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- [2] Parker Hannifin Corporation Electromechanical Automation Division Irwin, Pennsylvania [2]
- [3] S7-200 Programmable Controller System Manual Edition 09/2007 A5E00307987—03 [3], [4]
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Author Profile



Fares Mohammed Mehdi Hassan he is bachelor student (last year) in Tianjin University of Technology and Education, Auto Maintenance Engineering Education .his area of interest Microcontroller, PLC and Control system designing.



Asaad Musaab Ali Yousif he is M.S. student (last year) in Electronics Engineering Tianjin University of Technology and Education, during 2012-2014, he stayed in Communications signal processing, his area of interest PLC, Microcontroller, programming and Automation.