Plc-based interface design and implementation for control of test and separation station education

H. Kuscu [1], A. Gullu [2]

[1]*Trakya University Faculty of Engineering and Architecture, Mechanical Engineering Department, Edirne, Turkey*
[2]*Trakya University Ipsala Vocational School, Electronics and Automation Department, Edirne, Turkey*

Abstract

In this study, an interface was designed for the separation of components according to the required conditions and parts to be tested. This testing and separation automation is found the place of use in many parts of the industry. Interface design is installed, a human machine interface (HMI), and data control is provided with programmable logic controller (PLC). The system includes the testing procedures which Parts manually loaded with the help of sensors, counting, size measurements, made the finding of the black-white color, and material properties. After the test process, the parts on the conveyor according to the desired characteristics are divided according to three different separation process. In addition, monitoring of the system or the storage of the data are also provided. With the help of the interface, the program running in the background gives information about the system components and training of system is aimed.

Key words: PLC Control, Test and Separation, HMI screen

INTRODUCTION

Today PLC and HMI hardware have found a wide usage area thanks to the technological developments in the industry. PLCs have functions such as easy programming, precision control, error-free work. HMIs has provided controlling of the PLC easier and monitor data in a visual way. The Testing and Separation station, which is a Mechatronics System, is composed of pneumatic cylinders, electric motors, programmable controllers, and programmable equipment, such as touch

panel. In this study, person engaged in control, machinery, mechatronics, and electrical and electronic sciences aims to find the opportunity to apply the knowledge acquired by theory .In addition, industrial communication protocols (TCP-IP, PPI, RS 232, etc..) in the system are provided to teach how to use them. (1)

TEST AND SEPARATION STATION COMPONENTS

System components for performing the required testing and separation processes are PLC, HMI, a reflective optical sensor, an ultrasonic distance sensor, an optical black / white (contrast) sensor, inductive sensor, conveyor assembly, pneumatic cylinders, pneumatic valves.

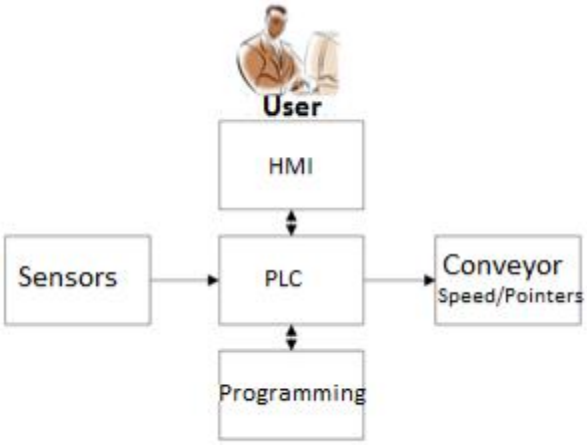

Fig 1. Block Diagram of the system

In this system, PLC programming, the "STEP7 MicroWin" software and HMI programming, the "DynaCon" software are used.

PROGRAMMABLE LOGIC CONTROLLER (PLC)

A programmable logic controller (PLC) or programmable controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLC's are used in many industries and machines. PLC's are programmed using application software on personal computers. The computer is connected to the PLC through Ethernet, RS-232, RS-485 or RS-422 cabling. Communication with PLC and HMI is provided with MPI to RS-232 Cable in this system. In this experiment, Siemens S7-200 CPU224XP PLC hardware is used for detecting input signals and controlling output signals.There are 10-bit

digital output, 14-bit digital inputs, 2 analog inputs, 1 analog output in the PLC. Digital outputs are controlled with semiconductor element (MOSFET). 0 / +24 V voltage levels is used digital input / output signals. Also there is memory which is 4096-word program memory and 2560-word data memory permanently. PLC's working voltage is 24 VDC. According to the load maximum current is able to provide a 700 mA in the outputs. PLC programming and other peripheral devices to communicate have two ports. (Port 0 and Port 1) (2).

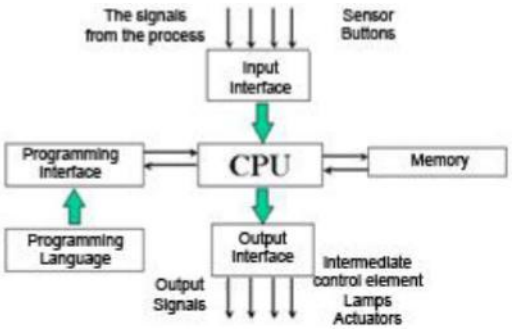

Fig. 2 Structure of the PLC

HUMAN MACHINE INTERFACE (HMI)

Lincon LC070SL 7 "color display with touch panel is used in the test and separation processes to provide interaction with the PLC. With this panel education with a visual way is provided. Control of the system and system control education was taken into account actively into panel program. HMI software installation is made via the Ethernet port. (3)

Fig. 3 Lincon LC070SL 7” HMI

OTHER MATERIALS

Distance Sensor

The length of the parts is measured for the test process. To do this, an ultrasonic distance sensor, which can measure between 50-300mm 0-10 V voltages generating in output, is used. (4)

Black-and-white sensor

There are optical contrast sensors in the system. Sensor can detect objects, which white rate of 90%, from a distance of 600 mm. When white object is detected by the sensor, output signal is

produced digitally. All other objects are perceived as black. The sensor is sensitive to white objects. (5)

Optical Sensor

Reflective optical sensor is used for detecting object and counting process. When parts supply is detected by the sensor, the system is prepared to work. At the same time, with the help of this sensor how many pieces come is counted.

Inductive Sensor

A inductive sensor is used to see whether the materials are metal in the process of testing. The sensor can detect metal objects from 0.4 mm distance

Conveyor

A conveyor mechanism is established for the testing and analysis procedures automatically from beginning to end. After the parts are tested on the conveyor, the separation process is done automatically. Only the parts supply and discharging operations are processed manually in system.

Pneumatic Cylinders and Other Pneumatic Equipment

Pneumatic equipment, proceeding on the conveyors and specified qualities of the objects are used to steer the appropriate channels. This process is utilized for the single-acting cylinders. The forward movement of the cylinders is provided with compressed air, which is directed by solenoid valves. The backward movement of the cylinder is maintained by spring, when valves cut off. The conditioner and analog pressure gauge is used for regulating and measuring which is using by pneumatic equipment.

Fig. 4 Test and Separation Station

Interface Design

Lincon Company's "DynaCon" software is used for the design of the control interface. The Software screen image is shown in figure (Fig. 5) Inputs-Outputs, the visual design of the panel, alarms and data storage functions are defined with this software. In addition to these standardized functions, PID, on / off control functions such as the possibility of using is provided. (ROBERT et al. 2008)

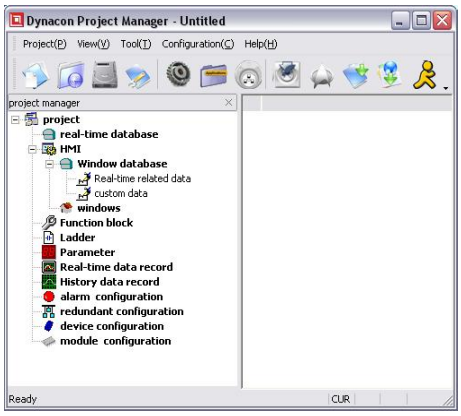

Fig. 5 Lincon HMI Programming Software (DynaCON)

The design of the panel screen editor presented is similar to the visual design screen in visual programming languages.

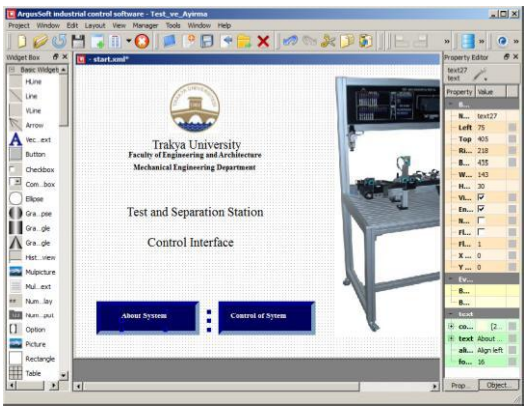

Fig. 6 HMI Visual Design Editor

The desired functions of the design of the screens, "C" programming language can be created.

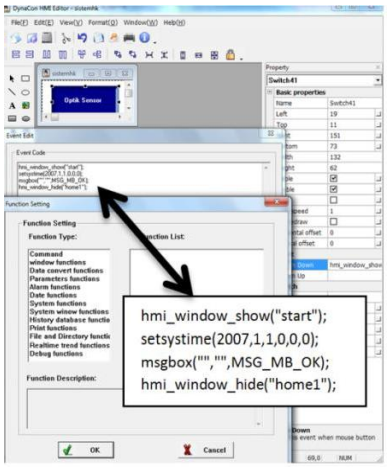

Fig. 7 Defining a Function for Button on the HMI screen

Printers, mouse and keyboard can be communicated with USP and serial ports which are placed on panel. Ethernet port provides the panel to communicate with the PC and connecting to Internet. In this way, the system control, and education can be made via Internet. (7)

Fig. 8 The panel communication with other hardware

A visual interface design was made to ensure the control of the system effectively. Designed interface structures are shown in figure (Fig. 9) This structure is designed different pages for training and system control.

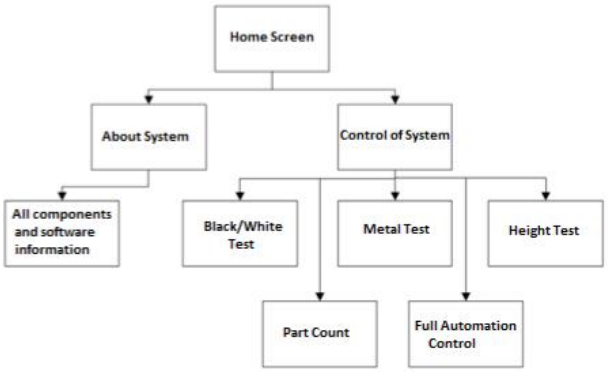

Fig. 9 Hierarchy of the panel design

When power is applied to the panel in the design, first opened as a home screen, and users are offered two options for the training and control.

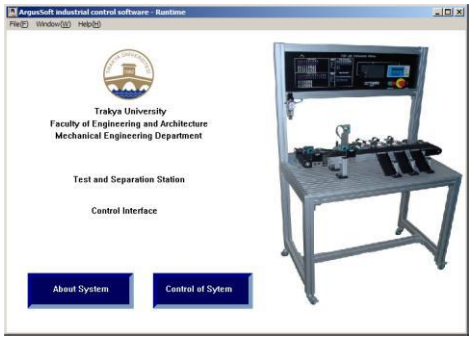

Fig. 10 Opening Screen

If users choose "About System" button, the screen will pop up giving information about the system education. Education screen gives information about the system hardware, operating principles of this equipment, catalogue information and the software that runs in the background of the system of control. If this station is used for formal education, the required experiments can be done via preparing experiment sheets suitable for course content. (GÜLLÜ et al. 2009)

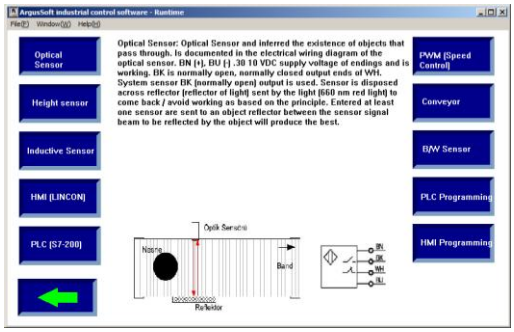

Fig. 11 System of Education Screen

If user's choice is "System Control" in the home screen, screen will be opened in the figure (fig. 12) On the screen parts left on the conveyor, can be tested separately. The required test can be selected with button on screen. The testing procedures which is black-and-white information, information whether metal-non-metal, height information and the total number of parts, can be displayed with hardware which defined in section 2

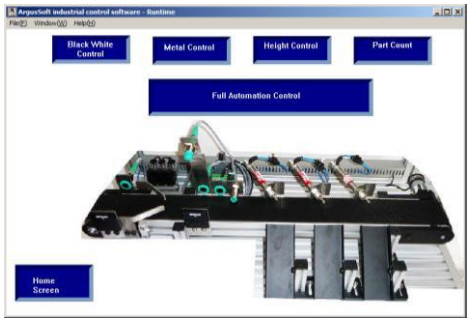

Fig. 12 System of Control Screen

"Testing and Separating Station Automation" is selected for all the parameters on a single screen to be seen. Opened on the screen, enter the required information and the separation process can be obtained.

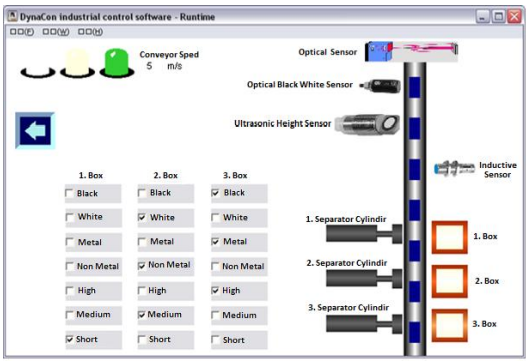

Fig. 13 Separation Screen

All test procedures other than height information of the parts have logic outputs. But the ultrasonic distance sensor output is given as analog signal. Here, analogue information taken with the help pf PLC is calibrated and converted into distance and size of the part can be displayed. To perform the separation according to the length of the part size ranges and tolerances specified value must be encoded via the PLC or HMI. In this study, the short, medium and long length of parts, including three of these categories have been determined and carried out the separation. Determination and comparison of their heights are defined in the PLC. Comparison Commands are used for this.

PLC is controlled DC motor that allows movement of the conveyor by a digital output. Changing the speed of conveyor is required according to the type of parts and the processing, in many applications, in industry. Production, such as applications, processing and testing of the part, to be error-free, production times are required to be as soon as possible. For this reason, conveyor speed should be controlled according to applied testing process and type of parts. PWM (Pulse Width Modulation) control technique is used for speed control. (ERGENÇ et al. 2010).

PWM signal is applied to digital as the implementation of a particular frequency, but the widths of pulses (occupancy rate) are changed. With PWM, the DC motor speed can be controlled. For the creation of the PWM signal, the PWM module is used in the S7-200 PLC. Users can enter information on the HMI screen, conveyor speed.

This information is converted to the PWM signal. Conveyor speed is controlled by PWM signal, giving a digital output.

```
Network 1
LD      F1
A       Pals_05_sn
EU
+I      -5, Pals_Genişliği
Network 2
LD      F2
A       Pals_05_sn
EU
+I      +5, Pals_Genişliği
Network 3
LDW<    Pals_Genişliği, 50
MOVW    50, Pals_Genişliği
Network 4
LDW<    Pals_Genişliği, 50
MOVW    50, Pals_Genişliği
Network 5
LD      Sürekli_Set
=       L60.0
LD      Band_Rotate
=       L63.7
LD      L60.0
CALL    PWM0_RUN, L63.7, 100,
        Pals_Genişliği, Pwm_Error
Network 6
LD      Sürekli_Set
MOVW    +100, Time_Constant
-I      Pals_Genişliği,
        Time_Constant
```

Fig. 14 Motor Speed Control Program with PWM (STEP7 created in MicroWin)

CONCLUSION

In this study, an interface is designed, for the recognition of mechatronics system, including the sciences; pneumatic, electronic, mechanical, and software, control of these and the realization of education. Designed with the help of the interface, users can perform system testing and release procedures in accordance with the desired parameters. Variables in software, providing system control which run in the background, are changed and controlling the system is facilitated actively. Besides, it is aimed for the education to be long-lasting and perceivable by presenting visually the control software's, information about the hardware found in the system to the users. In the design, the main target is to identify problems to be faced in industry and create solutions for these problems.

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Corresponding Author:

Assistant Professor Hilmi KUŞÇU, Department of Mechanical Engineering, Faculty of Engineering and Architecture, Trakya University, Edirne, Turkey,

Tel: +902842261217-2108, E-Mail: hilmi@trakya.edu.tr