Performance of Trainer Kits Sorting Station Basen on PLC, HMI and SCADA

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Abstract

This study aims to determine the performance of trainer kits on automatic goods sorting using PLC, HMI and SCADA systems. In this writing the author uses the RnD method with the ADDIE approach developed by Robert Maribe Branch. The stages used in this study are analyzing needs, designing, developing, implementing and evaluating. The author obtained research data by means of observation, questionnaires and interviews. The results obtained in the field are that it has been implemented and made an automatic goods sorting tool based on Programmable Logic Controller (PLC), Human Machine Interface (HMI) and Supervisory Control And Data Acquisition (SCADA), an automatic goods sorting trainer has been made in miniature form which can separate goods based on the type of material and material color, the performance of trainer kits sorting goods automatically works well along with the jobsheets and manual books functioning properly.

Keywords: PLC, HMI,SCADA

1. Introduction

In the current development of manufacturing technology it is very complex, one example is the development of manufacturing in the field of modular production systems (MPS), where there are many variations of existing stations such as distribution stations, assembly stations, processing stations, sorting stations and so on **(A.Harris & Gregory, 2020)** to move towards automated manufacturing, there is a need for a decentralized architecture that includes hardware and software modules that enable the distribution of controls automatically (POPOV, STOYANOV, & STAMBOLOV, 2013). To control one station in a manufacturing system requires a very complex system, starting from a controller to a good monitoring system. In the industrial world there are several types of controllers that are widely used, one of which is the Programmable Logic Controller or PLC, where the main function of the PLC is as the control center of a system. When the sensor detects a change or detects something, it will be forwarded to the PLC as the control center. After getting a signal from the sensor, the PLC will manage it to become an output signal that will drive the actuator. To run the system, an interface between humans and machines is needed, namely by using the Human Machine Interface (HMI) and Supervisory Control And Data Acquisition (SCADA) as human and machine interfaces. The main objective of this research is to produce automatic item sorting trainer kit products based on PLC, HMI and SCADA which can be used in the teaching and learning process and to find out the performance of automatic item sorting trainer kit products based on PLC, HMI and SCADA for practical learning in subjects of mechatronic control system engineering. in the mechatronics department at the Vocational High School level.

In order to improve the quality of education, researchers raise a problem and offer solutions in the era of technological development, especially in the manufacturing industry. The solution that the author offers is to make teaching aids or learning media that are miniature in nature which adopt directly from the manufacture industry which later these tools will be integrated using the Human Machine Interface (HMI) and Supervisory Control And Data Acquisition (SCADA) which later this sorting tool uses control PLC as main control. This learning media will be used in learning in the mechatronic engineering department as practicum material. This learning media will adopt a system that is used in the industry by using components that are integrated with one another by using a pneumatic system as a driver and using three kinds of sensors as sorters of goods according to the object material and object color.

Relevant research is Konstantinos Mykoniatis and Gregory A. Harris **(A.Harris & Gregory, 2020)** with the title A digital twin emulator of a modular production system using a data driven hybrid modeling and simulation approach. Explains the manufacturing system, namely the Festo Modular Production System (MPS). To ensure optimal design and high productivity in automatic modular production lines, well-adapted advanced control programs capable of maintaining speed at high stability and reliability. The use of PLCs allows users to execute these complex control programs to ensure higher efficiency and reliability of automated systems and machines. In the experiments carried out using Festo MPS with Rockwell Automation

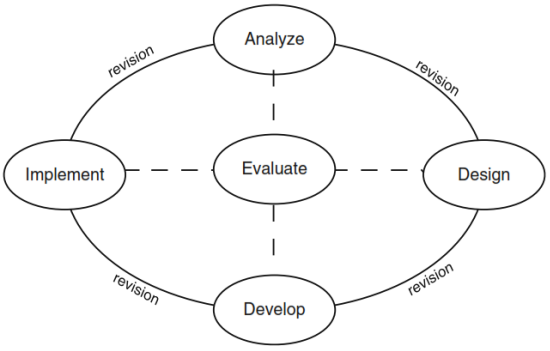
PLC. The MPS used consists of several stations, namely distribution, testing, processing, assembly, sorting, and storing stations. For experimental practice, only a few stations were used, namely distribution, testing, and sorting.

Darakorn Thappho and Sirichai Tammaruckwattana with the title Experimental Verification of Automatic Sorting Machines Using Infrared Proximity Sensors and Microcontrollers. (Thappho & Tammaruckwattana, 2020) The purpose of writing this article is to design and build an automatic marigold (economical plant) sorting machine with 5 sizes sorting using a conveyor, electric motor, and a microcontroller control unit. The designed system is connected to WIFI to store data on the cloud and can display information through the screen in real time in numeric and graphic data formats. Testing the accuracy of the system by comparing experiments between the microcontroller control unit and the PLC control unit. The results of repeated tests show that the automatic marigold sorting machine can operate according to the design by separating the marigold sizes. Darakorn Thappho and Sirichai Tammaruckwattana with the title Experimental Verification of Automatic Sorting Machine Using Infrared Proximity Sensor and Microcontroller. (Thappho & Tammaruckwattana, 2020) The purpose of writing this article is to design and build an automatic marigold (economical plant) sorting machine with 5 sizes sorting using a conveyor, electric motor, and a microcontroller control unit. The designed system is connected to WIFI to store data on the cloud and can display information through the screen in real time in numeric and graphic data formats. Testing the accuracy of the system by comparing experiments between the microcontroller control unit and the PLC control unit. The results of repeated tests show that the automatic marigold sorting machine can operate according to the design by separating the marigold sizes.

Prof. Nilima Bargal, Aditya Deshpande, Rucha Kulkarni, Rucha Moghe with the title PLC Based Object Sorting Automation (Bargal, Deshpande, Kulkarni, & Moghe, 2016) in this article discusses the development of low-cost automation for sorting goods based on height variations. This project mainly focuses on sorting 3 objects of different heights using a photo electric sensor and a DC motor that uses a Programmable Logic Controller (PLC) as the control center. This DC motor is used to push objects from the conveyor to the sorted place. The system consists of a conveyor which carries objects such as bottles, small boxes or packages in front of a sensor and thus sorting is decided by a PLC. The PLC is programmed with three different logics, each for sorting products of a different height. The system consists of a total of 4 optical proximity sensors or photoelectric sensors, used to detect the presence of objects and the height of boxes.

2. **Method**

In this writing the author uses the RnD method with the ADDIE approach developed by Robert Maribe Branch. Menuru (Sugiono, 2013) in his book states that conducting RnD or Research and Development research is the right method for research that produces products and for testing the effectiveness of the products produced. According to (Branch, 2009) states ADDIE is an acronym for Analysis, Design, Development, Implementation and Evaluation.



Picture

Figure 1 ADDIE (Branch, 2009)

3.Results

In this research the development model used is the ADDIE development model according to (Branch, 2009), with the steps according to the acronym, namely: Analyze, Design, Develop, Implement, and Evaluation. The development results based on these steps can be described as follows.

1. Analysis

   The results of the needs analysis survey with students (30 people) and teachers (2 people). The results showed that the needs most chosen by respondents in learning PLC practicum were: (1) PLC, HMI and SCADA PLC-based automatic goods sorting trainer kits in the form of miniature industrial processes chosen by 100% of industrial practitioners and 93.93% of students; (2) practical learning modules are chosen by 100% of teachers and 90% of students;

2. Design

   The design of an automatic goods sorting trainer kit using PLC, HMI and SCADA can be seen in the image below.

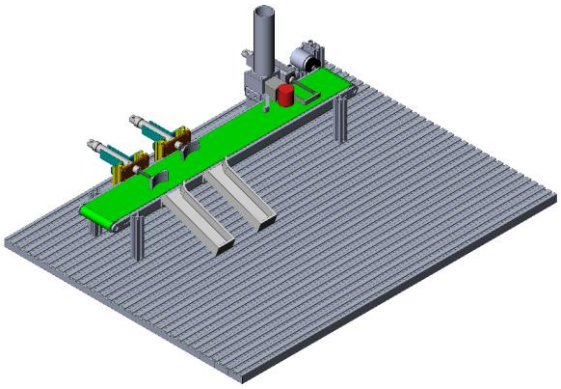


Figure 2 Design of sorting station

3. Development

The development results of the Trainer Kit for automatic sorting of goods based on PLC, HMI and SCADA are shown in the figure 4.

Figure 3 Implementation Machine

4. Implementation

The results of the trial or implementation can be seen in the following table.

Table 1 Trial Results

No.	Name	Keterangan
1	The 220 VAC voltage source is well connected.	√
2	The 24 VDC voltage source is well connected.	√
3	Wiring from the input and output components to the input output terminal block to the Trainer Component Module is good.	√
4	Pneumatic tubing from cylinder (1 and 2) to single solenoid valve (SV2 and SV3) is properly connected.	√
5	The Pneumatic Air Filter Regulator and Lubricator components function properly.	√
6	Double Acting Cylinder (Cylinder 1) works	√
7	Double Acting Cylinder (Cylinder 2) works	√
8	Push Button Start (PB1) works.	√
9	Push Button Stop (PB2) works.	√
10	Emergency Switch (EMG) works.	√
11	Reed Switch 1 (RS1) works.	√
12	Reed Switch 2 (RS2) works.	√
13	Induktif Proximity Sensor 1 (PRX1) works.	√
15	The Optical Proximity Sensor 2 (PRX2) works.	√
16	Ultra Sonic Sensor 3 (PS3) Work.	√
17	The Start Light Indicator (Green Light) works properly.	√
18	The Stop or Standby Lamp Indicator (Yellow Light) functions properly.	√
18	Emergency Light and Buzzer Indicators (Red Light and Buzzer) function properly.	√
20	Single Solenoid Valve 5/2 (SV1) works.	√
21	Single Solenoid Valve 5/2 (SV2) works.	√
22	Motor Conveyor (MTR) works.	√
23	DC to DC Motor Speed Controller Motor Capper Up/Down works.	√
25	The Relay Module is working.	√
26	The Human Machine Interface (HMI) works.	√
27	HMI and PLC Communication Cables can be used and work properly	√

4. Discussion

Based on the analysis conducted, the mechatronics department at SMK KB PUSDIKPAL really needs trainers for automatic item sorting based on PLC, HMI and SCADA in the form of miniature sorting processes based on material type and material color because it can provide an overview of

the implementation of PLC, HMI and SCADA systems directly and is oriented towards industry. Learning using an automatic item sorting trainer can also increase students' motivation, enthusiasm for learning and curiosity because the use of this tool is oriented towards the industrial world so that students can do it directly. In addition, trainer kits for automatic item sorting are urgently needed, namely trainer kits that are in accordance with the competence and KIKD subjects, are sized according to laboratory standards, are made of quality components, and refer to occupational safety and health.

Based on the results of the needs analysis in the field, the design in the figure above is carried out where the automatic goods sorting trainer kit consists of several main parts, namely the conveyor section to carry objects, the sorting section using pneumatic cylinder components to separate objects according to the color and type of material and where the control system is installed in the form of PLC, HMI, relay module and so on.

The next stage is the manufacture of an automatic goods sorting trainer kit according to the previous plan. In the early stages, namely making a base or pedestal that is used to place a trainer kit made of aluminum. The second stage is assembling the conveyor according to the design that has been made. The third stage is to assemble and place components and systems. In the next stage, wiring is carried out for each component and the last stage is finishing and testing the device.

The task description of the automatic goods sorting kit trainer can be described as follows. Objects will be placed on the conveyor section. If the proximity sensor detects metal objects and is gray, cylinder 1 will advance to sort goods. If the fiber optic sensor detects plastic objects and is green, cylinder 2 will advance to sort goods. If the item does not match the previous sensor, the ultrasonic sensor detects the object and the object will fall into the final container.

Based on the results of field testing, the students were very enthusiastic about trying to do programming and wiring the device directly and were enthusiastic about asking new things that students encountered. This is very good for the progress of student learning because with this item sorting tool students can see and simulate item sorting equipment directly and students get industry-based learning experiences.

5. Conclusion

PLC, HMI and SCADA-based automatic goods sorting trainers have been implemented and are working as desired. The sorting system uses 3 sensors to sort objects according to object material and object color using inductive proximity sensors, fiber optic and ultrasonic sensors. In addition, the goods sorting trainer kit has very good performance as evidenced in the table above which shows the components work 100% and function according to work standards

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6. References

A.Harris, & Gregory, K. M. (2020). A digital twin emulator ofiaimodular prod uction system using aidata-driven hybrid modeling andisimulation ap proach. *Journal of Intelligent Manufacturing, 1*(1), 1-13.

Bargal, P. N., Deshpande, A., Kulkarni, R., & Moghe, R. (2016). PLC Based Object Sorting Automation. *International Research Journal of Engineering and Technology (IRJET), 3*(7), 103-104.

Branch, R. M. (2009). *Instructional Design: The ADDIE Approach.* Athens: Springer Science Business Media.

POPOV, G., STOYANOV, K., & STAMBOLOV, G. (2013). AUTOMATION CONTROL FOR SORTING STATION BASED ON IEC 61499 FUNCTION BLOCKS. *The 8th International Conference on Electrical and Control Technologies , 1*(1), 13-16.

Sugiono, P. D. (2013). *METODE PENELITIAN KUANTITATIF, KUALITATIF DAN R & D* (19 ed.). Bandung : alfabeta.

Thappho, D., & Tammaruckwattana, S. (2020). Experimental Verification of Automatic Sorting Machine Using Infrared Proximity Sensor and Microcontroller. *IEEE, 1*(1), 1-4.