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PLC Controlled Assembly Automation for Spot Welding Work Station

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Abstract

Automation has created an eminent need in the present trend of manufacturing industries to boost its throughput with reduced manual intervention and benefit in terms of good product quality, reduced scrape rate, and efficient usage of resources. Assembly process necessitates more perfection to achieve good quality products, which can only be possible by employing highly skilled and experienced operators which costs more and hence Automation is the best choice to mitigate this problem. The present work is an effort to upgrade the manual assembly station for spot welding process to assemble three sub-components called cup, fastener and mesh together through spot welding process with an automatic part handling mechanism, controlled by sensor-based Programmable Logic Controllers (PLCs). The automated assembly station resulted in flaw less welded components with reduced cycle time, which enhanced the assembly process productivity from 2 parts/min to 6 parts/min.

Keywords: *Automated Assembly Line, PLC Controller, Spot Welding.*

1.0 Introduction

Automation is a trend of science where a process is accomplished according to the previously set programs with minimum human intervention[1]. Automation is an integration of Mechanical elements with Control Technology which has an ability to carry out the process with minimum human intervention[2]. There are mainly few basic elements of automation in control system to actuate, generate power, set of programming instructions and sense feedback from the devices through transformation process. The control system may include Programmable Logic Controller, relay systems, Human Machine Interface[3]. The Electro pneumatic systems and electrical devices like Motors, Solenoid are belonged to actuating system. The feedback system is very essential to check some of decision made and to minimize the deviation of system[4].

1.1 Some of the Project Works Done by Some of the Industry Experts

Umesh S. Patharkar and J.J. Salunke, explains the automation importance for less human intervention by previously set programs[1]. Michael J. McDonald. The authors identify the user communication for the better implementation of the various automation mechanization[2]. Sonja Stork, Christian Stossel, Anna Schubo explains useful control systems in automation and their application which includes Programmable Logic Controller, relay systems, Human Machine Interface[3]. Mohd Javaid *et al.* In this paper industry's strengths and applications are explained[4]. Gunter Reinhart *et al.* This paper explains that implementing multi-station assembly lines also improves

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accuracy, provides a stable process, and increases product variants[5]. Cosima Stocker *et al.* In this paper, the author explains the development of an automated orienting device. Without any human effort parts can be segregated based on their shape and orientation[6]. Chitransh Singh, M.L. Chandravanshi explains the importance of vibratory feed bowler in manufacturing industry, bowl mechanism, working and what are the concepts need to control in vibratory bowl mechanism[7]. Minghai Yuan *et al.* This technology is rapidly used because of its speed of welding, less consumption of energy, and the precision of the component will be more. Precision control and safety are high by adopting the Siemens-controlled welding system[8]. Shyamjith Uralath *et al.* automatic spot-welding method which leads to efficient products with less cycle time in mass production with more safety[9]. Mallikarjun G. Hudedmani *et al.* This paper discussed the previous mechanization and today's automation technologies to recognize and improve PLC application in any sector[10].

2.0 Methodology

2.1 PLC Controlled Assembly Automation for Spot Welding Work Machine

The assembly line is a complete system that consists of vibratory bowl feeder, servo press, carousal, conveyor and spot-welding machine which are all operating by the PLC controlling system through human machine interface[5]. This assembly station takes the child parts (cup, fastener and mesh) as input. The main objective of this project is to automate the part assembly and welding by reducing the manpower, increase the production rate with more repeatability so as to increase the production capacity.

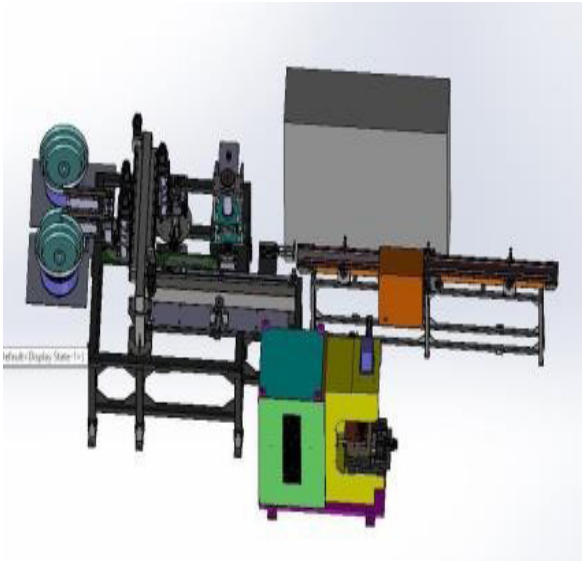


Figure 1. Proposed layout assembly station.

3.0 Vibratory Bowl Feeder

A bowl feeder is a mechanism used for supplying small parts like a cup and fastener to a production line for sorting bulk items for rapid use. It uses mechanical vibrations to move the parts from the bowl feeder to the next operation[7]. Here linear motion step bowl feeder system is used which sets on a spring- loaded base that moves vertically. Step bowl feeders are capable of arranging, selecting, feeding, and sorting parts for the operation. Bowl feeders are a practical way to eliminate manual labor costs. The bowl diameter is the central element of the process. The feeder system's base unit serves as its driving unit. It is chosen in accordance with the feeding materials, which take into account their dimensions, weight, length, and the number of pieces that will fit inside the bowl. Bowls are typically made from cast aluminum and stainless steel. These factors are controlled by a variable speed controller with a normal electrical supply. The vibratory bowl feeder is controlled by the amplitude controller[7]. To stabilize the motor speed, it has an electromagnetic field.

Figure 2. Vibratory Bowl Feeder.

4.0 Spot Welding Machine

Spot welding is used to weld mesh to the cup by applying the heat which is necessary for welding. It is operated by resistance to the flow of current through the electrode[8]. The electrode is made of copper and copper is a good conductor of electricity. Here the electrode is fixed where the current passes for the welding operation. Once the assembly and the ring stacking are finished the part moved to the conveyor. Then the operator picks up the component and places it on the work table. By using the clamps, tighten the component on the work table. The recipe will be already fed to the system by selecting the recipe, the operation will start as the slideway will start to move. Here the component needs six spots on the mesh, the current will pass through the electrode as per the requirement, the recipe will be fed on the system electrode will move down, and perform a weld on the required spot-on mesh. Then the electrode moves upwards and the slide moves again the electrode will move downwards and make another weld on the mesh like this the operation will continue up to six spot welding. The sensor is present on the slideway where if any human interaction is made then the operation will stop itself. A dresser unit is present on the machine for the dressing of the electrode. After that, the component will be take-off from the machine by the operator and the operation cycle carries out[9].

Figure 3. Spot Welding Machine.

5.0 PLC Program for the Application

PLC programmable logic controller is a system with customized instructions for performing a particular

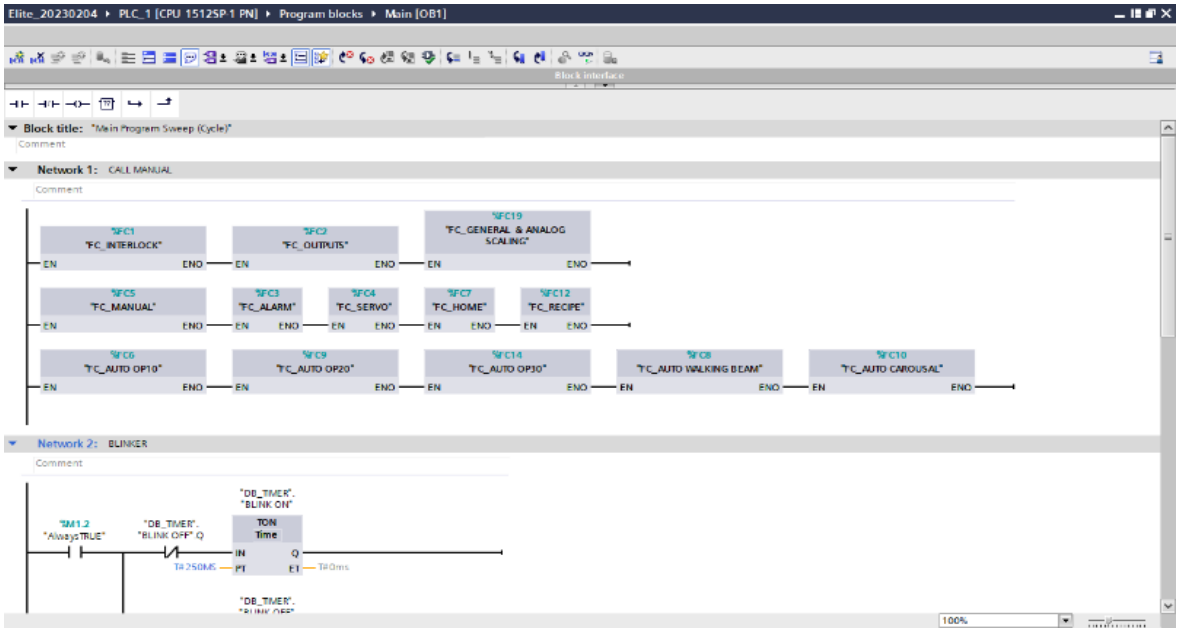


Figure 4. Main Program for the Assembly Line.

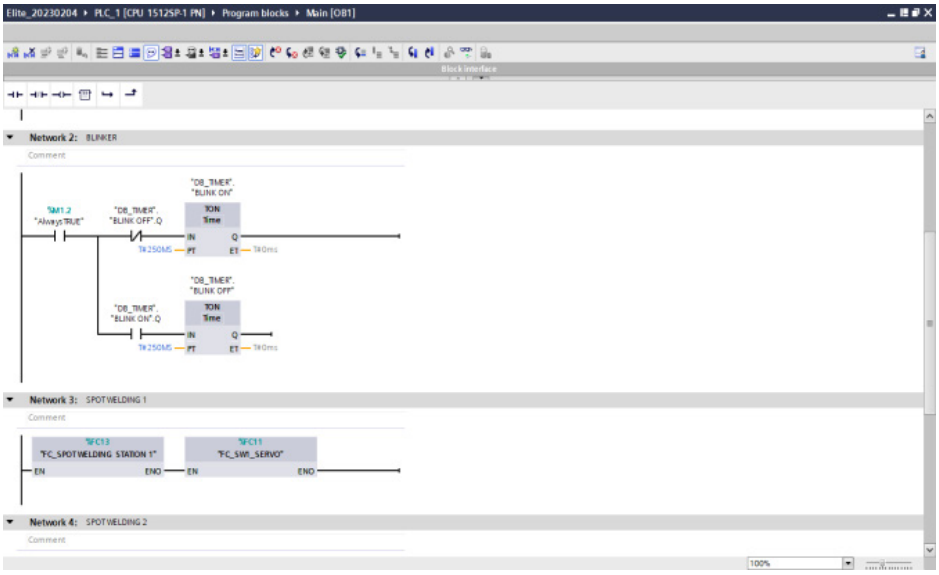


Figure 5. Spot Welding PLC Program.

task. PLCs are used in industrial control systems for a wide variety of applications[10]. PLCs are useful tools for repeatable processes because repetitively performing a single task while monitoring the conditions.

6.0 Result

Table 1. Comparison of Manual and Automation ProcessResult

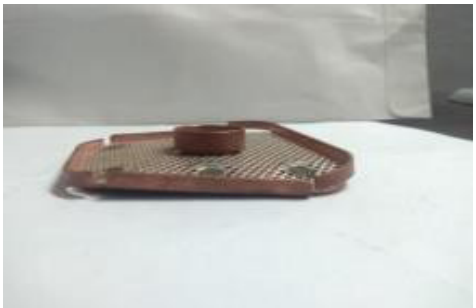
Before	After
	
	

Table 2. Result Analysis

Result	Manual	Automation
Production capacity	Less 2parts/min	High 6parts/min
Safety	Less	High
Manpower requirement	High	Less
Wastage	More	Low

7.0 Conclusion

Assembly Line Automation with Spot Welding Machine is carried out successfully. After executing the whole operation, it is confirmed that all the specification meets the requirement and the machine isready for production. Manual assembly and welding lead to some flaws where it affects the productionresults by consuming more time. To overcome this situation automation is installed. Because of this structure, the whole system runs without any troubles, and also the parameters like a high production rate with more safety, less wastage, low manpower involvement,less cycle time, and a more efficient product can be achieved. The production rate increased from 2 parts per min to 6 parts per min and also reduced the reworkand rejection of the assembled and welded parts. PLC controlled assembly automation for spot welding work station application is ideal for use in mining to repair and operate machinery and equipment, as well as to create new structures.

8.0 References

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