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Development of Stamping Machine Module to Improve Practical Competency

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Abstract

The aim of this research is to design and manufacture a stamping machine module controlled by PLC. Stamping machine is an application of electro-pneumatic system in industry to print image/text on the workpieces. The result of this research is a stamping module controlled by PLC, with reliable and easy to disassemble for learning Electro-pneumatic Practice.

Keywords: stamping, electro-pneumatic system, automation, PLC

1 Introduction

Entering the era of industrial revolution 4.0, more industries are implementing automation in their production processes. Thus, the need for workers who have expertise in accordance with the latest technological developments is increasing. Vocational education in engineering subject as a provider of skilled workers needs to equip students with skills that are in line with the latest technological developments.

One of the important components in industrial automation is the electro-pneumatic system. This electro-pneumatic system is widely used in the production process because it uses a cheap, clean and effective source of wind power. Knowledge and skills about electro-pneumatic is a mandatory skill that must be possessed by a technician in the industry. The competencies needed from this electro-pneumatic system are

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understanding of electrical and pneumatic components, functions, working principles, and how to control them; as well as assembling skills, troubleshooting, and commissioning of an electro-pneumatic system.

In the field of education, the delivery of electro-pneumatic material is provided using practical teaching aids. The disadvantage of this props is that the types of components provided are limited, so that what can be done is the demonstration/simulation of the motion of an electro-pneumatic system. Thus students have not yet gotten a real picture of an electro-pneumatic system as in the industry. Then we need examples of production processes that are close to reality with the industrial world, one of which is the stamping process [1]. The process of stamping, is the process of printing images / text on workpieces automatically. Some manufacturers such as Festo and SMC have offered practice modules that are examples of automation processes in the industry, but at very high prices [2, 3]. Singh [4] has also developed automatic press machines using pneumatic for large scale.

This paper offers the design and manufacturing of stamping machine modules with PLC control. This module will be used as an electro-pneumaticpractice prop. This module can be disassembled with the appropriate equipment, to meet the competencies of students in assembling skills, troubleshooting, and programming in an electro-pneumatic system. In addition, the cost of making modules in this paper is much cheaper than existing modules because they are self-developed and use used components that can still function properly.

The paper is organized as follows: Section 2 presents the module design while the method (steps) of making the module will be described in Section 3. The results of the research and discussion are written in Section 4. This paper concludes with some conclusions.

2 Design

In this section, the writer explains the design of the proposed tool, which is stamping process and mechanical design.

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2.1. Stamping Process Design

Stamping machine module used to stamp double-sided workpieces using tampon stamping method. This machine involves a sequence of operations illustrated in Figure 1 below.

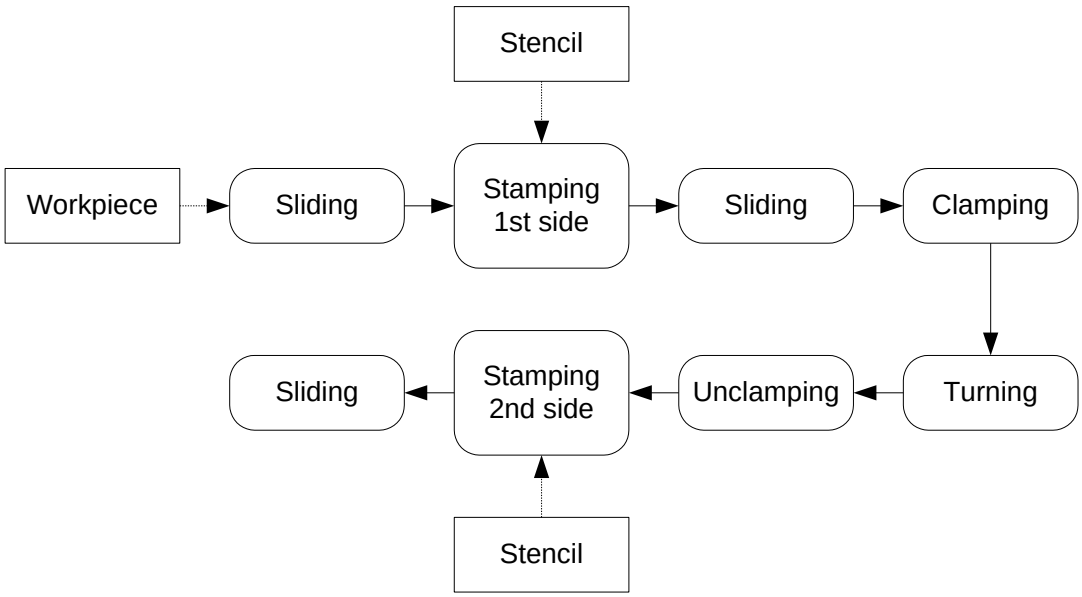

Figure 1. Stamping process

Stamping process starts by putting the workpiece on the conveyor belt, which will carry the workpiece to the stamping station. A plunger tampon will stamp the workpiece. The workpiece, which has already been stamped on one side, moves between the gripper jaws, and then closes. The workpiece is lifted, reversed, then lowered again to the conveyor. The stamping process will be repeated at the second station to stamp another side. After the two sides are printed, the workpiece will run towards the storage box.

2.2. Mechanical Design

This stamping module is designed to be easily disassembled, to meet desired practice competencies. Mechanical module design is presented in Figure 2.

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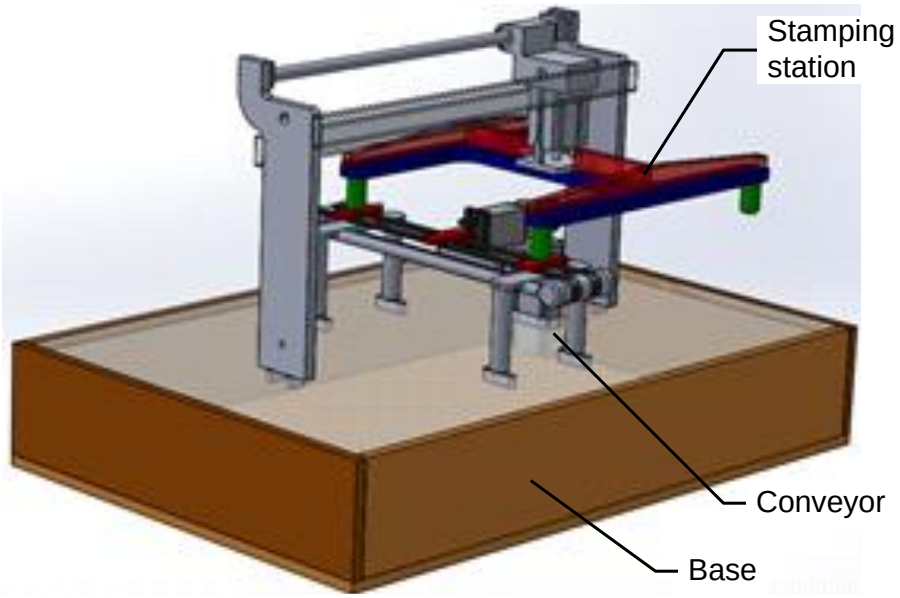

Figure 2. Mechanical design of stamping machine

The base is to put the control components, namely power supply, solenoid valve, and PLC. The upper part is to put a stamping machine that consists of a conveyor with timing belt and a pneumatic system to meet the stamping process. The module should be able to be dismantled and assembled with the appropriate tools.

3 Research Methodology

This section is devoted for the research method. Stamping machine module is done by pneumatic system with PLC-based controller.

3.1. Pneumatic System

The actuator used to carry out the stamping process is:

a) Sliding is done by a DC motor, which is actuating belt-conveyor.
b) Two tampon plungers actuated by a rodless cylinder.
c) A Parallel gripper is used to clamping the workpiece.
d) A semi-rotary drive is used to hold the gripper.
e) Two lifting cylinder used to move-up and down the semi-rotary unit and tampon plunger.

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The pneumatic stamping machine circuit is shown in Figure 3 below. Drawing and simulation pneumatic circuit are carried out using the Fluid SIM-P software [5].

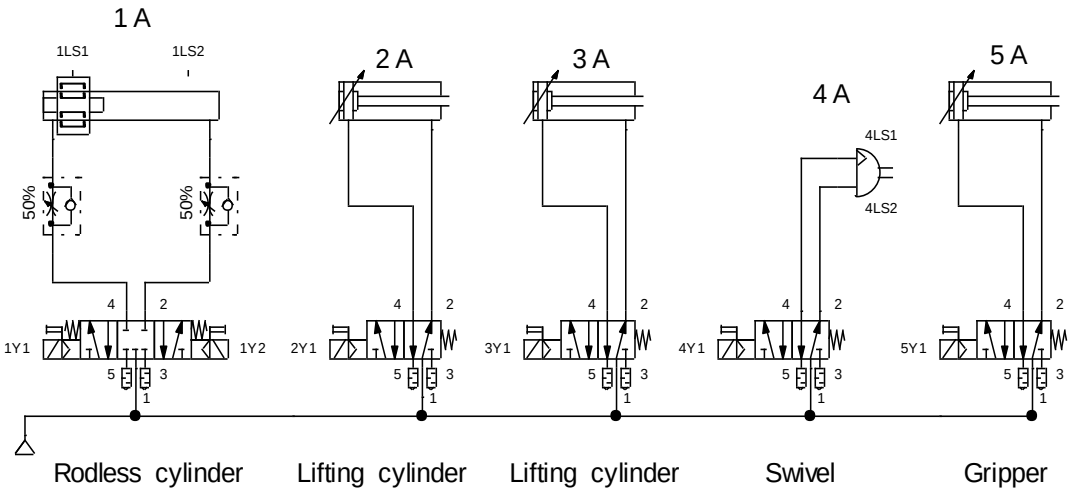

Figure 3. Pneumatic circuit

3.2. PLC-based Controller

This stamping machine is controlled by PLC OMRON. The various inputs and outputs are shown in Table 1.

Table 1. PLC inputs/outputs

Digital inputs	Digital outputs
Start	Motor M1
Stop	Solenoid 1Y1
Reset	Solenoid 1Y2
Manual/Auto M/A	Solenoid 2Y1
Emergency stop	Solenoid 3Y1
Limit switch 1LS1	Solenoid 4Y1
Limit switch 1LS2	Solenoid 5Y1
Limit switch 4LS1	M/A indicator
Limit switch 4LS2	

Limit switches 1LS1 and 1LS2 were placed to know the position of rodless cylinder, which is holding the tampon plunger. Limit switches 4LS1 and 4LS2 were placed to know the position of semi-rotary drive/swivel. Control action was taken according to

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the various inputs from the switches. The system can run at manual or automate mode by selecting M/A switch.

The sequential diagram of the PLC program is shown in Figure 4. A ladder logic program for this PLC was written in CX-programmer [6].

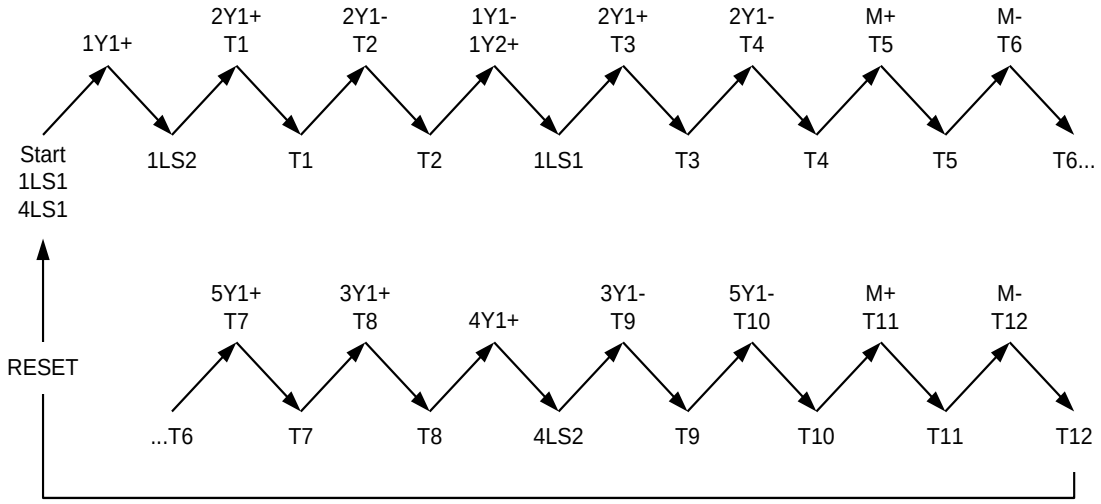

Figure 4. Sequential diagram

4 Results and Discussions.

The results of this research is a stamping machine module as presented in Figure 5 below.

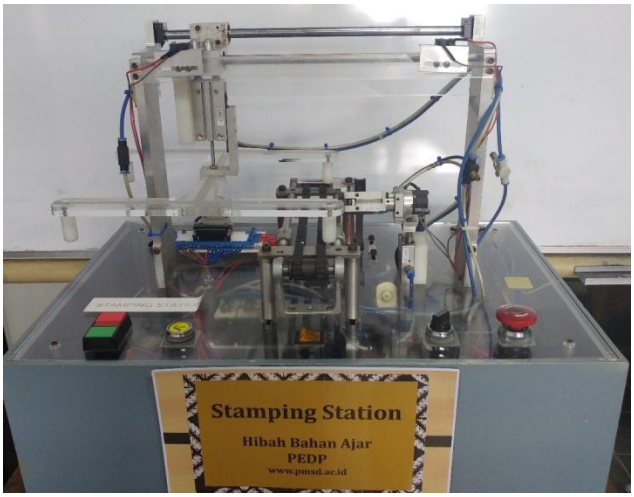

Figure 5. Stamping machine module

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Testing the first stage of the stamping machine module is done by running the system in the order of the planned process. The test results show that the module can work well according to the plan.

In Figure 6, the second stage of testing is carried out by students by using it in lectures on Electro-pneumatic Practice at the Mechatronics Department, Politeknik Mekatronika Sanata Dharma (PMSD). In this practice, students conduct assembling, troubleshooting, and programming stamping machine module based on the procedures in the Manual Book. The test results show that students can perform procedures based on the Manual Book to be able to run the stamping machine process properly.

Figure 6. Electro-pneumatic workshop using stamping machine module

5 Conclusions

A PLC-based controller for stamping machine module has been successfully designed and developed. It has been evaluated by simulating the stamping operation on Fluid SIM-P and real running on Electro-pneumatic Workshop.

This module is equipped with a Manual Book that can be used for assembling learning, troubleshooting, and programming a PLC-based electro-pneumatic system. Future studies will focus on developing other automation process modules.

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