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Design Robot Hand Pneumatic System Simulation Using PLC Control for Mechatronics Learning Applications

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***Abstract**: The Pneumatic System is a power transfer system utilizing compressed air as an intermediate medium. In conventional operation it is operated fully pneumatically or in combination with electricity (electropneumatic). In recent years it can be combined and controlled with a programmable logic controller (PLC). The operation of the pneumatic system with the PLC control system is carried out by desaign a program with a program language, one of which is the Ladder Diagram accompanied by I/O addressing, then the result design program must be transferred to the PLC as the controller of the pneumatic system in this case the controller. robot hand. This study aims to obtain a pneumatic robot hand circuit and a series of ladder diagram programs to control the PLC system in the robot's hand. The results of this research can be used as a reference in designing a pneumatic system with PLC control in the future.*

***Key words**: Pneumatic, Ladder Diagram, Mechatronic, Robot Hand Simulation*

The pneumatic control system is currently growing rapidly with the possibility of combining pneumatic control systems using a PLC. Therefore, the researcher is interested in making a robot hand simulation with a mathematical system using PLC control which can be used to support the practice of Mechatronics courses.

To design this simulation involves how to make pneumatic circuits and program language, especially PLC ladder diagram making, so that it allows robotic hand movements to occur, as well as how to combine and operate them into the desired movements according to the planned ladder diagram.

This design results is very important in PLC practicum learning, especially in supporting Mechatronics courses. Here, the manufacture of pneumatic circuits is carried out, making the PLC ladder diagrams according to the desired step diagram and online or transferring the diagrams made on the PC to the PLC devices, assembling the PLC inputs / outputs and operating them.

There are several studies related to research that will be carried out as a comparison. One of them is research conducted by Mirza W.P and Sutomo (2012) entitled "Simulation of Electro-Pneumatic Applications and PLCs as Water Gate Controls". In his research using PLC OMRON SYSMAC CP1E 20 I/O technology and electropneumatik as a simulator to automate the movement of opening and closing the floodgates. The input is a push button switch, while the output is a solenoid valve. PLC here functions as a controller that processes input and output.

Then there is another research conducted by Ahyar and Arifin (2018) entitled " *Rancang Bangun Media Praktikum Sistem Pneumatik Berbasis PLC* ". This research is experimental research that designs practicum media for automation systems in industry with electropneumatics.

Pneumatic System Structure and Signal

Flow. The general structure of a pneumatic system consists of an energy supply, an input signal, a signal processor, an end control element and an actuator. Elements in a pneumatic system are represented by symbols that indicate their function. The symbol can be a combination of several element symbols and has a specific function. At the actuator level added control elements to complete the structure. The control element controls the action of the actuator after receiving the signal sent by the processing element. The circuit diagram of the pneumatic element can be seen in the figure 1.

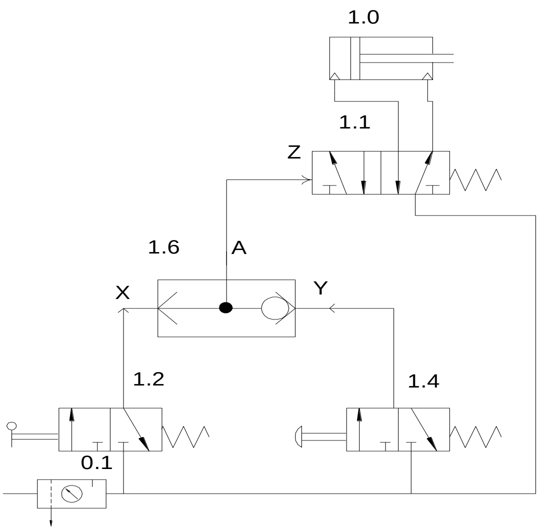

Figure 1. Circuit diagram of pneumatic elements

PLC Compilation Tool. PLCs manufactured by various leading control system companies today usually have their own characteristics that offer their system advantages, both in terms of application (enhancements) and the main module of the system. However, in general, every PLC contains the following four parts (tools): First. Power Supply. The power supply provides DC voltage to various other PLC modules in addition to additional modules with a total current capability of around 20A to 50A, which is the same as an integral lithium battery (which is used as memory backup). Should this power supply fail or the input alternating voltage drops from its specific value, the memory contents will be maintained.

Second. CPU Module. The CPU module which is also called the controller or processor module consists of two parts. First, the processor, functions is operated and communicates the PLC modules through existing serial or parallel buses and executes the control program. Second, Memory, have functions to stores changeable digital information in the form of data tables, image registers, or RLL (Relay Ladder Logic), which is a process control program.

In certain PLCs, sometimes we also encounter several processors in one module, which are intended to support system reliability. Some of these processors cooperate with a certain procedure to improve control performance.

The memory capacity of the PLC also varies. This memory capacity depends on its usage and how far you optimize the PLC memory space you have, which means it also depends on how many locations the control program needs to control a particular plant.

The PLC Software Program module recognizes a wide variety of software, including State Language, SFC, and even C. The most popular one is RLL (Relay Ladder Logic). All programming languages are made based on sequential processes that occur in plants (controlled systems). All instructions in the program will be executed by the CPU module, and writing the program can be done on line or off line. So the PLC can be written to the control program when it controls the process without disturbing the control that is being carried out. Software execution will not affect ongoing I/O operations.

Third. I/O Module. The I / O module is an input and output module which is responsible for controlling the PLC connection with external or peripheral devices which can be a host computer, switches, motor drive units, and various signal sources contained in the plant.

Input module. The input module functions to receive signals from peripheral sensing units, and provides signal settings, terminations, isolations, and indicators for the input signal state. The signals from the peripheral device will be scanned and the state will be communicated through the interface module in the PLC.

Output module. The output module activates a variety of devices such as hydraulic, pneumatic actuators, solenoids, motor starters, and a display of the status of the connected peripheral points in the system. Other output module functions include conditioning, terminating and isolating existing signals. The activation process is of course carried out by sending relevant discrete and analog signals, based on the nature of the PLC itself which is a digital device.

METHOD

Research about the design of pneumatic system simulation using PLC control on the robot's hand uses experimental methods with the following stages: problem identification, literature study, draft design and alternative designs, making electropneumatic circuits, making PLC control programs, assembly, testing and analysis.

Flow chart for this experimental methode can be seen at figure 2.

RESULTS AND DISCUSSION

In this research, simulations are made with the aim of assisting the learning process of Pneumatics and Mechatronics. This tool can be used to increase student learning media and creativity in making various kinds of automation programs that are driven by pneumatic and controlled by PLC using the Ladder Program.

The results of the research design for a simulation of a robot arm that is moved by pneumatic and controlled using a PLC can be seen in the figure 3

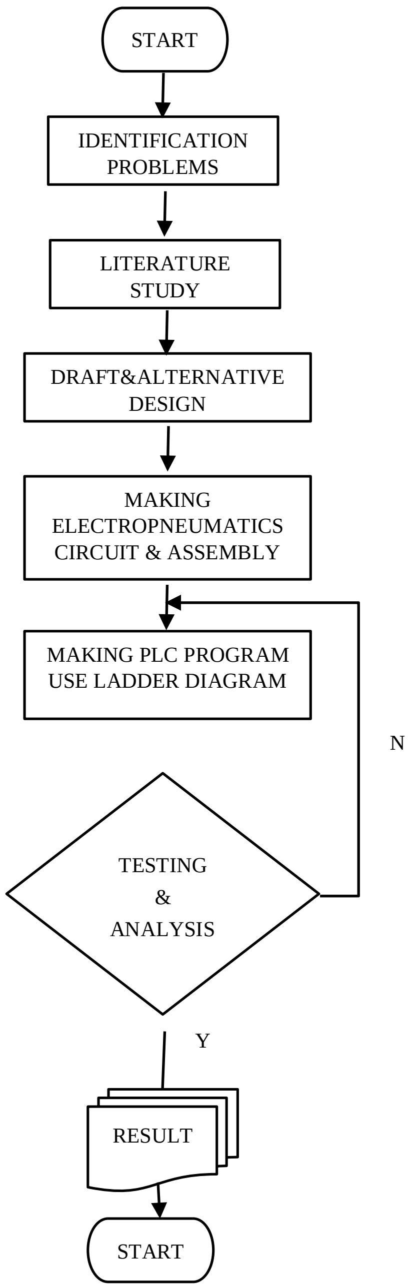

Figure 2. Experimental method flow chart

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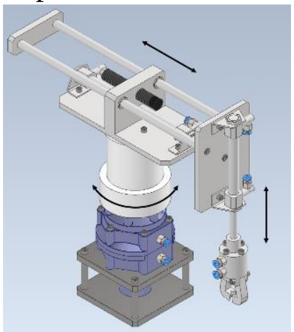

Figure 3. 3D design result Robot Hand Pneumatic System Simulation Using PLC Control for Mechatronics Learning

Applications

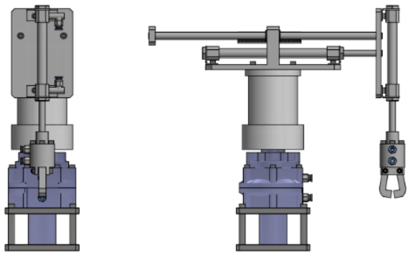

Figure 4. 2D design result Robot Hand Pneumatic System Simulation Using PLC Control for Mechatronics Learning Applications

This robot hand simulation tool with pneumatic drive and controlled by PLC can be used to do one of the practicum jobs from the Mechatronics course. This tool can be programmed with several variations of movement.

To create a PLC program, the Ladder programming language is used, also known as a Ladder Diagram. The robot hand simulation tool as a result of this design can be adjusted and moved according to what we want with the controller being a PLC programmed in Ladder language.

One example of a ladder diagram that is used to move a pneumatic robot arm simulation, arranged with a PLC can be seen in the figure 5.

CONCLUSIONS

Robot Hand Pneumatic System Simulation Using PLC can make variations in motion according to the program we created and needed. Movements can be designed using the Ladder Programming Language or Ladder Diagrams.

Design result a Robot Hand Pneumatic System Simulation Using PLC Control can be used as a practicum medium for the Mechatronics subject.

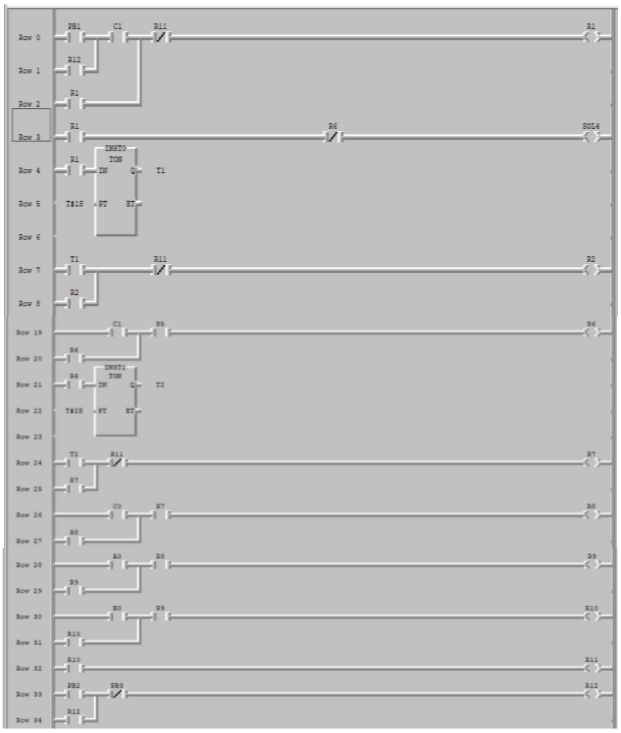

Figure 5. Ladder Diagram for move a pneumatic robot arm simulation, arranged with a PLC

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