Optimization of printed circuit board components placement

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Abstract. In order to optimize the throughput rate of these automatic systems, the time taken for the pick and place electronic components for each board has to be minimized. This study focused on optimization problems faced in automated assembly of electronic component in Printed Circuit Board (PCB). Components are placed on PCB where the process of pick-up and placement occurs starting from the machines to pick up the components from the feeder magazine. The number of components to be picked and placed maximum four components, depending on its contribution to minimize tour distance. Increased complexity of PCB assemblies, components and shorter product obsolescence timescales implies machines utilization must be maximized in order to achieve cost efficiencies. The difference in size and shape of components is handled by the head, which brings the optimization problem closer to real machine situation. In hope that the electro-pneumatic arm design can speed up the working time of installing components on the PCB and can add new designs to be registered for patents.

1. Introduction
Mechanization is the process of replacing and using various machines, as well as various technical means that are intended to replace human or animal labor. Pneumatic is a drive system that uses air pressure as its driving force. The advantage of the pneumatic system is that it is environmentally friendly/clean (if there is a leak in the piping system). Electro-pneumatics basically consists of two pneumatic and electronic control systems, control using a power source from the air, and an electric power source with a relatively small voltage and power capacity.

PCB is an object that is shaped like a thin board used to compose a series of electronic components. PCB stands for Printed Circuit Board which in Indonesian is often translated as Printed Circuit Board. PCBs can be found in almost all electronic equipment such as cell phones, televisions, cars, motorbikes, and so on. There are many things a designer must pay attention to in order to design a printed circuit board that can function according to the specified specifications.

2. Previous research
Today's industrial sector requires equipment that can replace human work, which can work automatically to shorten production times, reduce production costs, and eliminate routine work. Automatic transfer of material uses PLC as an electro-pneumatic control actuator and is operated automatically [1].

Electro-pneumatic installation made according to the cascade method. A cascade is a method used to construct pneumatic installations. To take advantage of the cascade method, it is necessary to replace pneumatic components in the input and power signal control systems, with electrical components that...
have the same function in the installation, thus enabling the use of the Cascade Method in making electro-pneumatic installations [2].

Design of Tofu Printing Machine and Tofu Sticks Using an Electropneumatic System, initially tofu molds in the traditional way, namely by loading with stones which take a long time, require large space, require more employees and have a high risk of employee accidents so that producers know piety and tofu sticks have low effectiveness and productivity. From the above problems, a tofu printing machine and tofu sticks are needed, where to use an electro-pneumatic system [3].

Based on these predecessor researchers, using electro-pneumatic technology can help solve the installation of electronic components quickly and accurately and of good quality.

2.1. PCB (Printed Circuit Board)

PCB is a board that connects electronic components conductively to the track, from copper sheets laminated to a non-conductive substrate. PCB can be in the form of 1 layer, 2 layers, or many layers (multilayer). PCBs can be found in almost all electronic equipment such as cellphones, televisions, cars, motorbikes, and others. There are many things that must be considered by a designer to be able to design a printed circuit board that can function according to the specified specifications.

The following are some of the points and terms used, including the copper thickness, trace width, component footprints, board thickness and layers, path, and component spacing. trace clearance and creepage), via, solder mask and silkscreen.

2.2. Pneumatic

Pneumatics is a theoretical branch of flow or fluid mechanics and includes not only the research of air flows through a duct system, which consists of pipes, hoses, devices, and so on, but also the action and use of compressed air. Compressed air is air taken from environmental air which is then blown forcibly into a relatively small space.

2.3. Electro-pneumatic

Electro-pneumatic is the development of pneumatics, where the principle of action is to choose pneumatic energy as the working medium (driving force), while the controlled media uses electric or electronic signals. The electric signal flows to the coil which is attached to the pneumatic valve by activating a switch, sensor or limit switch that functions as a connector or signal breaker. The signal sent to the coil will generate an electromagnetic field and will activate the directional valve as the final element in the pneumatic work circuit. Meanwhile, the pneumatic working media will activate or move the pneumatic working elements such as pneumatic motors or cylinders that will run the system.
2.3.1. Electro-pneumatic system
a. Electrical signal. The basic component of an electrical signal is using 24 Volt DC electricity. The simple circuit of the electrical circuit consists of the DC source voltage, the load, and the wiring system.

Figure 2. Simple DC electrical circuit.

b. Switch. A switch is a component in a circuit that functions to disconnect or connect the current to the load. There are two types of switches, namely, push-button switches and mechanical switches.

c. Limit switch. Mechanical limit switches can be set in a certain position or condition. When the workpiece touches the limit switch, it will issue a signal to control a system. This limit switch is usually used to disconnect or connect the current flow.

d. Relay. Relay is a component for line connectors and signal controllers, whose energy requirements are relatively small. This relay usually functions with an electromagnet that is generated from the coil. Initially, this relay was used in telecommunication equipment which functioned as a signal amplifier. But now it is common to find in control devices, both on machinery and others.

3. Design the electro-pneumatic arm
The purpose of this research is to optimize the placement time of components on the automatic light fitting PCB board. Automatic light fittings are lamps that are attached to these fittings which can turn on and off independently without an operator according to the user's wishes. Program settings by users using a mobile device. The main parameter that determines the success of the device is the timing accuracy and timing of turning off the lights. The timing of on and off according to the user's wishes is the design of the Automatic Light Fitting system. In general, automatic light fittings consist of 4 (four) main components, namely: (a) an electronic switch; (b) Power supply (power supply); (c) Infrared signal receiver; (d) The main program microcontroller controlling the system.

Figure 3. Automatic light fittings.

To optimize the placement of components on the automatic lamp fitting PCB, it is necessary to make an electro-pneumatic sleeve design. The tools and materials used are microcontrollers, aluminum, pneumatic piston, stepper motor, vacuum rubber, and vacuum pump. The working principle of the electro-pneumatic arm is that the proximity sensor is adjusted to locate the component to be taken, after which the arm moves closer to and until it touches the component. Then the vacuum pump is given
directions by the microcontroller to suck the components that will be placed on the PCB. After the component is carried away, the robot arm directs and places it according to the coordinates of the component's placement.

![Design electro-pneumatic arm](image)

**Figure 4.** Design electro-pneumatic arm.

4. Conclusion
In hope that the electro-pneumatic arm design can speed up the working time of installing components on the PCB and can add new designs to be registered for patents.

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