

Original Article

Smart Natural Paper Vending Machine using Sensor and IoT System

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Received: 26 February 2023

Revised: 02 April 2023

Accepted: 12 April 2023

Published: 25 April 2023

Abstract - In this study, a coin-operated service machine made of natural fiber paper containers was created to demonstrate an understanding of how to handle iron-type equipment. Pneumatic cylinders and aluminum metrics are connected with programming to regulate the operation. The technology is implemented by integrating the vending machines to create the novel container-forming vending machine, which is invented utilizing a microcontroller system. Paper is made of natural fibers for use at the point of sale of food. In order to make it easier for consumers to obtain food packing containers. Avoid using plastic and foam containers. The researcher's goal in planning and conducting this study is to promote using natural materials. Included as a strategy to limit the usage of plastic and foam containers in the service area, which serves as a guideline for the technology's national and international expansion.

Keywords - Internet of Things, Vending machine, Monitoring, Automation system.

1. Introduction

Currently, large volumes of garbage are an issue in our world today. Plastic trash, in particular. This is due to the fact that plastic garbage takes longer to disintegrate than natural waste. Humans have developed a culture of consuming by storing food in containers. However, some food vendors at neighborhood flea markets sell food packaged in plastic bags to the consumer; foam cups, plastic packaging, and plastic cups are sometimes used to assist consumers. So that they can dine right away, plastic is widely used in food containers, including plates, cups, and bowls, which are regularly seen and purchased in the market. When these plastic containers are used up, they decompose into biodegradable waste, and the amount of waste generated by these containers is directly proportionate to the number of people who live in that area. At the same time, growth in the number of customers will result in an increase in the amount of waste produced. As a result, many organizations are aware of the problem of plastic waste created by packaging containers in various places and have devised a strategy to address it. There are numerous organizations devoted to environmental conservation at the moment and encourage people to be aware of the need for natural resource conservation. Natural materials such as banana leaves, betel nut leaves, teak leaves, lotus leaves, and other natural materials have been utilized to make containers in Thailand instead of plastic-containing materials. In this

study, a coin-operated service machine made of natural fiber paper containers was created to demonstrate an understanding of how to handle iron-type equipment. Pneumatic cylinders, aluminum and a microcontroller system, are used to merge metrics with functional control programming. By combining technology development with the application of technology by bringing vending machines together, natural fiber paper containers to be utilized at food distribution stations were produced. Overall, plastic and foam containers should be used less frequently to make it easier for customers to get food packing containers. The researcher focuses on encouraging the usage of natural materials by planning and conducting this study. Included as a strategy to limit the usage of plastic and foam containers in the service region, which serves as a roadmap for the technology's national and global expansion.

2. Research Method

Automation in workplace *PID* controls is used in this industry. Proportional-Integral-Derivative is the abbreviation for Proportional-Integral-Derivative. These three controls are coupled in such a way that a control signal is generated. It gives the necessary level of control output as a feedback controller. Before the invention of control microprocessors, there was no such thing as a control microprocessor. So, according to the law, setting the values of K_p , T_i and T_d ensures that the system runs smoothly.



It is possible that the system has an overshoot value. As a result, there is an unacceptably high requirement to modify both satisfactory outcomes.

2.1. Hardware Design

It will be possible to create a mechanical model of an

electro-pneumatic system. The model's simulated response will reveal information about the behavior of an electro-pneumatic system, including the impacts of various nonlinearities. Figure 1 shows a schematic diagram of an electro-pneumatic position control system.

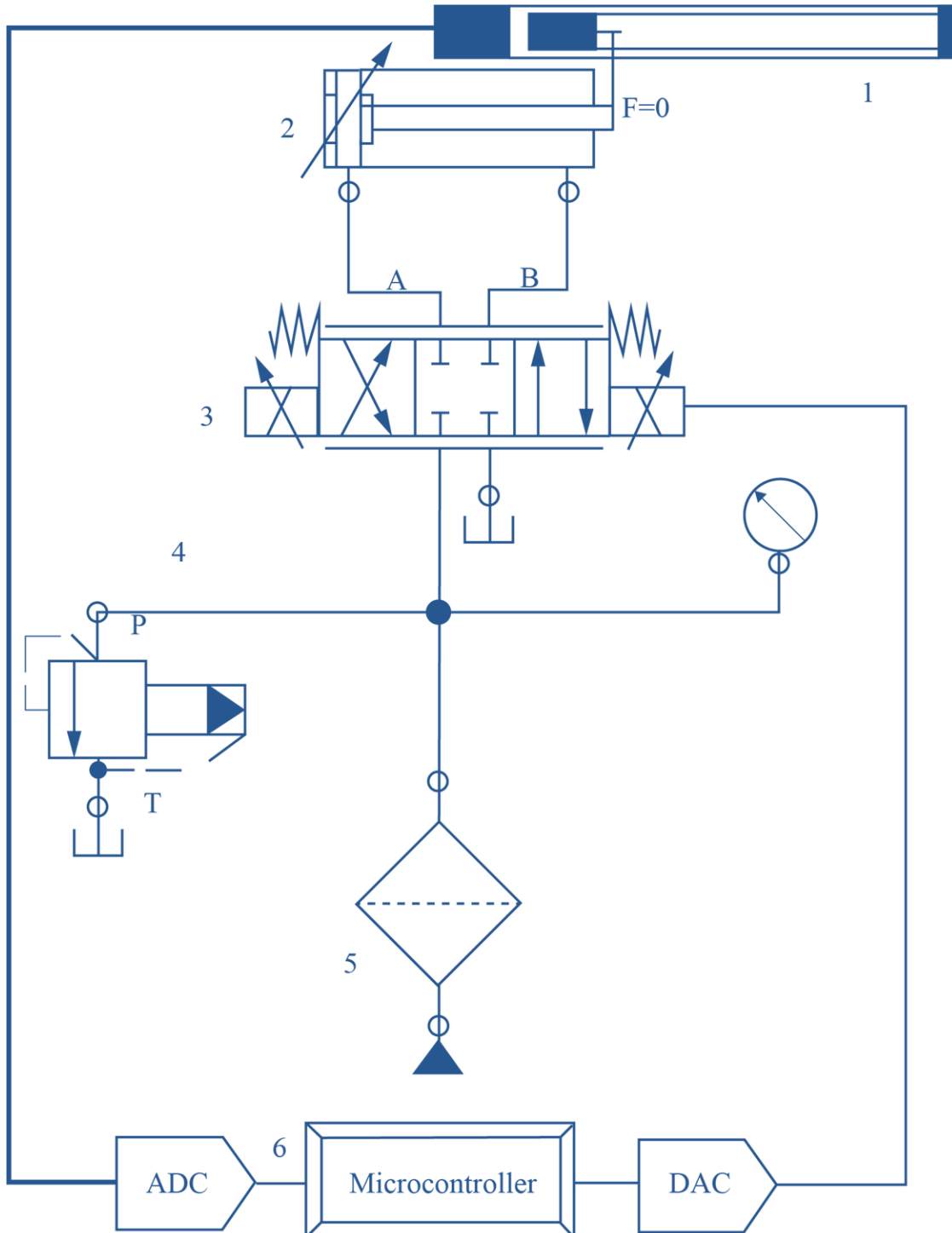


Fig. 1 Electro-Pneumatic Position Control System

The feature of the system includes the following.

1. Linear potentiometer
2. Pneumatic cylinder
3. Servo valve
4. Pressure gauge
5. Pump
6. Microcontroller and Power supply



Fig. 2 Vending Machine

The power source for this type of metal stamping machine is compressed air. A regular air cylinder and a control valve make up the system. A button is used to start a cycle of pressing and moving the pushrod up and down in a safe manner. The bore size, as well as the pressure of the

regulated air source, define the maximum force of this pump, which is relatively low. The pressure, on the other hand, remained constant throughout the thrusting stroke. This metal stamping machine has a fast speed, which is a benefit. It features a cheap total cost of ownership and lowers operator fatigue.

Vending Machine principles of operation allow users to pick how much they want to make, how many banana leaf plates they want, and how much one wants to spend on coins. The machine will next process the data and transmit a signal to the pneumatic system, which will pump the workpiece in the order depicted in the diagram below.

2.2. Control System Design

2.2.1 Conceptual Design

The main concerns of a machine tool application are speed, precision and pneumatic system stability. Due to space and time constraints, every system is likely to be a compromise between these uses. After the design goals for a pneumatic system have been identified, the actual design process can begin. Figure 4 depicts the generalized pneumatic system design and analysis procedure. The design concept to be integrated into the pneumatic system must be established from the design goals, and a system schematic and operating parameters for the system must be developed.

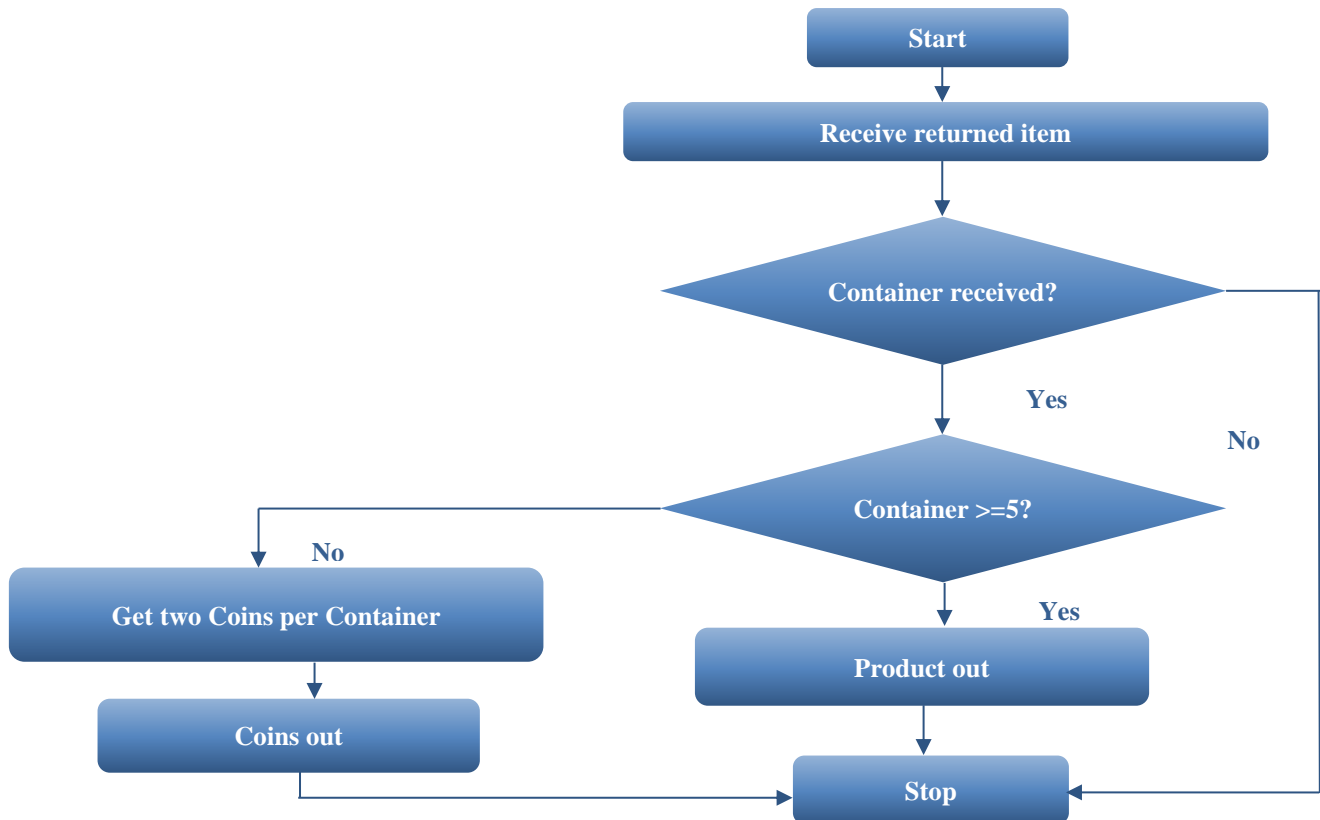


Fig. 3 Flow Chart of Process Method

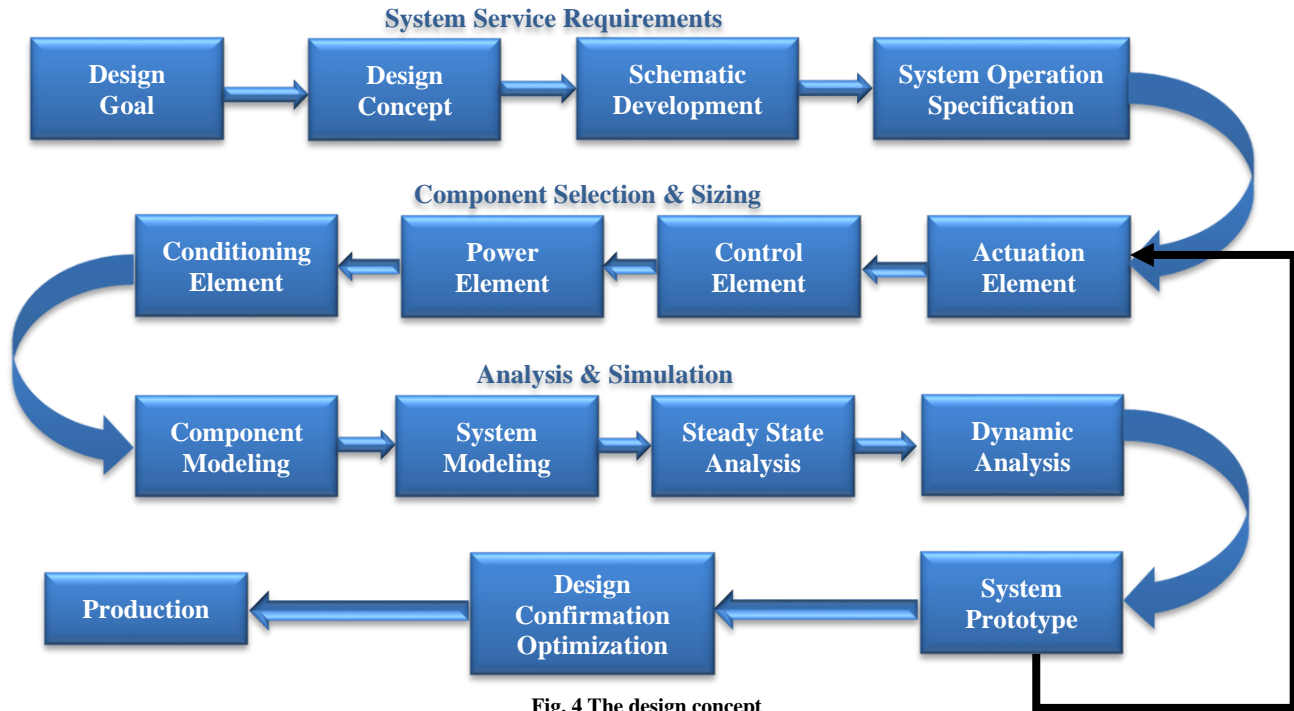


Fig. 4 The design concept

A microcontroller is an ESP8266. The WiFi connection, which includes a Full TCP/IP Stack, is the key feature. The chip is inexpensive. Furthermore, becoming a microcontroller entails being able to program it. The ESP8266 has several advantages, including being both inexpensive and programmable, and having a built-in WiFi capability, making it something that answers to the emergence of the Internet of Things era, making it extremely popular.



Fig. 5 NodeMCU ESP8266

2.2.2. Liquid Crystal Display

A Liquid Crystal Display (LCD) screen is a type of character display. Numbers or characters with some types are also capable of displaying images. This LCD monitor is indispensable for any job that requires displaying various functions. In order for consumers to be able to connect as part of the electronic circuit



Fig. 6 LCD 16*2

2.2.3. Heater Press Machine

Hot pressing heat press machine accessories with silicone rubber heater, foam silicone and steel sheet and power at 1350 watts.

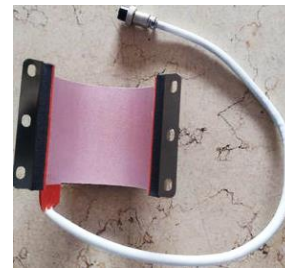


Fig. 7 Heater 1350 Watts

2.2.4. Coinstar Machine

A vending machine is another way to make money, especially if you need extra cash. Because the vending machine industry is fully automated. The device will perform services and receive payments without human intervention. It is simple to do business with the machine's owner. You are not obligated to sell.

2.2.5. PID Controllers

Depending on the manufacturer, PID controllers come in various shapes and sizes. The PID controller offers an appropriate level of error reduction, as well as stability and damping. PID controllers are so effective in processing industries like petroleum refining, papermaking, and metallurgy that they have become standard. All three control components are split into proportional, integral, and

derivative in the *PID* controller. All of their gain constants can be changed. It is possible to derive the proportional, integral, and derivative control (*PID*) transfer function model as follows:

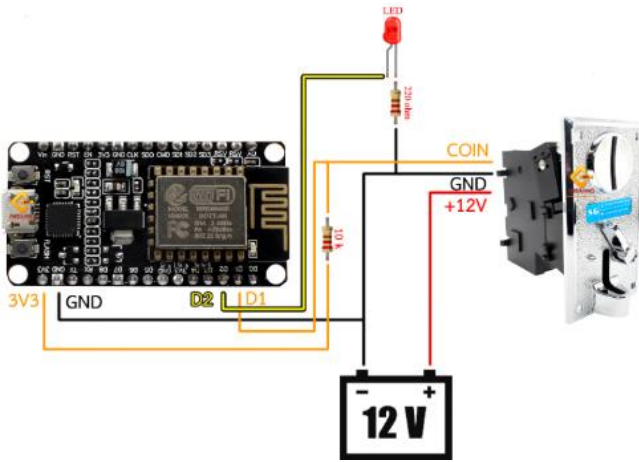


Fig. 8 Coinstar Machine

$$\begin{aligned}
 u(t) &= k_p[r(t) - y(t)] + k_d \frac{d}{dt}[r(t) - y(t)] \\
 &\quad + k_i \int_0^t [r(t) - y(t)] dt \\
 &= k_p e(t) + k_d \frac{de(t)}{dt} + k_i \int_0^t e(t) dt
 \end{aligned} \tag{1}$$

$$\begin{aligned}
 U(s) &= k_p e(s) + k_d s e(s) + \frac{k_i}{s} e(s) \\
 &= e(s) \left(k_p + \frac{k_i}{s} + k_d s \right)
 \end{aligned} \tag{2}$$

As a result, the matching block diagram representation is illustrated in Figure 9. This is how a generic *PID* controller's desired system parameters or gains, which are chosen to produce the desired system dynamics, are modeled. The terms used to describe these three types of benefits are proportional, integral, and derivative gains.

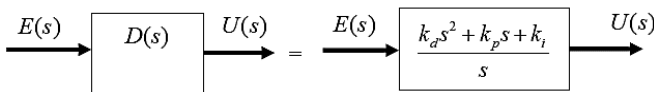


Fig. 9 Block Diagram of PID Controller

2.3. Software Development

The Internet of Things (IoT) refers to the concept of everything being connected to the Internet. It allows humans to use the Internet to control the operation of numerous things, such as turning on and off electrical appliances, autos, and mobile phones. Tool for communication IoT technology connects agricultural instruments, buildings, dwellings, and ordinary appliances to the Internet network, among other things.

2.3.1. HTML Language

Hypertext Markup Language (HTML) is the most common language for creating web page files. The idea was inspired by Tim Berners-invention Lee's, a standard language for creating documents in the form of web pages published on the Internet. Tags are a type of writing structure that uses diacritics to regulate the display of text, images, and other things. These papers are retrieved using a web browser such as Mozilla Firefox, Opera, Netscape Navigator, Internet Explorer, and other similar programs.

2.3.2. CSS Language

Cascading Style Sheets (CSS) is an acronym for Cascading Style Sheets. It is a language, like HTML and XHTML, that has a defined syntactic writing style and is established by the World Wide Web Consortium (W3C). We can customize the border, background, spacing, and other elements as we see fit. HTML elements such as <body>, <p>, <h1>, and others can be given properties.

2.3.3. JavaScript Language

Another prominent programming language is JavaScript. To bring value to the process of developing a valuable and high-quality website. Whether for E-Commerce, a Web database, or E-Learning, these tasks may not operate correctly if only scripting languages like PHP, ASP, JSP, or others are used. Statements in JavaScript must be written in conjunction with HTML. They can be written before or after the <Body> statement, or they can be inserted between the <Head> and <Head> statements.

2.3.4. Anto.Io

Anto is a communication tool. It is similar to a channel for communication between devices on the Internet,

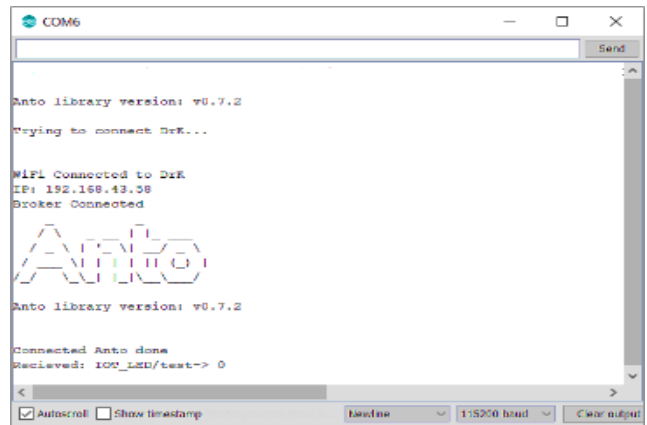


Fig. 10 Anto platform

such as when wishing to use the mobile phone to control a microcontroller board over the Internet. Our systems now support HTTP, HTTPS, MQTT, MQTTS, and Websocket communication. This saves team time in server installation and setup, as well as system maintenance.

2.3.5. Firebase

Google Firebase is a platform for building mobile and online applications. Envolv offers an API that allows developers to integrate online chat capabilities into their websites.

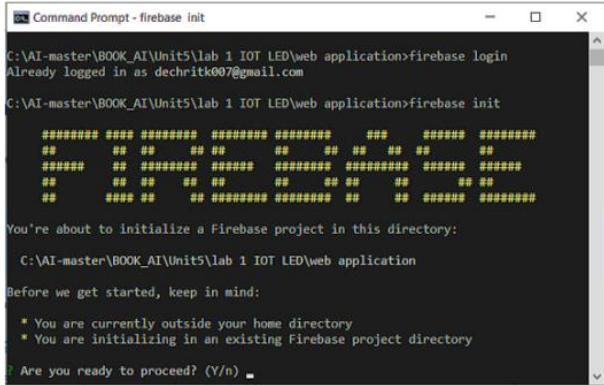


Fig. 11 Firebase platform

3. Experimental Results

A pneumatic actuator, a typical pneumatic servo system, is the subject of simulink. Experimentation and theoretical analysis are utilized to obtain the nonlinear model, and then the system identifies the model of this system used in the simulation. To build a control algorithm, the model's parameters must be identified. The stages for finding dynamic models of the pneumatic system include creating an experiment, selecting a model structure, selecting a fit criterion, and devising a procedure to evaluate the chosen model. The Simulink model is shown in Figure 12.

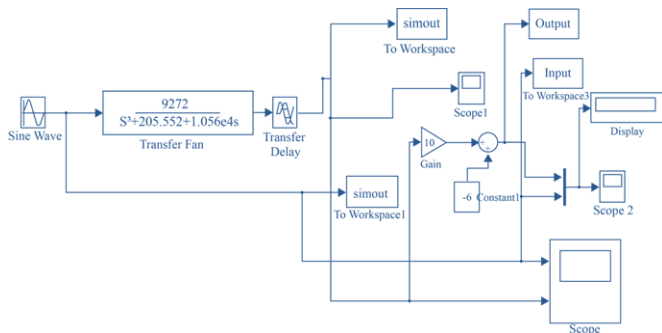


Fig. 12 Pneumatic and closed loop control

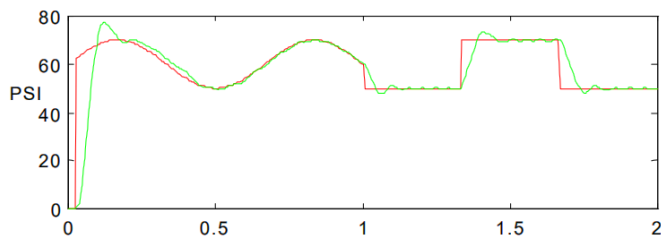


Fig. 13 PID Controller

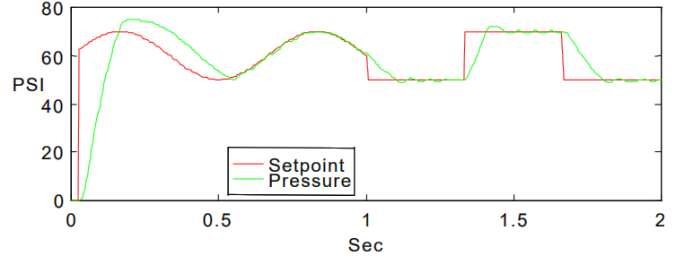


Fig. 14 PID and Feedforward Controller



Fig. 15 Vending machine processing



Fig. 16 A bowl of banana leaves and a carton of paper

4. Conclusion

The use of a conventional PID controller to regulate a class of pneumatic Proportional Modulator relay valves was examined. The plant was designed using a Simulink model based on an empirically produced relay valve model. The PID scheme was then created by adding a nonlinear mechanism and servo valve to the existing PID controller. It was demonstrated that the new control system boosted the system's bandwidth and improved the system's step and command following response. Furthermore, it was shown that adding the PID controller significantly improved the system's efficiency.

Acknowledgements

The authors wish to express their gratitude to the Valaya Alongkorn Rajabhat University in Pathumthani, Thailand.

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