IMPLEMENTATION OF AUTOMATION CONTROLLER USING ELECTRO-PNEUMATIC & PLC FOR FOOD PROCESSING

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ABSTRACT

This project describes a design and Implementation of Automation Controller using Electro pneumatic and PLC for food processing. The proposed model system is designed based of the usage of pneumatic, electro pneumatic and Programmable Logic Controller (PLC). This project is focus to small medium industry (SMI). SMI is defined as manufacturing companies or companies providing manufacturing related services with annual sales turnover not exceeding RM25million and with full-time employees not exceeding 150. The aim of this project is automating the processing food in the industry that still using manual system. It because many industry nowadays using automation machine in processing their production. Automation machine can gives more advantages to the industry such as it can improve quality and accuracy of the product, increase productivity and also tremendous amounts of power and energy which humans do not possess will be decrease by using automatic machines like electro-pneumatic and PLC. The electro pneumatic and PLC design will be proposed to that process in prototype model. This system can be applied in industry factories that are developed to automatic system.

ABSTRAK

Projek ini adalah bertujuan untuk mereka sebuah aplikasi untuk mengautomatikkan mesin memproses makanan.Projek ini menggunakan asas pneumatik,elektropneumatik dan PLC sebagai perantara.Projek ini adalah lebih tertumpu kepada industri makanan kecil dan sederhana (SMI).Industri sederhana ringan ini didefinasikan sebagai syarikat pembekal atau syarikat yang menyediakan perkhidmatan yang mendapat pulangan tahunan atau syarikat yang menyediakan perkhidmatan pekerja sepenuh masa yang tidak melebihi RM25 juta dan menyediakan pekerja sepenuh masa yang tidak melebihi 150 orang.Matlamat bagi projek ini adalah untuk mengautomatikkan mesin pemprosesan makanan yang masih dijalankan secara manual di sesetengah industri pemprosesan makanan.Ini kerana kebanyakan industri sekarang ini menggunakan mesin automatik dalam perusahaan mereka,.Mesin automatik memberi banyak kelebihan kepada industri kerana ia boleh membaiki kualiti dan ketepatan sesuatu produk, meningkatan produktiviti dan mengurangkan tenaga manusia dengan menggunakan elektro-pneumatik dan PLC.Sistem rekaan menggunakan elektropneumatik dan PLC yang dihasilkan ini adalah dalam bentuk prototaip.Sistem ini akan diaplikasikan di mana-mana kilang industri yang ingin mengautomatikkan system mereka.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The transformation of the manufacturing industry into automation sector with high value-added, capital intensive, high technology as well skill and knowledge structure will increase the efficiency and productivity of Malaysian industries especially to small medium industry (SMI). Small and medium industry in the manufacturing, manufacturing related services and agro-based industries are industry with full-time employees not exceeding 150 or with annual sales turnover not exceeding RM25 million.

1.1.1 Automation and the advantages

Why automate? Let looks at the story from Fortune magazine entitled, "Manufacturing the Right Way." A small part of this article, quoted here, refers to the Caterpillar factory in East Peoria, Illnois, and its factory redesign. The story describes the presence of old technology side-by-side with new, automated technology.

[The Caterpillar plant]..turns out 120 types of transmission for the whole catalogue of Caterpillar machines. In the area where transmission cases are prepared for assembly, a along line of 35 machine tools, each requiring its own operator,streches down one side of the aisle. On the other side are four (of an

eventual 32) flexible cellular systems. Both the same work of milling, drilling, boring, tapping, debarring and reambling the crude steel from the foundry.

Because the old machines can handle only one kind of case at a time, the area around them is jammed with bins of cases waiting to go through in batches. When a batch is finished, the operator spends anywhere from four hours to two days setting up the next batch. Once he is ready, he might need two or three tries to get the tool running right. With adjustments being made at 35 stations, many $1000 cases end up in the scrap heap before the next batch runs through smoothly.

Automation will help a manufacturing facility to:

1. Gain complete control of the manufacturing process.
2. Achieve consistency in manufacturing.
3. improve quality and accuracy
4. work in difficult or hazardous environments
5. Increase productivity.

The pie chart in **figure 1.1 [1]** below shows to us about the increasing of automation between year 1996 and 2000.

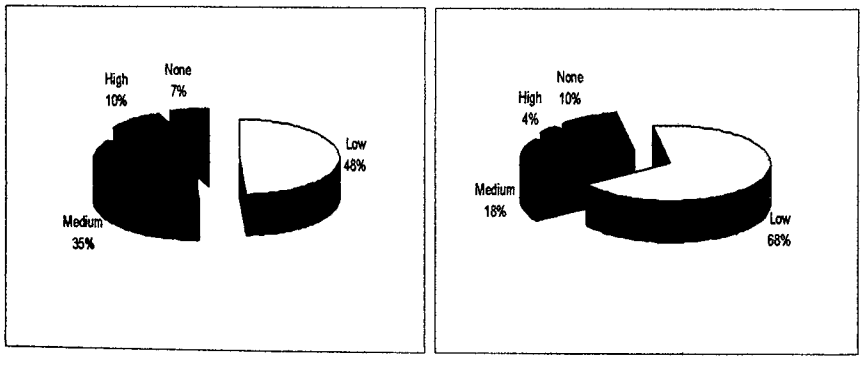


Figure 1.1: Level of automation

High level automation means more than 70% to full automation
Medium level automation means indicates to 40-70% automation

Low level of automation means less than 40% automation

The proportion of companies with high level of automation more than doubled from 3.5% in 1996 to 9.6% in 2000.Companies with medium level automation rose to 34.5% in 2000 in from 18.2% in 1996.Consequently, the proportion of companies that indicated low level automation was reduced by 19% to 49%.About 7% is still without automation as compared to 10% in 1996.Overall, the extend of automation has increased.

The graph in **figure 1.2 [1]** below tells us about the pattern of automation by company size.

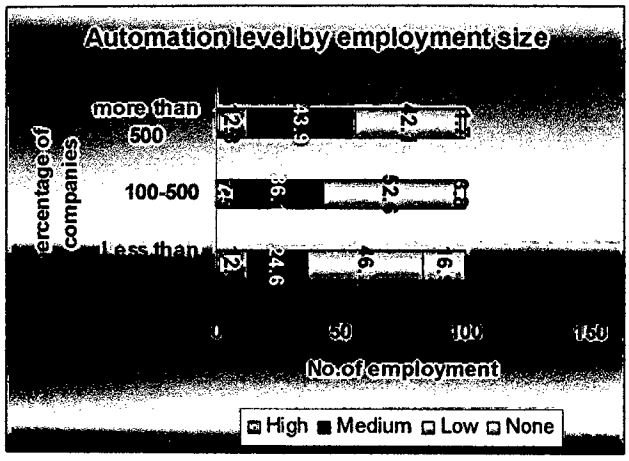


Figure 1.2: Pattern automation by company size

The pattern of automation by company size shows that larger companies are inclined to have greater extent of automation. On other hand, small and medium size companies recorded lower level of automation. A total 56.2% of large companies (more than 500 employees) have medium to high level automation as compared to 36.9% in small companies(less than 100 employee).About 17% of small companies have not implemented any automation(1996:28%).

1.1.2 Pneumatic and Electro-pneumatic

Electro pneumatics is used in many areas of industrial automation. Production, assembly and packaging systems worldwide are driven by electro pneumatic controls. Electro pneumatic controls can combine the best features of electronic and pneumatic controls; such system can consist of pneumatically actuated valves, electrical/electronic controllers, sensors and control systems, plus electro pneumatic positioners or converters.

In contrast to a purely pneumatic control system, electro pneumatic controllers are not shown in any single overall circuit diagram, but in two separate circuit diagrams-one for the electrical part and one for the pneumatic part. For the reason, signal flow is not immediately clear from the arrangement of the components in the overall circuit diagram.

Electro pneumatic controllers have the following advantages over pneumatic control systems:

- Higher reliability (fewer moving parts subject to wear)
- Lower planning and commissioning effort, particularly for complex controls.
- Lower installation effort, particularly when modern components such as valve terminals are used.
- Simpler exchange of information between several controllers

1.1.3 Programmable Logic Controller (PLC)

The question, "Why use a PLC?"Really should rephrase to, "Why automate?" Programmable logic controller (PLCs) is used in every aspect of industry to expand and enhance production. Where older automated systems would use hundreds or thousands of relays, a single PLC can be programmed as a replacement. PLCs have been gaining popularity on the factory floor and will probably remain predominant

for some time to come. Most of this is because of the advantages they offer includes:-

- Cost effective for controlling complex systems.
- Flexible and can be reapplied to control other systems quickly and easily.
- Computational abilities allow more sophisticated control.
- Trouble shooting aids make programming easier and reduce downtime.
- Reliable components make these likely to operate for years before failure.

The S7-300 is the universal PLC for a wide range of applications in automation engineering - with the emphasis on production engineering. Its modular construction without fans, simple implementation of distributed structures and user friendly orientation make the S7-300 an economical and practical solution for a wide range of automation functions. The outstanding features of the S7-300 include:

- high processing speeds for short cycle times
- powerful instruction set for complex functions
- compact design for use in confined spaces
- 100% maintenance free

1.2 Overview of the implementation of automation controller using electro pneumatic and PLC

Nowadays, many industries using automation machine in processing their production. It because using automatic machines to control processes is we can harness tremendous amounts of power and energy which humans do not possess. Electro pneumatic is successfully used in many areas of industrial automation. Production, assembly and packaging systems worldwide are driven by electro pneumatic control systems.

This implementation of automation controller is divided into three parts, first, implementation by using pneumatic and electro pneumatic control system, in which relays are used for signal processing. Second, by using programmable logic controller-PLC (SIEMENS) as signal processing for electro pneumatic control system and third, make a comparison between part one and two.

For the part 1,in a pneumatic control, pneumatic components are used, that is, variable types of valves,sequencers,air barriers, etc.In an electro pneumatic control, the signal control section is made up of an electrical components, for example with electrical input buttons, proximity switches or relays. Signal processing is implemented by means of suitable wiring of relay coils and contacts.

For the part 2, the programmable microprocessor system of the PLC undertakes all signal processing part of an electro pneumatic controller. Lastly, the part is describing about the comparison between part 1 and part 2.

1.2.1 Problem Statement

Fish crispy is a snack made from fish, which is popular among Malaysians people. This product is produced by small food industry which still using manual system to process it. From this project, it will give more benefits to this industry because it upgrades the manual system in their production to the automatic system. From the automation we can improve the productivity of processing product. It because manual system gives more disadvantages such as dispensing ingredients is not similar for each process, the processing of manual system is slow because human take a longer time to finish one process to another process and also industry need more employees to process the product.

1.2.2 Objective

The main objective in this project is to implement automation controller in order to upgrade the technology for processing food industry that still using fully manual processing system. This is can achieve by using:

- Pneumatic and electro pneumatic
- Electro pneumatic controlled by PLC(SIEMENS)

After implement these entire controller to the design, I will make comparison which the controller is suitable and has more advantages to implement it to the selected food processing.

1.2.3 Scope

- This project is focus on the basic and electro pneumatic and PLC(Siemens)
- All the components used is from pneumatic workstation in lab.
- This project is not real application and it's just a model in education type

1.3 Thesis outline

Chapter 1 explains about the background of automation controller that has been used in this project. It briefs about the usage of electro pneumatic and programmable logic controller (PLC) also their advantages. This chapter also includes the overview of this project including the problem statement, objectives and scope.

Chapter 2 explains about the literature review which includes the sources that has been referred for the entire of this project. The sources that have been used are books and internets.

Chapter 3 focuses the methodologies of implementation of automation controller using electro-pneumatic and PLC for food processing. It gives the brief review of all the methods includes: by using electro-pneumatic with relay or PLC as signal processing.

Chapter 4 discusses all the results of this project obtained and the limitation of this project.

Chapter 5 discusses the conclusion of development this project and it also includes the problem and recommendations for the future modification.

CHAPTER 2

LITERATURE REVIEW & RESEARCH METHODOLOGY

2.1 INTRODUCTION

This chapter describes about the literature review and research methodology of this project.

2.2 LITERATURE REVIEW

2.2.1 Fundamentals of pneumatic control technology. [2]

There are certain automation systems that allow for human substitution when performing a certain task in a manufacturing system. System that can perform small tasks, calculation and make decisions are referred to as automation systems. Automation systems depend on the type of technology being used. Pneumatic is one of automation systems that made by using components which uses compressed air.

2.2.2 The fundamental of electro-pneumatic[3]

Electro-pneumatic is one of the automation systems that used in many areas of industrial automation. Production, assembly and packaging systems worldwide are driven by electro pneumatic controls.

2.2.3 Survey on Small Medium Industry (SME) factory

i) Address of SME factory

Keropok Kering

Na Nazmi

2N Pusat Video Geliga, Kg . Geliga,

Kuala Kemaman , 24000 Kemaman

Terengganu Darul Iman

ii) The process of "keropok kering"

The **figure 2.1** and **table 2.2** below shows the process of "keropok kering".

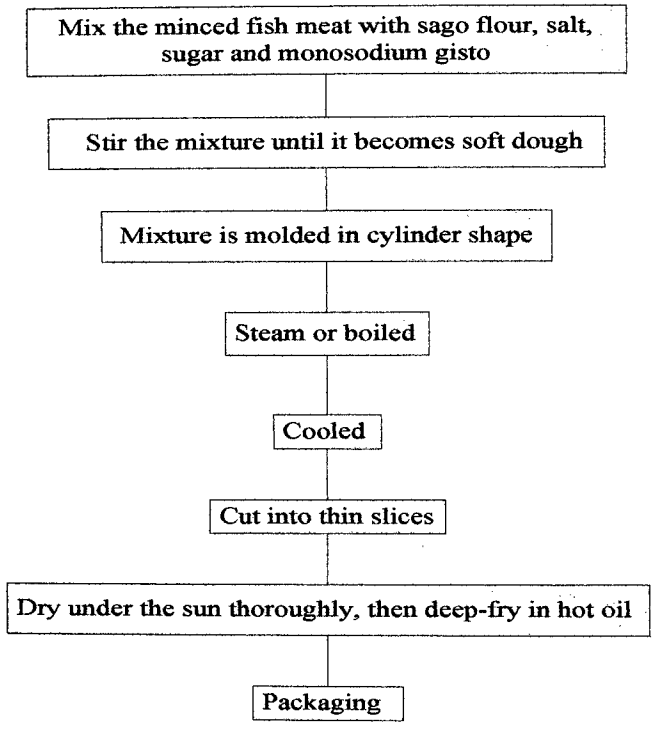
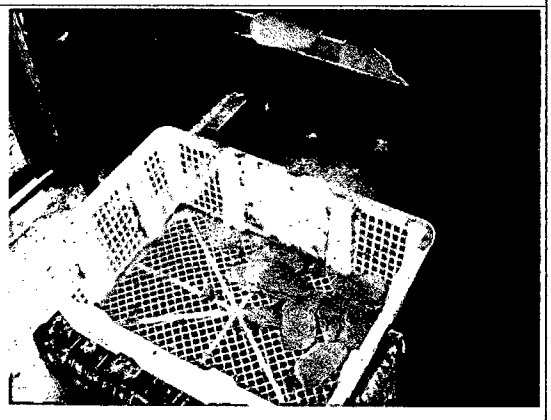


Figure 2.1: The process of "keropok kering"

Process	Picture
a) Mixture ingredients process	
b) Stir the mixture process	
c) Mixture is molded into cylinder shape	

d) Steam	
e) Cooling/drying	
f) Cutting process	

g) Drying	
h) Packaging	

Table 2.2: The process of "keropok kering"

2.3 METHODOLOGY

Figure 2.3 below shows the process of method that has been used in this project.

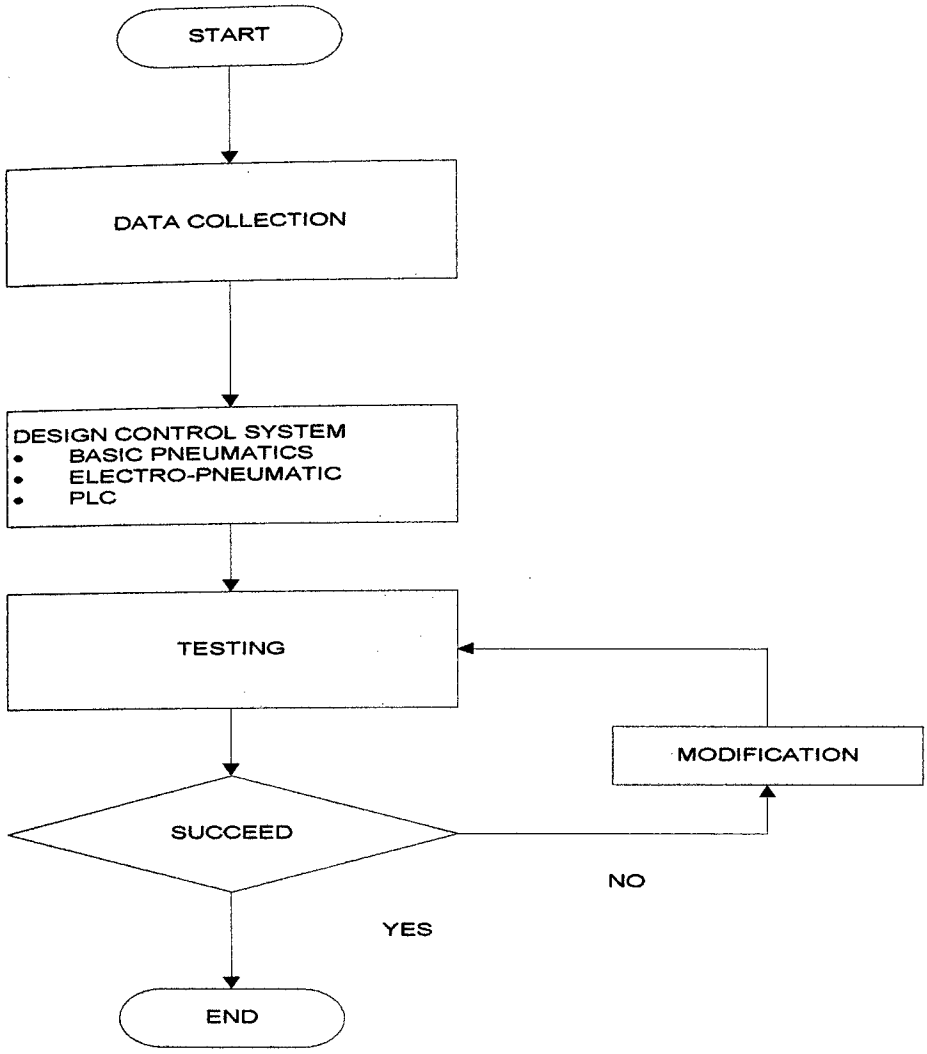


Figure 2.3: Flow chart of methodology

a) Data Collection

To succeed this project, the data has been taken from the visiting SMI (Small Medium Industry). The SMI that has been selected is "keropok keping" factory. This factory is still using manual system in producing their product. So, the aim of this project is to automate their system using the basic pneumatic, electro pneumatic and

PLC.After visiting this factory, two processing has been chosen for this project which is the packaging keropok keping and the bottling sauce process.

b) Design control system

In designing the control system of this project, three control system has been used which are by using basic pneumatic, electro pneumatic and programmable logic controller.

c) Testing and modification

After designing the control system, the design will test at the workstation in the lab. If the design not success, the modification will be taken.

CHAPTER 3

HARDWARE AND SOFTWARE

3.1 INTRODUCTION

This chapter focused on the hardware and software for the implementation of automation controller using electro pneumatic and programmable logic controller-PLC (SIEMENS).For the part 1, the project is focused on implementation automation controller by using pneumatic and electro pneumatic control system, in which relays are used for signal processing. **Figure 3.1** shows the relay as a signal processing.

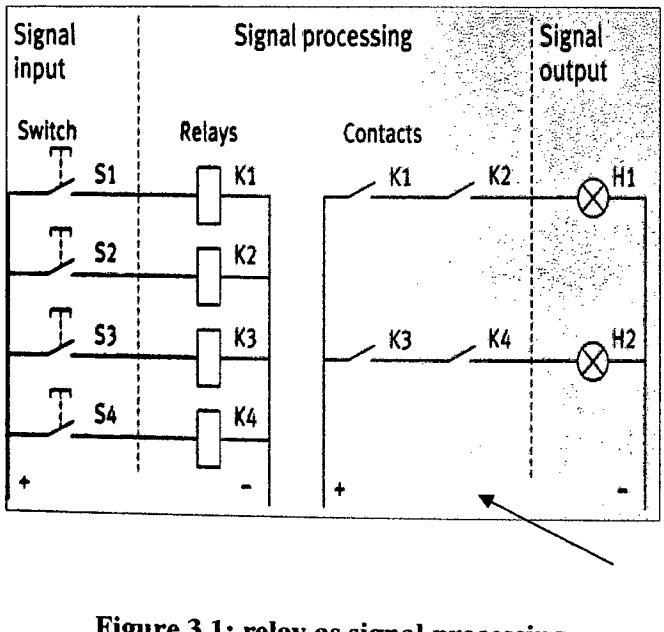


Figure 3.1: relay as signal processing