UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DESIGN IMPROVEMENTS ON SMALL SCALE PRODUCTION SYSTEM

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotics and Automation) (Hons.)

by

JOSEPH RANGGA ANAK LIUM

B050910209

900107-13-5487

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics and Automation) (Hons.). The member of the supervisory is as follow:

………………………………

(Project Supervisor)

ABSTRAK

Projek Sarjana Muda ini adalah mengenai naiktaraf projek barisan pengeluaran berskala makmal. Penambahbaikan ini adalah penting untuk memastikan sstem yang asal dapat mencapai tujuannya sebagai alat untuk membantu proses pembelajaran pelajar kejuruteraan di universiti ini. Sistem ini sesuai digunakan untuk mendedahkan para pelajar kepada mekanisme asas yang terdapat pada barisan pengeluaran dan juga sistem kawalannya. Cabaran utama dalam pembangunan projek ini adalah untuk memasang semula penyambungan wayar sistem tersebut kepada Pengawal logik boleh aturcara (PLC) yang baru kerana PLC yang digunakan sebelum ini telah digunakan untuk projek yang lain. Dengan penambahbaikan ini, projek ini dapat menyumbang dalam pembangunan akademik di universiti ini. Sistem asal yang sedia ada mempunyai beberapa kelemahan mekanikal yang boleh menjejaskan operasi sistem ini, jadi beberapa penambahbaikan adalah perlu bagi memastikan sistem ini dapat beroperasi seperti yang dirancang. Keseluruhan sistem ini adalah berdasarkan barisan pengeluaran seperti yang terdapat di industri. Penggunaan PLC untuk mengawal sistem pneumatik ada digunakan di sesetengah industri. Automation Studio 5.0 digunakan untuk membuat simulasi bagi pengaturcaraan PLC. Pengaturcaraan dalam bentuk gambarajah tangga disimulasikan menggunakan Automation Studio 5.0 bagi memastikan pengaturcaraan tersebut boleh berfungsi. Penggunaan PLC menjadikan sistem ini sebagai sebuah sistem yang fleksibel serta boleh dinaiktaraf lagi. Oleh itu, projek ini mempunyai potensi untuk dipertingkatkan lagi untuk menjadi sistem pembuatan yang lebih kompleks.

ABSTRACT

This Final Year Project is about the improvement of small scale production line. Improvement of the existing project is needed so that the system serves its purpose and functionality as a learning aid for engineering students in this university. This system is suitable as a learning aid to expose students about the basic mechanism in a production line and its control system. The main challenge in developing this project is to rewiring the system with a new Programmable Logic Controller (PLC) as the previous PLC for this system has been used for other project. With the new improvements, this project can contribute to the learning process of students in our university. The existing system has several mechanical flaws that could compromise its operation, therefore some improvements is required to ensure that this system can operate smoothly as it should be. The whole system is based on a real production line that can be found in industries. The application of PLC to control the pneumatic system has been used in some industries. Simulation for the PLC programming is done by using Automation Studio 5.0. Programming in forms of ladder diagram is simulate using the software to make sure that the programming is working. The improved programming was done to compensate with the hardware specifications. The usage of PLC makes the control system flexible and available for further improvements. Therefore, this project has potential to be further improved into a more complex manufacturing system.

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LIST OF ABBREVIATION, SYMBOLS AND NOMENCLATURE

FYP	-	Final Year Project
PLC	-	Programmable Logic Controller

CHAPTER 1
INTRODUCTION

1.1 Background

Production line plays a crucial part in a manufacturing industry. Production line is where the assembly and processing of products took place, thus the rate of product produce are depends on the efficiency of the production line. In the past, almost every part of the production line was operated by the operators. Though the numbers of these workers can be increased but the efficiency is still low. This may be due to human error and needs. Nowadays, most large scale manufacturings make use of automated production line that was run by machine. These automated systems are far more efficient than human workers, the system can runs continuously for a long period of time, so this will decreased the production lead time. Downtime is lessened because of fewer breakdowns than on a manual production line. Robots are programmed to do several tasks along the production line, shifting the task depending on what's required at the moment. Some workers are still needed, especially technicians, to do the maintenance for the system. The cost to operate this system is relatively cheaper than the cost for workers salary. Since the output rate for automated production line is much higher than man-powered production line, therefore an automated production line in a large scale is more cost-effective. The material waste of an automated production line is minimized; this is because the system operation is efficient. That is, it can operate at a minimal material usage without any fault on the work piece. As the technology keeps improving rapidly, an automated production line will become more efficient and more flexible.

1.2 Problem Statement

Engineering students need technical experience as part of their education. As in engineering fields, experience is more precious than theoretical knowledge. In industries, automated production line is runs by a complicated system. This kind of system requires a highly experience engineer for its maintenance and service. Therefore, a freshly graduated engineer may face a problem to work with such a system. This is because the theoretical knowledge about this system is different from the hands-on experience on the system itself. To overcome this situation a technical lesson about the automated production line is needed. The lesson should expose students to a small scale automated production line that can be easily understood. Thus, this small scale production line fits that purpose. This project can help students to learn about the basic in an automated production line. Especially the basic about the Programmable Logic Controller (PLC) that were use to control the pneumatic system. The operational features of this system can be analyzed by students to expose them to a maintenance task of a production line.

1.3 Objectives

The objectives of this project are;

(i) To improve the small scale production system.

(ii) To provide a classroom scale production system that can be learning aid for engineering students.

(iii) To apply control system and pneumatic knowledge in a real automated system.

1.4 Scope of Study

This study focuses on the automated production line that uses pneumatic actuator and is control with a Programmable Logic Controllers (PLC). Pneumatic system is widely use in industries because the system can be easily designed using standard cylinders and other components. This project uses PLC because it can be reprogrammed and it can be tested easily in the lab. Electric motor is also used in this project to run the conveyor. Most mechanical system in industries uses electric motors due to its low-cost and efficient.

1.5 Summary

This chapter is an introduction chapter about this project. This project is a small scale of a production line that is usually found in industries. This system operates using a pneumatic actuator and electric motor that are controlled using a Programmable Logic Controllers (PLC). This system can be operates in the lab and can be used by students in their study about pneumatic and control system.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Automated production lines are usually used for high production of parts which require multiple processing operations. The production line itself consists of many dispersed workstations within the plant, that are connected by a mechanized work transport system that transfer parts from one workstation to another in a pre-defined production sequence. The sequence start with unprocessed parts enters the automated production line and undergoes a system of automated processing at various workstations along the fixed production line. A mechanized transport system was employ to transport the parts so it is passed from workstation to workstation. The complete processed part was ejected out of the automated production line after the last process occurs to the part at the final workstation in the system.

2.2 Production Line

This section will elaborate on the history of the production line and its recent improvement from the past ten years. The details included in this section are taken from journals and books.

2.2.1 History

The first mass production line was applied by Ford Motor around the year 1908 and 1915 and this sped up the manufacturing process dramatically. The company used the production line approach to mass produce the Model T's magneto that is a part which generated electricity for the ignition system. Before this approach was applied, each worker has to assemble each magneto from start to finish. After this approach was applied, each worker performed a single task as the unit traveled past the station on a conveyor belt. This approach was extended to almost every phase of the manufacturing process because it dramatically saves time and money. The success of this production line has reduced the price of car that it is affordable for an average person. The production line system advance rapidly during the Industrial Revolution as product can be manufactured in massive scale with lower capital cost Thus, the production line has made many products affordable.

The concept of lean production was pioneered by Eiji Toyoda and Taichi Ohno at Toyota Motor Co. in Japan after the Second World War. This concept combines elements of both craft and mass production while avoiding the high costs and rigidity of each system. Other Japanese companies and industries copied their manufacturing system and this contributes to the rise of Japanese industries. The company is more flexible because lean manufacturing uses more input from suppliers and employs teams of multi-skilled workers at every levels of the organization. Today the concept of lean manufacturing in mass production line is still improving as time changes to achieve higher efficiency.

2.2.2 Improvements

In the past ten years, most production lines in multinational industries is automated. Automated assembly lines consist entirely of machines and are being run by machines. Some assembly lines are completely mechanized and consist almost entirely of automatic, self-regulating equipment. This kind of line can be found in continuous-process industries as petroleum refining and chemical manufacture and in many modern automobile-engine plants.

In 2003, there was a development on the 2-stage design method for Assembly Lines System and presents a management design approach to the system. The strategic management of cost versuss lead-time is discussed by introducing the production matrix table. The purpose of this management design approach is to provide a positioning strategy for Assembly Lines System management. This is to maximize profit by tweaking the assembly lines management. (Yamada & Matsui, 2003)

Managing an Automated Production Lines has many difficulties. This becomes more complex if a fault or problems occur in the lines. By 2004, an Artificial Intelligence Planning approach was proposed to make this task less difficult. This technique was proven to bring more quality to reconfiguration procedures. This is because it can consider various types of knowledge such as availability of plant components, constraints between them and others.(Ghariani & Lille, 2004)

In mixed production lines, different product types are simultaneously manufactured by processing small batches. In 2005, a study was conducted to develop a simulation models for a mixed model production line. This study was done in a refrigerator company. Arena simulation software was used to model the production line in order to identify bottlenecks and evaluate vacuum station. AGV performance, cycle times, and production data was also determined by the software analysis. (“Proceedings of the 2005 Winter Simulation Conference M. E. Kuhl, N. M. Steiger, F. B. Armstrong, and J. A. Joines, eds.,” 2005)

Production line in auto motor factory has multi-product and variable lots. This is to cope with competitive market and large increase in product demand. Thus in 2006, an optimal control system for the production line was proposed. The system was design at the outset of rapid changes in modular structure so that it can adjust production capacity and functionality. This is to cope with sudden changes. The system monitoring and data analysis was achieved. This system was tested in SAAE Co., Ltd. and shows it effectiveness and efficiency that increase the adaptability of multi-products and varied lots Auto motor production. (Li, Xie, Cui, & Principle, 2006)

In 2007 a research about using a wire driving robot manipulator in production line was conducted. This robot was different than conventional industrial robot manipulator as its driving mechanism was a tensioned wire. This make this robot manipulator structure becomes compact and simple, so the whole weight is relatively less. Thus, the output power to do work and the displacement accuracy are relatively increased. The manufacturing cost is also less, the output power and work efficiency is increased relatively.(Yuan, Zhang, Tao, Wan, & Tang, 2007)

Improvement of mechanical production line was continued in 2008 by a simulation and optimization analysis. This method of simulation can identify bottlenecks factors of production systems, and based on this result the production line is reconstructed to increase the capacity of products. This research was conducted in an industrial case study. This research was carried out by developing simulation as a desktop resource named NEU-Simulation. (Zhiwei & Yongxian, 2008)

Production line architecture based on Single Source Product Data was used in 2009 for digital composite component production line. This is to solve the integration problem of multi-systems for the production line. This designed architecture can set up a production line that is better in term of integrality, validity and uniqueness of product data. Therefore, it provides competitiveness, efficiency increase, cost saving, better production coordination and customer services improvement.(Cong, Younus, Saleem, & Fan, 2009)

Production line was continued to be improve in 2010 by means of work study technology. The machining process was analyzed. Then, the bottleneck processes were selected through measurement of standard time and the existing processes were adjusted. Then any idea of operational design improvement and eliminating waste in operation can be proposed. This is to optimize the production process. This method could enhance the working efficiency and increase the production line balance rate. (Lixin, Yunqi, & Danting, 2010)

Programmable Logical Controller (PLC) was used in the research and design of the flexible production line control system in the year 2011. To replace the traditional mode of transport of modern construction, PLC based on field bus technology and computer monitoring system for effective control of the conveyor belt was proposed. The conveyor belt was in a continuous, pollution-free, efficient and safe operating condition. The advantage of this system is its control system can be understood easily.(H. Zhang & Gao, 2011)

The usage of PLC in production line continues in 2012. PLC was used in system architecture and control procedures in a beer filling production line. The PLC was used to control the motors and solenoid valves. To improve the system efficiency, timely adjustments are made based on different operation. Appropriate controls treatments are made to any system faults that were are diagnosed. This production line level of automation was increased and its efficiency was improved with the PLC application. (T. Zhang, Dong, & Yuan, 2012)

2.3 Controllers in Production Line

Controllers control the sequence of process that is done in the production line. Controller such as PLC is used to maintain some variable constant, or follow preprogrammed change. Based on the research conducted by Shuping & Jianjun (2010), PLC was used to controlled pneumatic cylinder because PLC is reliable and has stable performances. It reduces working intensity and reduces hidden safety troubles. The author stated that PLC is very suitable for the automatic control of machines with loading and unloading gear. PLC has simpler hardware, higher reliability, is easier for programming. The expansion of its application can simplify the designed mechanism. Thus this will intelligentize the control of the machine compared to relay control unit. The author also stated that pneumatic system controlled by PLC has many advantages. The coordination of operational motions can be done by adjusting relative pneumatic valves. Therefore it is used in linear motion automatic feeding machinery.

According to Homayouni, Sai Hong, & Ismail, 2009 a complex production systems can produce more than one part type. In this systems, production rate and priority of production for each part type is determined by production controllers. In their research paper, they develop genetic fuzzy logic control (GFLC) methodology that was used to develop two production controller architectures namely ‘‘genetic distributed fuzzy” (GDF), and ‘‘genetic supervisory fuzzy” (GSF). These kinds of controllers have been used in single-part-type production systems. The purpose of establishing control systems for production system is to reduce the long term average cost of manufacturing system; this is to be competitive on price. Fuzzy logic controllers (FLCs) have been implemented in production systems to improve the performance of different control architectures since 1990s. The result of their research shows that GSF and GDF controllers have been used for complex production systems can produce more than one part type and may use the reentrants in the process flow of the products.

2.4 Programmable Logic Controller in Production Line

Programmable logic controllers (PLC) is extensively used in industrial automation and process control systems. This controller usually used to control machinery or factory assembly lines. PLCs have multiple inputs and outputs. It is able to operate under high temperature ranges and have insulator to electrical noise. PLC can resist vibration and impact. Based on study conducted by Hong, 2011, PLC has high reliability, strong anti-interference, flexible combination, simple programming and easy maintenance. In the study, Siemens PLC of SIMATIC S7-200 CPU266 was used to control hydraulic system. This system was design for work piece turnover, a device that clamps the workpiece and then turns them over 180°. The result shows the system improves the system stability, simplify control circuit, reduce the failure rate and reduce the volume of control device.

PLC is also used in flexible manufacturing system (FMS). FMS can be described by logical and sequential functions under the support of a programmable logic controller. According to Hu, Starr, & Leung, 1999, operational problems associated with control processes are often confusing to maintenance personnel. So a study was conducted to develop automatic diagnosis techniques. PLC's capability in fault detection is limited in sophisticated FMS because of its inflexible programming system. It has no inherent architecture for fault diagnosis other than of its own functions and hardware. FMS operation is a complex process with multiple operating conditions. Several actuators may act simultaneously at a given time. The next action and actions of other components will be affected when one action is out of synchronization. The purpose of their study was to provide effective methods for maintenance personnel to identify, classify, and correct operational faults occurring in production line. The proposed logical analysis model describes the spread of the effects of faults through a machine system and its components. The authors concluded that the logical analysis model and sequential analysis model have been successfully used in an existing automatic analysis system.