DESIGN OF CONTROL AND INTEGRATION STRATEGY FOR MULTIPLE HANDLING SYSTEM USING PROGRAMMABLE LOGIC CONTROLLER

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

by

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APPROVAL

This report is submitted to the faculty of Manufacturing Engineering of Universityiteknikal Malaysia Melaka as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics & Automation) (Hons.).

The members of the supervisory committee are as follow:

…….

(Dr. Muhamad Arfauz Bin A Rahman)

ABSTRAK

Tujuan projek ini dijalankan adalah untuk mereka strategi kawalan dan integrasi untuk sistem pengendalian barangan pelbagai dengan menggunakan pengawal logik. Pertama sekali, sistem untuk strategi alat kawalan dan pendekatan tentang pengendalian barangan pelbagai telah dikaji. Kajian termasuk pelbagai aspek yang berkaitan dengan projek ini seperti pertambahan komponen. Sistem pengendalian barangan di dalam projek ini melibatkan dua sistem pengantar dan silinder satu paksi. Beberapa komponen digunakan untuk membantu sistem dalam strategi bersepadu telah ditambah. Strategi bersepadu untuk sistem ini dibangunkan dengan menggunakan alat pengawal logik yang boleh diprogramkan. Alat pengawal untuk sistem pengendalian barangan ini diprogramkan dengan menggunakan pirisian program CX. Bahasa program yang diguna pakai untuk memprogramkan program kawalan logic ialah gambar rajah tetangga. Strategi penyepaduan untuk sistem pengendalian barangan ini diuji dengan ujian kelajuan mengendali barangan dan ujian kebolehkerjaan alat kawalan bersama komponen. Ujian-ujian ini dijalankan bersama dengan semua komponen untuk sistem dan hasil setiap ujian dicatatkan. Berdasarkan ujian yang dijalankan, sistem tersebut adalah berjaya.

ABSTRACT

The aim of this project is to design a control and integration strategy for multiple handling systems using programmable logic controllers. Firstly, the current control strategy and approach of integrating material handling systems were studied. The study included all aspects which were related to this project such as additional devices. The material handling systems in this project are two conveyors and one single axis slider. Some devices which help the systems in integration strategy were added. The integration strategy for those systems were developed using the programmable logic controller. The controller of the material handling systems was programmed using CX-Programmer software. The programming language used for programming the PLC was the ladder diagram. The integration strategy of the material handling systems was including the speed of the material handling systems and the workability of the controller with the attached devices. The test was successfully conducted with all system components and the result of every trial was recorded. From the test conducted, it shows that the system was a success.

DEDICATION

My beloved father, Mohsen Saleh

My appreciated mother, Wedad Habib

My adored brothers and sisters, Saleh, Khaled, Osamah, Aroub, Malek, Fares, Lamar and Anas

For giving me moral support, money, cooperation, encouragement and also understandings

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LIST OF ABBREVIAIONS

PLC	-	Programmable Logic Controller
MHS	-	Material Handling Systems
BHS	-	Baggage Handling Systems
MFC	-	Material Flow Controller
ISI	-	Institut systemtechnik innovationsforschung
CPU	-	Central Processing Unit
AC	-	Alternating Current
DC	-	Direct Current
ALU	-	Arithmetic and Logic Unit
MELSEC	-	Mitsubishi Electric Sequence Control
MELSOFT	-	Mitsubishi Electric Engineering Software
CPM	-	Compact Programming Manual
HMI	-	Human Machine Interface
SCU	-	Serial Control Unit
FDT/DTM	-	Field Device Tool/Device Type Manager
EMF	-	Electromotive Force
CP1E-N40DR-A	-	PLC Unit
CR30-15DN	-	Proximity Sensor
MY2J	-	Relay

LIST OF SYMBOLS

MHz	-	Mega Hertz
V	-	Volt
cm	-	Centimeter
ml	-	Milliliter
min	-	Minute

CHAPTER 1
INTRODUCTION

1.1 Background

Referring to Mikell P .Groover (2015) manufacturing system is defined as the system that has a set of equipment and human resources which their task is to execute processing and/or assembly operations on a beginning raw material, part or collection of parts. While referring to Peter Scallan (2003) manufacturing system is defined as the system that converts raw materials from one form to another which known as a product, earning a higher or added value in the process and then making wealth in the form of a revenue.

In general, manufacturing system is defined as the system that combines both the arrangement and implementation of all aspects involved in the manufacturing process. Manufacturing system includes receiving orders or designing products, producing, assembly, storing, and transportation. The manufacturing system as a wider definition includes everything contributes in manufacturing a product.

Manufacturing system might be categorized out into four main sections physical system, operation, information and humans (Garbie, 2014). The physical system involves all the physical aspects in a factory such as facilities, machines, tools, raw materials, material handling systems and the products too (Manufacturing system types, 2016). Every section completes the other section. Therefore, the existence of every section in an industry is important. For example, an industry has all the sections exclude the humans, so how the processes can be done. There are fully automated machines. How the product will be moved from station to station? Are there fully integrated systems. How the orders are received? The answer for the last question can prove that every single section in the manufacturing system

is important to complete the system. The material handling system is one of the sections involved in a manufacturing system.

Material handling system is the equipment which moves between stations or buildings inside an industry to perform a task. The equipment of the handling system can be manual, semi-automated or automated. Manual handling system which uses the employees' hands to carry or move an item or container to specific areas. Semi-automated handling system which uses both workers and automatic equipment. Semi-automated handling is most existing industries because the need of the human cannot be neglected for the tasks like loading/unloading and driving. While automated handling system is where the equipment is fully automated without the need of labor's hands.

Material handling systems are a variety of equipment used in manufacturing field to perform a specific task. The equipment of the material handling system can be classified as transport, identification and tracking, unitizing and storage equipment. Transport equipment refers to an equipment which moves a material from one location to another. Conveyor is a one example of a transport equipment. Conveyor is an equipment designed to move materials over a fixed path between specific points usually in large quantities or volumes. Another example of transport equipment is a slider. The slider is designed to move over a specific track to transfer materials from one path to another. Sliders usually carry a robot arm which can grip a material to transfer it to the following stations.

Nowadays the industries are growing up by developing their technologies. At the beginning the industries started with conventional or normal manufacturing technology. The way of manufacturing products was non-automated when industries arise. Most processes were carried out by humans. The integration between the manufacturing systems in the industries was not exist. So, as industries increased in numbers and the combat between them became stronger, the industries started focusing on improving their manufacturing technologies to be better than others. The improvement of manufacturing technologies helped the industries in optimizing productivity and minimizing cost. One of the manufacturing technologies that is contributing in development in manufacturing is the integration technology.

The integration of manufacturing systems in an industry is a technology which the industries started focusing on it to optimize their manufacturing level. The systems integration in the industries became an important element for development. The integration reduces the number of workers needed to handle a non-integrated equipment. So, as the systems are integrated the number of workers will reduce which will minimize the cost as well, thus the profit will increase. The integration is carried out using different types of controllers such as a microprocessor or programmable logic controller, but the type that is used here is programmable logic controller.

The programmable logic controller is an apparatus which is used to integrate the systems. An operating electronic apparatus is defined as the PLC, it has a programming memory for the interior storage of its commands to implement certain purposes such as logic, sequencing, and timing (Bagad, 2007). By programming the PLC as required the multiple handling systems can be integrated. The programming is done using an application software then it is transferred to the PLC through Ethernet cabling.

Therefore, to create an automated and integrated material handling system these multiple systems (conveyors and slider) should be integrated. The integration process is carried out by programming a PLC using CX-programmer software.

1.2 Problem Statement

As the manufacturing technologies in industries are developing, the need of using new manufacturing technologies in industries became important. Industries, which use old technologies are less productive and have delay in their manufacturing processes. So, this issue leads the industry to be late in submitting their products to their customers. Thus, the number of the customers of that old technology industry is decreasing. So, the use of new technologies in the industries becomes necessary to get customer satisfaction. One of the modern manufacturing systems controls is the integration. The integration of systems in an industry playing an important role in increasing productivity and minimizing cost. As an old technology, there is a material handling system which is not integrated. Therefore, the integration of the current material handling systems is required. The material handling systems are two conveyors and one slider. The two conveyors are working individually using

a direct current. By switching the button on the conveyor will work. While the slider currently is working using a PLC. Therefore, to create an integrated material handling system in a manufacturing environment, the three equipment should be integrated together, to call the system as an integrated manufacturing handling system. The integration of the three equipment should be done using a programmable logic controller. So, the equipment after integration will be working automatically without the need of switching to one after the other. By one switch the whole system will work instead of the current situation. The current situation can cause delays on the production line in industries. In addition, the delay of production can decrease the industry outcome which will lead to have a minimum income. Therefore, the integrated material handling system is needed.

1.3 Objectives

The main aim of this project is to design a control and integration strategy for different types of material handling system using programmable logic controllers to provide an executable material handling system for manufacturing environment. To achieve the aim, the following objectives are to be achieved:

i. To study the current control strategy and approach of integrating material handling systems.

ii. To design and develop the control and the integration strategy for the material handling systems using programmable logic controller.

iii. To test and analyze the workability of the controller with the integrated material handling system.

1.4 Scope

This project will focus on integrating the two types of material handling system, two conveyors and one slider to provide an executable material handling system for manufacturing environment. Currently, both types are working individually, without an

integration between them. The slider is connected to a programmable logic controller, while each conveyor is connected to an electric plug without the use of a controller. A limit switch is attached to the slider track which can limit the movement of the slider. The control strategy for the material handling system is conducted using programmable logic controller. The PLC is programmed using a software called CX-Programmer. The method of arranging the three equipment is based on the programming of the PLC. The way of programming the PLC is the way of how the system works. The integration strategy will be done using one programmable logic controller. There is already a PLC connected to the slider, so for the conveyors they can be connected to that PLC. The way of integrating the systems depends on programming the PLC. Additional devices may be added to the system such as proximity sensors and limit switches to perform special tasks. The method of programming the PLC is the method of running the system. The main point is to integrate the three equipment no matter how they are arranged or programmed. As long as the system can work, the programming method of the PLC is not limited to a specific process.

1.5 Significance of The Project

As the manufacturing technologies in most industries are developing from time to time the need of most modern technology in industries becomes important. Most industries always tend to use the latest technologies for manufacturing once the technology is discovered. This development helps the industries to become among the best industries around the world which implement most modern technologies for manufacturing. This can give a good reputation in the industry, which can help in increasing their customers. So, this project will benefit the industries to implement a modern technology that is integration of material handling systems using programmable logic controller. This project will benefit the manufacturing domain especially robotics and automation industries. The integration will ease to the industries their control processes and will decrease the need of workers as well will decrease the effort needed to play every system individually. By integration the systems of an industry will be automatically ran.

CHAPTER 2
LITERATURE REVIEW

2.1 Material Handling System

At present, material handling systems (MHS) running the goods in a continuous path plays a significant role in most factories (Klotz et al, 2013). Furthermore, in the total production of goods, material handling systems are a sensitive indicator. In manufacturing and distribution, the automation is developing, so the effect of material handling system will develop much in the future. According to an ideal manufacturing factory, material handling represents 25% of whole operators, 55% of the whole factory space, 87% of the manufacture period, and 15%-70% of a product fee. Therefore, strong desires on material handling are there, besides being effective, as well as possessing a huge output, they are recommended to remain sound of design faults, safe, flexible and extremely existing. A popular area of application that uses a material handling system is baggage handling systems (BHS) at airports. Over there, conveyor paths extend to very long distance, hundreds of kilometers, contain tens of thousands of conveyor parts and deliver more than nineteen thousands of baggage per hour. The demands of these systems are increasing due to the continuous globalization operation and the reality that many persons travel. However, according to AEA customer report in January-June 2012, these demands have not been totally accomplished. Based on that, 1.7 million travelers at European airports their flights delayed due to their delayed luggage. In baggage handling system BHS, particularly the accomplishment of complicated transport strategies is difficult and subjected to error because these strategies have to deal with weight balancing, substitutional tracks if there is a failure, various points of security check, etc. Moreover, transport can be accomplished by local strategies on the programmable logic controller level and by global strategies supplied by the material flow controller. As a summary, the right implementation of these transport strategies is sensitive, significant, and safe.

Through the simulation, the design failures of MHS can be found according to the test situations taken into account. Otherwise, the errors cannot be verified while they are absent. Therefore, the model checking gives a general means to show the adjustment of the system with consideration to its specification.

By designing and simulating the system various main performance indicators such as output, utilization and track length can be gained and examined during the facility planning phase (Seidel et al, 2012). In addition, the evaluation and comparison of moving and storage strategies can be achieved. As consequence of the facility planning phase practical definitions and requirement specifications for the material flow controller (MFC) along with the programmable logic controller (PLC) can be obtained.

For different control levels, the execution, examination and verification of control programs are executed individually. In present up-to-date material handling systems, there are different control levels of control components as shown in Figure 2.1 interacting with each other (Seidel et al, 2012). The lack of a common test bench leads to test the material flow controller (MFC) and programmable logic controller (PLC) programs individually. A test which combines equipment and control apparatuses can only be done on location and at a very late phase during the project duration. The outcomes of this method are conflicts between the planned behavior and the executed behavior. As result, the implementation of the system will be late due to programming faults lead to increase financial and prestige dangers for customer and contractor.

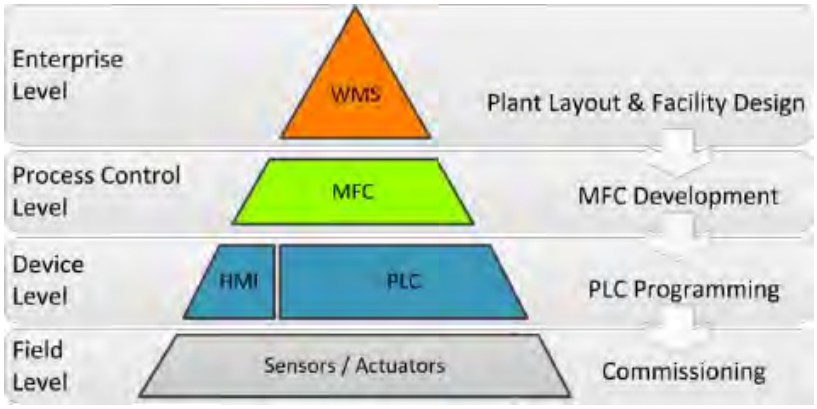

Figure 2.1: Control levels and corresponding project stages of material handling systems (Seidel et al, 2012).