FACULTY OF ELECTRICAL ENGINEERING

FINAL YEAR PROJECT REPORT

A RECONFIGURABLE LOGIC CONTROL METHOD FOR CIM SYSTEM

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"I hereby declare that I have read through this report entitle A Reconfigurable Logic Control Method for CIM System and found that it has comply the partial fulfilment for awarding the degree of Bachelor of Mechatronic Engineering"

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A Reconfigurable Logic Control Method for CIM System

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A report submitted in partial fulfilment of the requirements for the degree of Mechatronic Engineering

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DECLARATION

I declare that this report entitles A Reconfigurable Logic Control Method for CIM System is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : …..……

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Date : ……..……

To my beloved family

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ABSTRACT

This project is related to a reconfigurable logic control method for Computer Integrated Manufacturing (CIM). The CIM is developed for the implementation for automation and manufacturing platform. The main problem to reduce the errors leading defect in the product and it will lead to a highly expensive damage that need to be prevented by any necessary. Moreover, this application needed to maintain the quality of the product beside to reduce the time to operate the works. Therefore, the operation of this plant based on the sequence of the program that's being developed using PLC controller and also need to fulfil specification of the system. This process required model of the system that can be obtained from the PLC program that's being written in Ladder Diagram (LD), then the program will transform to Sequential Functional Chart (SFC) to understand the behaviour of the model using CX-programmer This main objective is to determine a control flow structure of a CIM system by using Grafcet/SFC with Petri Net and to verification checking of multiple properties using Petri net software. This experiment will carry out with Liveness, Safeness and Boundedness. For analysis technique, the reachability graph analysis that allow to simulate the analysis in real time process. Petri net software will be analyzed and made solution for the reconfigurable logic control for CIM Hence, this project can benefit from the good impact related to the manufacturing and automation industries.

ABSTRAK

Projek ini berkaitan dengan kaedah kawalan logik boleh konfigur untuk Computer Integrated Manufacturing (CIM). CIM dibangunkan bagi pelaksanaan untuk automasi dan platform pembuatan. Masalah utama untuk mengurangkan kesilapan kecacatan utama dalam produk dan ia akan membawa kepada kerosakan yang sangat mahal yang perlu dielakkan oleh mana-mana yang perlu. Selain itu, permohonan ini diperlukan untuk mengekalkan kualiti produk di sebelah untuk mengurangkan masa untuk mengendalikan kerja-kerja. Oleh itu, operasi ini berdasarkan urutan program yang yang sedang dibangunkan dengan menggunakan pengawal PLC dan juga perlu untuk memenuhi spesifikasi sistem. Proses ini model yang diperlukan sistem yang boleh diperolehi daripada program PLC yang yang sedang ditulis dalam Ladder Diagram (LD), maka program ini akan mengubah kepada Carta Fungsi Turutan (SFC) untuk memahami model yang menggunakan CX-programmer ini utama objektif adalah untuk mencari sesuatu struktur aliran kawalan sistem CIM dengan menggunakan Grafcet / SFC dengan Petri Net dan pengesahan sifat-sifat menggunakan perisian Petri net. Eksperimen ini akan mengesan sifat-sifat seperti liveness, Safeness dan Boundedness. Untuk teknik analisis, analisis perhubungan graf yang membolehkan untuk mensimulasikan analisis dalam proses masa sebenar. perisian Petri net akan dianalisis dan dibuat penyelesaian untuk kawalan logik boleh konfigur untuk CIM Oleh itu, projek ini boleh mendapat manfaat daripada kesan baik yang berkaitan dengan industri pembuatan dan automasi.

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LIST OF ABBREVIATION

ABBREVIATION	TITLE
CIM	Computer Integrated Manufacturing
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CAAP	Computer Aided Process Planning
CNC	Computer Numerical Control
DNC	Direct Numerical Control Machine
FMS	Flexible Manufacturing System
ASRS	Automated Storage and Retrieval System
PLC	Programmable Logical Controller
IEC	International Electro-Technical Commission
LD	Ladder Diagram
FBD	Functional Block Diagram
SFC	Sequential Function Chart
ST	Structural Text
IL	Instruction List
TIM	Timer
IL	Interlock
P	Place
T	Transition
I	Input Process
O	Output Process
M	Marking Process

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays, industrial companies have to implement advance technology in order to move forward in their industry field. Thus, the Computer Integrated Manufacturing (CIM) is an example of technology that can be used as to improve all the process and the design of manufacturing process. Moreover, it also can improve the industry field to save labour cost, energy and material which it can be improve the accuracy, quality and precision of the manufacturing process.

The Computer Integrated Manufacturing (CIM) to Provide Industry with a new generation of engineers having interdisciplinary skill necessary to deal with state of the art technology in designing, manufacturing, maintenance, selecting and procuring manufacturing engineering system. CIM machine include CAD (Computer Aided Design), CAM (Computer Aided Manufacturing), CAAP (Computer Aided Process Planning), CNC (Computer Numerical Control) machine tool, DNC (Direct Numerical Control Machine Tools), FMS (Flexible Manufacturing System), ASRS (Automated Storage and Retrieval System), use of robotic and automated conveyance, computerized scheduling and production control [1].

A.A. Chowdhury and A. M. Mazid have reviewed several paper regarding on CIM from Harrington where he described computer integrated manufacturing as a control and communication structure to integrate manufacturing system [2]. Beside reviewing from Harrington the author also cited Foston et al. proposed the interpretation of computer integrated manufacturing as an enterprise to achieve effective integration of advance

technologies in various functional unit to achieve objective [3]. Also from, Nagalingam and Lin summarized the evolution of manufacturing technologies that are associated with development towards CIM system and reviewed some of the new terminologies and technologies that have been granted during the past four decades [4]. Authors also mention a close link between technical and organizational aspects like the company's data acquisition, information about orders, production facilities, inventories and personnel which will be recorded and they form the input to the production control. This illustrates the relationship between CAM, data acquisition, production control, Computer-Aided Quality Control (CAQC) and pay-roll accounting [5]. Figure 1.1 shows a general layout of the CIM system.

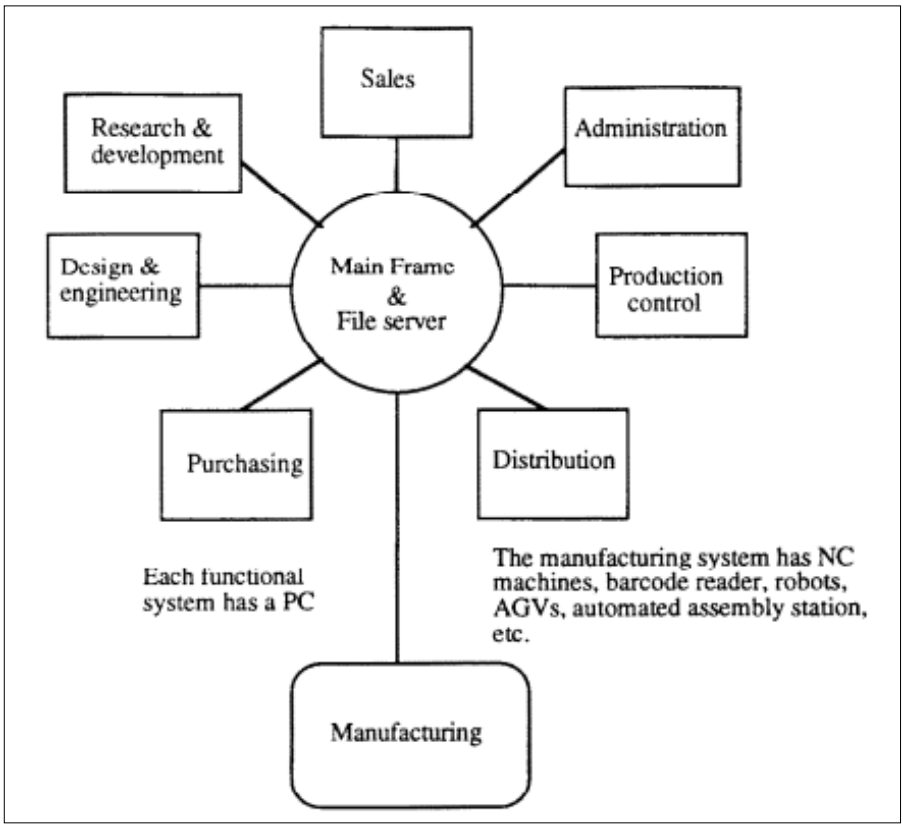

Figure 1: A general layout of the CIM system [5].

In many processes, all machines must operate with the following the sequence of process, synchronization flow and accurate concurrency. Thus, a logic controller is a part of CIM which is a discrete event supervisory system which control all these synchronize sequence of operation in each machine in order to fulfil the target of the machining system.

1.2 Motivation

As automation increasingly takes its place in industry, especially high-risk industry, it is often blamed for causing harm and increasing the chance of human error when failures occur. I propose that the problem is not the presence of automation, but rather its inappropriate design. The problem is that the operations under normal operating conditions are performed appropriately, but there is inadequate feedback and interaction with the humans who must control the overall conduct of the task. When the situations exceed the capabilities of the automatic equipment, then the inadequate feedback leads to difficulties for the human controllers [7].

PLCs are actually easier to controller than traditional hard-wired control systems. Programmable logic controllers (PLCs) have become important building blocks for automated systems. Because they have constantly increased in capability while decreasing in cost, PLCs have solidified their position as the device of choice for a wide variety of control tasks. One reason for the popularity of PLCs is their high reliability in harsh industrial environments; occasionally, however, things do go wrong and troubleshooting becomes necessary. The internal operation of a PLC can be monitored via a handheld programmer, terminal, or personal computer, and many indicator lights are provided for I/O troubleshooting. There are some limitations on what will overcome. First, it's assumed that the PLC system under analysis was operating correctly at some time in the recent past, so the problems of program debugging and wiring errors that are more typical of a start-up situation will not be addressed. It's also assumed that the PLC is programmed using some form of ladder-logic and not a higher-level language, and the discussion is limited to the most common I/O module types, namely those that support digital and analogue inputs and outputs [8].

As analysis model checker for controller assembly program, verification of software for PLCs written in Ladder diagram (LD), a low-level programming language that is very similar to assembly. The main problem of model checking is the so-called state-space explosion. The number of possible system states grows exponentially in the domains of variable and the number of concurrent processes. Analyses only consider the source code of a program and scale to larger code-bases than model checking, but they typically deliver less precise results [9].

1.3 Problem Statement

A production machine plants consist of several operations which divided into a several workstation and at each workstation operates specific jobs or tasks that in highly automated complex system. Therefore, the operation of this plant based on the sequence of the program that being develop and also need to fulfil specification of the system. However, the errors leading defect to the product and it will lead to a highly expensive damage that need to be prevent by any necessary. Thus, to reduce this error it also needed high cost and high effort being apply to test whether to analyses the control in advance. Therefore, it can improve the reliability in the system performance by avoiding unnecessary error being produce by the system

Hence, an example for CIM, a Programmable Logic Controller can be used for the automation industry. This is because the PLC is a microcontroller that can act as central processor unit to control the sensor and other devices using the program which being design by the user itself. Therefore, PLC system is a very precise to be used in the packaging workstation because it can be programmed by the operation of sequence instruction. However, at the same time it also needed to maintain the quality of the product beside to reduce the time to operate the works. Thus, as the complexity of the application increases, it is very crucial to ensure the safeness, liveness and boundedness properties of the system, while to maintain the performance of the system.

Moreover, the programs for logic controller embedded the system are produced manually from ladder diagram with complex and long program. The problem with this method is that is not a formal way to produce the control logic program. Thus, the modification of the program due to changes of operation of system is very difficult and takes a longer time.

1.3 Objective

There objectives need to be achieved which are:

1. To reconfigurable a logic control flow structure of a CIM system by using GRAFCET/SFC and Petri Net.
2. To verify model checking of multiple properties using Petri net software.

1.4 Scope of the project

The scopes for the project are:

1. A GRAFCET method which describe the various sequential operation.
2. Produce model of operations to operate workstation base on the SFC.
3. Model combination of the work station layout using Solidwork.
4. The method of Petri Net for analyze properties the control logic of the reconfigurable logic controller.
5. CX-programmer being used as software platform to program the PLC.

CHAPTER 2

LITERATURE REVIEW

This section reviews all information and method that will be implemented in this project. This include all the information method related about on PLC, program PLC language, verification of properties, model checking and many more that relating on the automation manufacturing project. Therefore, it will discuss briefly in term of history, definition, types and function of the system of the topic that will be present. Hence, this chapter also is an important way to be used as a guideline to complete this project because all the knowledge and the information from the journal and research paper are used.

2.1 Introduction

Manufacturers today, seek to transform their operations of global business processes across their value by automating, executing and managing their processes. This means, an end to end integration of processes across operations is needed- regardless of where these facilities and operations are physically located. Technological advancements in process monitoring, control and industrial automation over the past decades have contributed greatly to improve the productivity of virtually all manufacturing industries throughout the world. Businesses can run through this section to gain insights through report that highlights automation and minimization of manual and personnel-related work over industrial process, production processes, and manufacturing.

2.2 Programmable Logic Controller (PLC)

PLC is being early introduced at the year of 1960 and still being applied until nowadays. PLC is an example of microprocessor based controller which implements programmable memory in order to do and store instructions to control the process of machine. Many industry platforms were being used such as in petro-chemical plants, smelting furnace, automobile production line and much more.

The PLC is used to apply in entirely in real-time systems. The PLC are function to control the systems by using actor and sensor [10]. For example, a sensor will act whether the tank is full or not. If the tank is full occupied, the signal from sensor will on, otherwise it will turn off. For actor the example is used to control opening and closing a valve. This condition happens when the valve is open, the tank will be filled. Therefore, the PLC will control the input signal from sensor and control the actor of the system.

The advantage of the PLC is on the flexibility on their working. Thus, the program can be modified easily and quickly according to situation involved. As for the disadvantages of PLC, there is certain delay between the change in input and output signals.

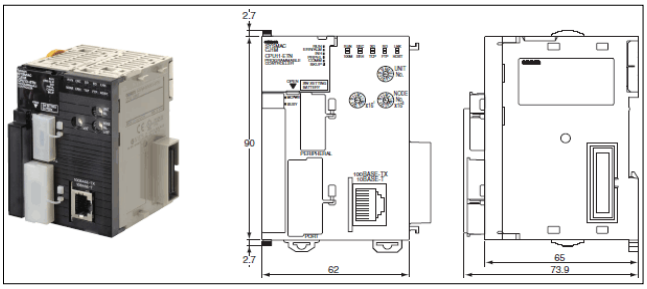

Figure 2. 1: OMRON CJ1M

The pick and place robot in this project will use the PLC of OMRON CJIM programmable controller like in the Figure 2.1 above. The PLC can be divided into two which are module type and fix type. As for this CJIM is a module type of PLC which can be wiring through trucking and the wiring connection can connect through input source and output source. This type of PLC it is being implemented in many control system applications in the machine line [11]. This is due to the advantage that can overcome and withstand the humidity, temperature, vibration and noise.