UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MOTION CARD SIMULATION FOR MASTER SLAVE ROBOT FOR PAINTING APPLICATION

Thesis submitted in accordance with the partial requirements of the
Universiti Teknikal Malaysia Melaka for the
Bachelor of Manufacturing Engineering (Robotic and Automation)

By

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April 2007

APPROVAL

This thesis submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotic & Automation). The members of the supervisory committee are as follow:

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Mr Samsi bin Md Said

PSM Supervisor

(Official Stamp & Date)

DECLARATION

I hereby, declare this thesis entitled “Motion Card Simulation and master slave robot for painting application” is the result of my own research
except as cited in the references.

Signature : …….
Author’s Name : ……...
Date : ……

ABSTRACT

Master slave robot is two types of robot calls master robot and slave robot. That application of the robot is for painting application and in global world, master slave robot using for pick and place one device from origin place to another point place. Three main partitions required before manufacturing their robot for saving the time to finish the complete of robot. Those parts are mechanical design, motion card simulation designing and programming system. These works concentrate in design and development a motion card simulation for this robot. In motion card designing and simulation, three types of circuit must be analysis and type '3' is choosing using PIC 16F873 as a main device to servo motor driving. Those types must be able to speed and position control of three piece servo motor at a one time. Input device for these circuit using a modification switch for create only one pulse output for driving one step of servo motor. During work progress, many problems comes example circuit troubleshoot, circuit burning, programming fail and etc but that all of problem already solve successfully. All circuit reference from electric and electronic journal, internet website specializing for electronic course, and from latest electric component book. That is a new knowledge for robotic and automation course but its very important as future experience.

DEDICATION

I dedicate this PSM project to my beloved parents, Che Rahimah binti Che Lah and Wan Harun bin Wan Ahmad

ACKNOWLEDGEMENTS

Assalamualaikum ,firstly a truly thanks to Almighty God, Allah s.w.t because His bless and strength for me to finish and fulfill the requirement of Degree of Manufacturing Engineering (Robotic and Automation)

Here, I would like to express my appreciation to my father, Wan Harun Wan Ahmad, my mother, Che Rahimah Che Lah and my brother and sister because spiritual support for me in order to finish my thesis and project (Motion card simulation and master slave robot for painting application).

Specials thanks to my first supervisor, Mr Samsi bin Md Said and my seconds supervisor, Mr Saifuddin Hafiz bin Yahaya because give me a big support and help to finish this project successfully. His idea can help me to generate more idea to complete this project.

Finally, I would like to thanks to all my friend expecially for Shikin(BSDP) Asru(BMFA), Nuar(BMFA) ,Mohd Faiz(BMCD), Malik (BEKP), my roommate (A-2-4) and to all individuals or groups who involved directly and indirectly during the process of finishing this project.

Thank you.

Muslim bin Wan Harun

April 2007

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS

PIC	-	Programmable Integrated Circuit
PCB	-	Printed Circuit Board
Volt	-	Voltage
Amp	-	Ampere
PLC	-	Programmable Logic Control
MC	-	Motion Card

CHAPTER 1
INTRODUCTION

1.1 Introduction

Today, industrial automation with robots is very efficient and fast has used in production lines. Actually, types of robot that using in automation industrial using programming system and teach pendant as main controller. Programming process must have a trainer operator for handle that robot and if using teaches pendant, it not suitable for handle robot in far location example to handling robot at painting area.

Painting process is a dangerous application for human breath. Chemical reaction will make human illness example lungs cancers and etc. Master slave robot will produce to solving their problem and change human work at hazard area and at the same time it's so easily to robot controller. This robot can be controlled by manual user and suitable for new trained operator. The differential from other robot in industrial work is from their controlled. Robot's operator does not require in some knowledge in programmer system but just moves their hand to move the robot.

The interaction between human and robot with used 100% in manual application. Spray nozzle is located at end of robot angle. Load of the nozzle is very light and not give more force for servo motor rotation.

Painting application is one of easily application different other work example welding application, pick and place application and etc. So, three joint of robot is selected and it's related with human arm. First joint is for human shoulder joint, second joint is for human elbow joint and the last joint is related to human hand joint.

To produce new types of robot, three main parts make to research; mechanical design, programming system to setup accurate of motor and motion card as an electric circuit of robot. Each partition will study with different person for saving time to finish the complete of master slave robot for painting application.

1.2 Background Project

Master slave robot for painting application is one flexible system to reduce human work at dangerous location. Motion card for this system is one piece of robot part. To define the perfect circuit of robot, all the intelligent chip like a Programmed integrated circuit, basic stamp and etc will study from basic knowledge until goal of this project.

Master slave robot is two different of robot, master robot and slave robot. That used of master robot is to send input for slave robot with one electric or electronic circuit. The motion of that robot must parallel for each step. More detail about master and slave robot is:

a) Master Robot;

I. Location of this robot is at human arm and the function is to measure each motion from arm moving
II. Input switch to measure each angle of human arm moving. That have three joint at master robot and three input switch has prepare to locate at each angle.

III. The related switch must research is potentiometer, variable resistor, rotary switch, timing circuit and combine one or more component.

b) Slave Robot;

I. Must fabricate a new design of robot with three joint of degree.
II. This robot will drive with three selected motor, one motor for each joint.
III. The related motor to research is servo motor, stepper motor, dc motor and dc servo motor.
IV. Must have one electric or electronic device to control all the motor. Research about that device from PIC component, combined with potentiometer and comparator circuit and basic stamp electric circuit.

One research about motion card will research as a piece for the main robot component. That research about that motion card designing and simulation will detail describing in this report. One electric called as motion card is design for the main driving system for the robot moving.

1.3 Problem statement

Motion card is the new technology of manufacturing especially for painting application. For the project, we need a higher budget to buy complete set of a motion card. Motion card include the 3 main components. That component is:

- Digital camera for vision system and for input to motion card
- Motion control card for read the image from digital camera, drive servo motor in robot to accurate painting and save programming for rapid the printing application.
- Personal computer to run motion card hardware and programming motion card software.

For reduce the higher cost of project, one simple circuit has design using PIC to control servo motor and that input to send pulse is must define. Pulse must accurately control for give robot motion with smoothly.

1.4 Benefits of study

With studding this project (master and slave robot for painting application) especially for motion card simulation, new knowledge about electronic circuit for robot can get in future experience. That knowledge is about:

I. Circuits for driving servo motor
II. Voltage measure and signal comparing system
III. Type of component to make a painting robot
IV. Application of robot
V. Robot manipulator
VI. Robot programming
VII. Calculation for moving each degree of freedom arm robot
VIII. Electrical principle for each electronic component

All theories are comes from lecture note and related resource. For robotic and automation course, each principle and robot moving is easy to understand for real practical in this project.

1.5 Objective

The objective of this research project is to explore the basis consistent software and hardware environment, and a flexible framework that enables easy and fast modifications, and optimal design of robot manipulator parameters with online control, monitoring, and simulation for the chosen electronic component.

This environment should provide a mechanism to define design objects that describe aspects of design, and the relations between those objects. Another goal is to build a complete circuit for master slave robot.

Objectives of this research are ;

I. Doing one device to motor control.
II. To learn that information robot painting from literatures review
III. To understand the types and application from selected circuit.
IV. Understand interfacing with master and slave robot for painting application.
V. To match between circuit, programming system and motor driving.
VI. Speed control and position for robot moving.

1.6 Scope of Project

Make an electronic circuit for the master slave robot.

1. Potentiometer function.
2. Comparator circuit.
3. Basic stamp function
4. PIC 16F873 function
5. Modification Switch for pulse input
6. Motion Card Hardware

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

To design one device for master slave robot, circuit selection is the important rules for choose the best circuit to implementation of robot. The types of circuit can analyses with take an all factor for selected that circuit. Those three types of circuit are:

1. Motion card hardware and software
2. Basic Stamp hardware with using comparator circuit to servo motor speed.
3. PIC circuit using modification switch as pulse input.

Each type wills analysis that factor example accurate of position and speed control can manipulated with. Research about those three devices can be in detail explanation for their related function.

2.2 Type 1 (Motion Card Hardware and Software)

Figure 2.1: Motion Card model MC2140

That type is the perfect device for control motion of robot. It can control each position of the robot and speed of robot but cost for their hardware about $ 1000 USD. The motion control card consists of three basic elements; the controller card, the MS driver card and their power supplies. The controller card contains the Cybernetic Step Motor Controller for storing application routines. All actions of this system are controlled by these commands.

The remainder is for general purpose Input and Output functions (I / O) such as controlling relays or valves (output) and reading switches (input). The command set of the Cybernetic contains instructions such as Test, Wait, Delay, and Loop which are used along with the motion instructions to provide a wide range of machine operations. The MID system can be described as a "mini-PLC with motion". The Step pulses and the Direction signal from the controller are connected to the motor driver.

Additionally, the Stop (PWR) signal shifts the driver from Park power to Full power. A Home Sensor channel is also part of the system. Each system includes a CI cable (controller interface cable). This 20 pin cable is divided into two sections. The I / O section contains + 5 v power and ground as well as six User Bits. The Chassis section connects the Home Sensor, User Bit 2, Jog Switch, and Limit Loop signals back to the controller.

This system is self-contained and can operate independently or under the direct command of a host computer. In Memory Mode, the host computer is used to "teach" the system by sending a string of commands which are stored, for later execution, in the on-board memory of the controller card. In Direct Mode, the host commands are executed immediately ((1) Hertling, P., Hog, L., Larsen, L., Perram, J.W Peterson, 1997).

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2.2.1 Functional Description

The Motion card is a low-cost, reliable, compact, high performance, C/C++ programmable industrial motion controller. It includes a DSP chipset (MC2140/2120, PMD) and it is driven by a host (x-Engine): A-Engine, A-Engine86, i386-Engine, or 586-Engine**.** The MotionC2140 is a complete, ready to run, motion controller with built in sophisticated field proven control firmware. User only needs to define parameters for PID algorithm and trajectory profile. The DSP calculates velocity, position and stabilizes the motor output. At the same time, the host x-Engine interfaces with a PC, monitors I/Os, and computes or pre-loads a new set of parameters.

The x-Engine interfaces to the DSP chipset via high-speed data bus. User can easily develop, download, and debug application programs via serial link to a PC. The host writes pre-defined motion commands to the DSP. The DSP can interrupt the host at any time. The MotionC2140 provides protected inputs for home switches, limit switches, and fault switches via Darlington arrays which are capable of inputs up to +30V. Seven solenoid drivers are available and can sink up to 350mA at 50V. A PPI (82C55) provides 24 user-programmable bi-directional I/O lines. Two RS-232 and one RS-485 drivers can be installed.

The Motion card supports up to 4-axis closed-loop digital servo controls. The digital servo control signals use incremental quartered encoders for position inputs. The DAC outputs ±10V servo control signals. Each axis contains sophisticated trajectory profile and digital servo capabilities.

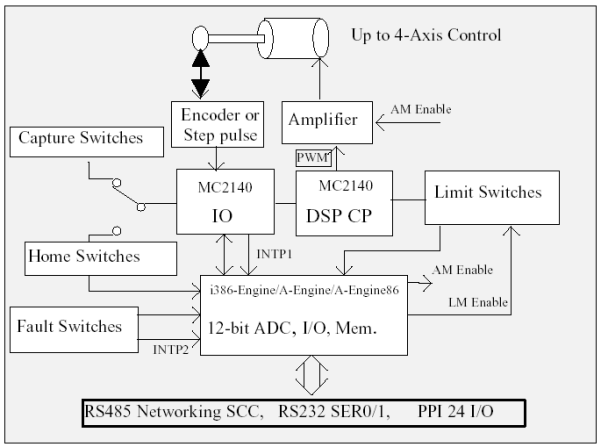

Figure 2.2: Functional block diagram of the MotionC 2140

2.2.2 Standard Features:

- Dimensions: 4.65 x 3.75 inches (MC2140, 40 MHz)
- Driven by an i386-Engine/A-Engine/A-Engine86/586-Engine (C/C++ programmable)
- Power consumption: 200 mA at 12V
- Temperature range: -40°C to +80°C
- 7 solenoid drivers, 24+ TTL I/Os
- RS-232 drivers, 1 RS-485 driver (optional)
- Protected switches for position, velocity, acceleration and jerk
- 32-bit registers for position, velocity, acceleration and jerk
- S-curve, trapezoidal, or contoured velocity profile modes
- Electronic gearing for multi-axis

- 1/T counter for stable low velocity motion
- PID or PI control, Programmable loop rate to 100 microseconds

2.2.3 Physical Description

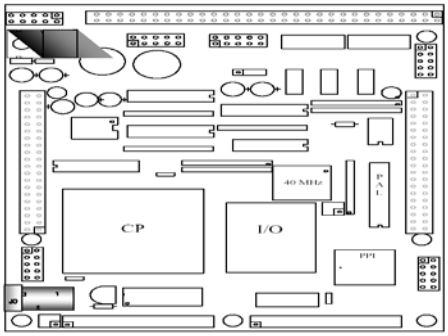

Figure 2.3: Physical layout of the MotionC2140

2.2.4 Motion Card Programming Overview

Development of application software for the MotionC2140 consists of three easy steps, which are:

Step 1

- Serial link PC and Motion Card + x-Engine.
- Generate source code in C/C++ using samples on TERN CD.
- Compile Link, Locate, and Remote Debug source code with Paradigm C/C++ Environment.

Step 2

- Test Motion Card + x-Engine in the field, away from PC.
- Application program resides in the battery-backed SRAM.
- Return to STEP 1 for source code adjustments, if necessary.

Step 3

- Create application BIN or Intel HEX file based on source code and Paradigm C/C++ DV-P Kit.
- Create application ROM with BIN file or download Intel HEX file into ACTF Flash. Project is complete.
- There are three steps in the development of a TERN controller C/C++ application program. These steps are explained thoroughly in the Technical Manuals for the A-Engine/A-Engine86/i386-Engine/586-
- Engine. The EV-P Kit supports Step 1 and Step 2, but does not support STEP 3. Step 3 allows generating an Intel HEX or BIN file to produce your own ROM/Flash chip. The full Development version (DV-P) is required for STEP 3.
- This technical manual is intended primarily to provide hardware support for MC2140. The respective technical manuals for your host engine can provide additional details on the development of the application.

2.2.5 Minimum Hardware Requirements

- PC or PC-compatible computer with serial COMx port that supports 115,200 baud
- MotionC 2140 controller (MC2140)
- x-Engine host controller:
- 586-Engine with debug kernel 5860_115.hex loaded into on-board flash, i386-Engine with DEBUG ROM ie8_0_115, A-Engine with DEBUG ROM ae_0_115, or, A-Engine86 with debug kernel ae86_115.hex loaded into on-board flash
- Debug serial cable (RS-232; DB9 connector for PC COM port and IDE 2x5 connector for controller)
- Center negative wall transformer (+9V 500 mA)