SEMI-AUTO ROBOT FOR ROBOCON

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ABSTRACT

This final year project is about to build a Semi-Auto Robot for Robocon 2010. The *Asia-Pacific Robot Contest* (ABU Robocon) is an Asian Oceanian College robot competition. It was founded in 2002 by Asia-Pacific Broadcasting Union. In the competition robots compete to complete a task within a set period of time. *Robo-Pharaohs Build Pyramids* is the main theme of this contest for next year, 2010. The new target is to build parts of the three Pyramids in sequence. Competing team members should be accurate, fast and cooperative. Semi-auto robot (Manual robot) is one of the robots in the team. This semi-auto robot play important rule in the competition. The design and mechanism of this robot was based on the Abu Robocon 2010 competition specifications and rules. The semi-auto robot will able to compete with other team to complete the task in short time and perfect. In this final year project, there is three main parts involved; mechanical, electrical and programming. However, in this project, the focus given on finding the best design for the robot to complete the task given with good precision and fast.

ABSTRAK

Projek akhir tahun ini adalah mengenai menghasilkan sebuah Robot Separa-Automatik untuk Robocon 2010. *Asia-Pacific Robot Contest* (ABU Robocon) adalah pertandingan di antara institusi pengajian tinggi di Asia Pacific. Ia diasaskan pada tahun 2002 oleh *Asia-Pacific broadcasting Union*. Di dalam pertandingan ini, robot –robot bersiang unutk menyelesaikan tugasan dalam satu jangka masa. *Robo-Pharaohs Builds Pyramids* adalah tema utama pertandingan untuk tahun depan 2010. Sasaran terbaru adalah untuk membina tiga buah piramid dalam turutannya. Ahli kumpulan yang bersaing mestilah mempunyai ketepatan, pantas dan nilai kerjasama. Robot separa-auto (robot manual) adalah salah sebuah robot dalam kumpulan itu. Robot ini memainkan penting dalam pertandingan ini. Rekabentuk dan mekanisma robot ini adalah berdasarkan pada segala spesifikasi dan peraturan di dalam pertandingan ABU Robocon 2010 ini. Robot separa-auto ini mestilah dapat berdaya saing dengna robot lain unutk menyelesaikan tugasan yang diberikan dalam masa yang singkat dan sempurna. Dalam projek akhir tahun ini, terdapat tiga bahagian utama yang terlibat iaitu; mekanikal, elektrikal dan pengaturcaraan. Walaubagaimanapun, projek ini mengfokuskan rekabentuk terbaik bagi robot ini supaya ia dapat berfungsi dengna baik serta menempurnakan tugasan dengna lancar dan pantas.

DECLARATION

"I hereby declared that I have read through this report entitle "Semi-Auto Robot for Robocon" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Mechatronic Engineering"

Signature : .....

Supervisor's Name : Mr. Herman B. Jamaludin

Date : 10 MAY 2010

DECLARATION

"I hereby declared that this report entitle "Semi-Auto Robot for Robocon" is the result of my own work 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 : .....

Name : Mohammad Syahid B. Abdul Jamil

Date : 10 MAY 2010

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CHAPTER 1

INTRODUCTION

1.1 Background

The word robot was coined by the Czech writer Kapek in his play 'Rossum's Universal Robots'. Since then countless devices have been created and have been associated with the word 'Robot'. The works of Isaac Asimov have laid the foundation of sociology pertaining to the use of robots instead of humans and the word 'Robotics' was also coined by him. In today's world, work on robots, that resemble and look almost human, and others which don't resemble humans in any way, progresses in leaps and bounds. The world has forerunners in this technology like MIT, CMU, Sony, Honda etc. In this world of ASIMO, AIBO, Packbot etc., we have made an attempt to create machines which we dare call 'Robots' [1].

In this era where organizations like ABU – Asia Pacific Broadcasting Union are organizing robot contests like Robocon we have made an attempt to make robotic systems which could send and receive communication signal amongst them and complete the task assigned to them with coordinated efforts. Today when technology is developing faster than a blink of an eye and the competition is tough to win at any stage may it be national or international, we have put in tireless efforts to implement the technology in simpler and effective form to compete against some of the best in field of robotics in the country [2].

1.2 Problem Statement

The idea of semi-auto robot came from the last Robocon 2009 in title of "Travel Together for The Victory Drums". Manual robot identified has some weakness. In the competition, the pilot/operator has to fully control the robot by himself. Sometimes he must control two or more parts in the same time and that has increased the possibility of making a mistake and thus delay the movement of the robot. To construct a good semi-auto robot, the pilot and the robot must interact and coordinate motion together. Therefore, some of the characteristics that should be present in the robot is

a) Stability : The weight of the robot must be suitable with the function. The size of the robot also can affect the weight of the robot. If the robot is too tall, the robot becomes less stable.
b) Automatic : The robot is enhanced with some automatic function.
c) Efficiency : The robot has good combination of motor, base, and other function that can perform fast with good precision.

1.3 Objective

The research objectives and its descriptions are:

a) Design a manual robot for Robocon 2010.
   Build manual robot base and the other parts that can function perfectly and can do the task given.
b) Test the performance of manual robot.
   Test the function and the efficiency of the manual robot. Redesign and improve the manual robot.
c) Identify design of manual robot that can be improved to automatic.
   Identify part that can be improved to automatic function.
d) Design a semi-auto robot for same task.
   Improve the function of manual robot with auto function. Improve the mechanism, circuit or coding to make the auto function.

1.4 Scope

Scope of this project can be divided to three main parts; hardware, software and programming. The categories that involved in this project is designed, mechanical, electronic and software. The design and mechanism that will be produced was based manual robot on the Abu Robocon 2010 competition specifications and rules [3]. The microcontroller that will be used is PIC18F2685. The controller is Interface Free Controller (IFC). Software and programming used to program the microcontroller is MPLAB [4].

1.5 Report Layout

This report will be conducted in few chapters and each stated as below:

a) Chapter 1: Introduction
b) Chapter 2: Literature review
c) Chapter 3: Methodology
d) Chapter 4: Result
e) Chapter 5: Discussion, suggestion and conclusion

CHAPTER 2

LITERATURE REVIEW

This chapter focus on reviews of the existing project to get a brief understanding on this project research. The related project review as:

2.1 Manual Robot of Team 1 Robocon 2009

Title : Manual Robot with Mecanum Wheel for Robocon 2009
Designer : Shivaraj A/L Samugam
Institution : FKE, UTeM
Descriptions :

This manual robot of team A is a 4 wheel drive mobile robot with Mecanum wheel. This manual robot has no automatic function at all. At the competition, it just completes the second task once. The second task is to pass the ramp (Mountain Side). The weakness of this robot is that the stabilizer did not work efficiently and lacks of automatic function that could have improved its operations. The advantage of this robot is that it was implemented with Mecanum wheel. Mecanum wheel is;

a) A special wheel design that has a number of small passive rollers mounted on the periphery of a normal wheel.
b) By controlling the four wheels attached to a platform, Omni-directional mobility can be achieved.
c) Using four of Mecanum wheels provides Omni-directional movement for a vehicle without needing a conventional steering system [5, 6].

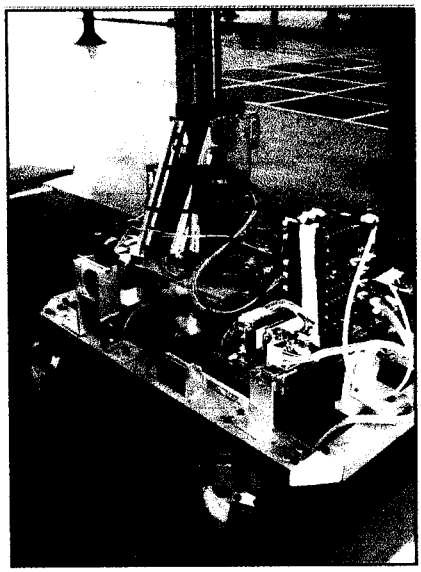

Figure 2.1: Manual Mobile Robot A for Robocon 2009

2.2 Manual Robot of Team 2 Robocon 2009

Title : Manual Robot for Robocon 2009
Institution : FKE, UTeM
Descriptions :

This manual robot of team B is a 4 wheel drive. It also has no automatic function. This robot does not have succeeded to pass the ramp at the competition. This mobile robot was a 4 wheel drive mobile robot. The advantages and disadvantages of this mobile robot are:

a) The 4 wheel drive mobile robot has very high torque and speed.
b) This robot was easy to control.
c) The weakness of this robot is when it comes to turning. The turnings produce high drags and make the turning imprecise.
d) This robot also vibrates strongly and make the robot unstable when its start to move and stop.
e) No stabilizer function to stabilize the *Kago* when passing the ramp.

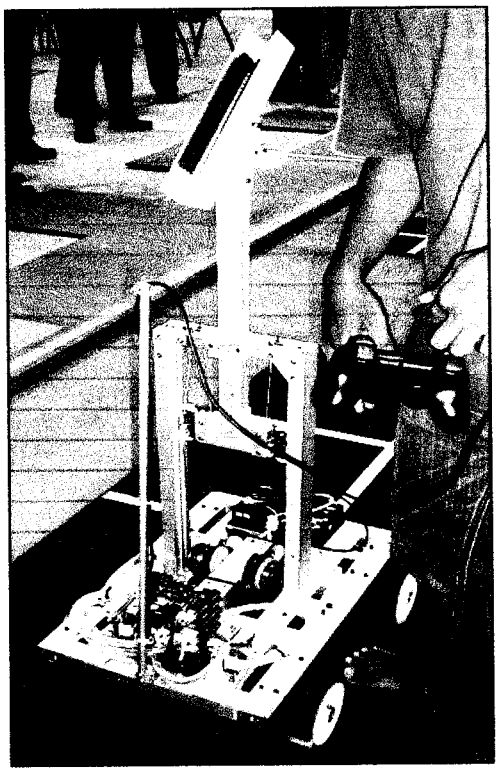

Figure 2.2: Manual Robot B of team UTeM for Robocon 2009

2.3 LuSAR - Luleå Semi-Autonomous Robot

Title : Lusar Semi-Autonomous Robot
Author : Johan Forsberg
Institution : Luleå University of Technology
Descriptions :

Lusar is a main lab robot at Lulea University. It's capable of traversing uneven terrain and can be used to test both indoor and outdoor navigation. This robot use sensor IBEO Ladar 2D scanning range measuring laser. The sensor allows the robot to see a profile of the environment, from which it can build a map and navigate. Lusar robot has internet connection and can send the map of the environment to the main computer. The capability autonomous of this robot is following wall and following behind a person or another robot [7].

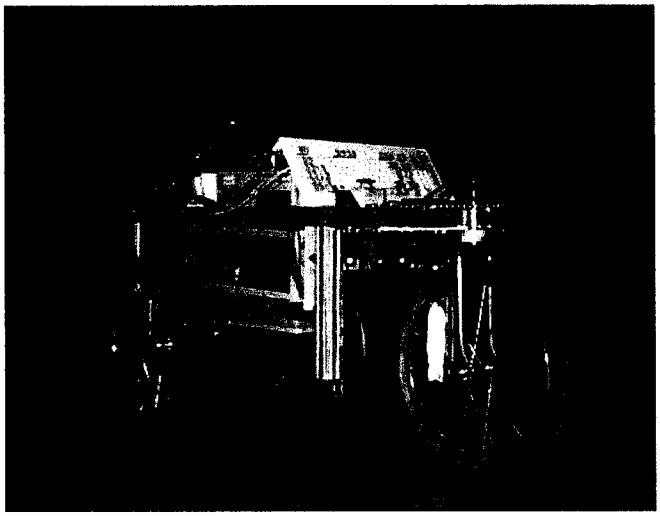

Figure 2.3: Lusar Semi-autonomous Robot

2.4 The Pioneer 2 Arm

Title : The Pioneer 5 DOF 2 Arm plus Gripper
Institution : Mobile Robot Inc
Descriptions :

Pioneer 2 Arm is a low-cost arm use for research and the classroom. It has 5 degree of freedom (DOF) robotic arm holds a gripper. Driven by six, reversible 5V DC open-loop servo motors. The arm can reach up to 50 cm in radius from the centre of its robot base. All joints, except for gripper fingers, pivot or rotate 180 degrees. Robot top plate or accessories may reduce potential motion in some directions [8]. Features of this arm robot are:

a) Nose mounted 5-axis arm allows grippers to handle objects 1 to 8 cm wide
b) 6 degrees of freedom, including gripper
c) Reach of 50cm
d) RS-232 compatible

The specifications and details of Pioneer 2 Arm:

a) Construction : Anodized, CNC fabricated, and painted aluminium, and plastic, with foam-covered gripper fingers.
b) Motion : 5 DOF arm and 1 DOF gripper.
c) Power : +5 and +12 VDC supplied by Pioneer robot.
d) Arm Range : 50 cm fully extended.
e) Gripper Range : Grippers part to 5 cm.
f) Payload : 150 gm (5 oz.) lift capability.
g) Speed : 1 second from fully extended to fully relaxed position.
h) Positional : +/- 1 cm.

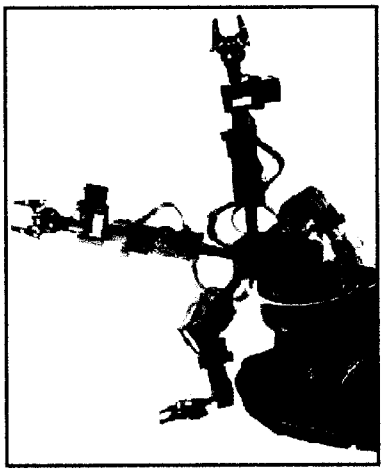

Figure 2.4: Pioneer 2 Arm

2.5 Direct Drive 5 Axis Arm Robot

Title : Direct Drive 5 Axis Arm Robot

Institution : SuperDroids Robot Inc.

Descriptions :

Direct Drive 5 Axis Arm. This arm is a simple arm with no clutches or position feedback. The base rotates ~300 degrees with limit switches to stop its travel. The Shoulder rotates 180 degrees with limit switches to stop its travel. The Elbow travels about 140 degrees with limit switches to stop the travel. The Wrist is continuous rotation.

The Gripper can open up to 5.5 inches. The entire axis has speed control. The camera is mounted on the base and rotates with the base. The camera has a 360 degree pan, 140 degree tilt, and 30X optical zoom. The arm can lift up to 25 pounds fully extended.

As pictured, the custom HD2 Treaded robot is equipped with a 5-Axis arm. Each joint is independently controlled with a gamepad controller and has position feedback and speed controlled positioning. The position control can be used to hold a position or go to preset memorized positions. All the motors have speed control allowing very precise and intricate positioning. The joints also have clutches that protect the arm from overload [9].

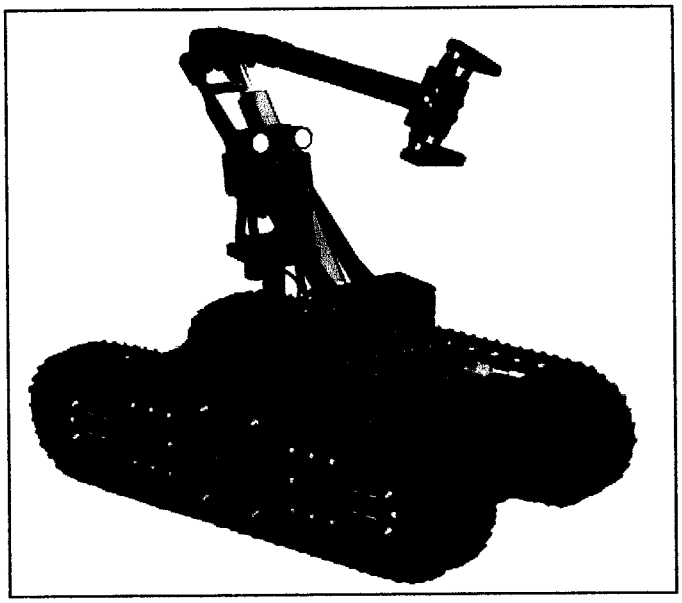

Figure 2.5: Direct Drive 5 Axis Arm Robot

2.6 Components

This semi-auto robot is a manual mobile robot that equipped with arm and gripper to place the block. It will have some automatic function to solve the task faster. This robot has basic elements which are include the controller, motor system, electronic, mechanical and programming. The components that will use included the materials, motor, controller and etc.

2.6.1 Comparison of motor types

The usual motor that have been use to design a robot is

a) Servo motor
b) Brushless motor
c) Brush motor
d) Stepper motor

2.6.1.1 Servo motor

RC servos are composed of an electric motor mechanically linked to a potentiometer. Pulse-width modulation (PWM) signals sent to the servo are translated into position commands by electronics inside the servo. When the servo is commanded to rotate, the motor is powered until the potentiometer reaches the value corresponding to the commanded position [10].

2.6.1.2 Brushless motor

A brushless DC motor is a synchronous electric motor which is powered by direct-current electricity (DC) and which has an electronically controlled commutation system, instead of a mechanical commutation system based on brushes. In such motors, current and torque, voltage and rpm are linearly related [11].

2.6.1.3 Brush motor

The classic DC motor design generates an oscillating current in a wound rotor, or armature, with a split ring commutator, and either a wound or permanent magnet stator. A rotor consists of one or more coils of wire wound around a core on a shaft; an electrical power source is connected to the rotor coil through the commutator and its brushes, causing current to flow in it, producing electromagnetism.

2.6.1.4 Stepper motor

A stepper motor (or step motor) is a brushless, synchronous electric motor that can divide a full rotation into a large number of steps. The motor's position can be controlled precisely, without any feedback mechanism. Stepper motors operate differently from DC brush motors, which rotate when voltage is applied to their terminals [12]. Table 2.1 compare the characteristic of different motors.

Table 2.1: This table compare the characteristic of these motor.

Type	Advantages	Disadvantages	Typical Application	Typical Drive
AC Induction (Shaded Pole)	Least expensive Long life high power	Rotation slips from frequency Low starting torque	Fans	Uni/Poly-phase AC
AC Induction (split-phase capacitor)	High power high starting torque	Rotation slips from frequency	Appliances	Uni/Poly-phase AC
AC Synchronous	Rotation in-sync with freq long-life (alternator)	More expensive	Industrial motors Clocks Audio turntables tape drives	Uni/Poly-phase AC
Stepper DC	Precision positioning High holding torque	Requires a controller	Positioning in printers and floppy drives	Multiphase DC
Brushless DC electric motor	Long lifespan low maintenance High efficiency	High initial cost Requires a controller	Hard drives CD/DVD players electric vehicles	Multiphase DC
Brushed DC electric motor	Low initial cost Simple speed control (Dynamo)	High maintenance (brushes) Low lifespan	Treadmill exercisers automotive starters	Direct PWM

2.6.2 Controllers

The controller that usually use for manual robot or semi-auto robot in Robocon and other competition are reviewed below:

2.6.2.1 PS40B Manual Robot Controller

PS40B is enhanced version of PS40A. It is designed to control manual machine using Sony PS2 joystick. It has been designed with capabilities and features of [4]:

a) Industrial grade PCB with heavy copper material for high current applications.
b) No programming is necessary to operate it, is a plug and play platform.
c) 40 pins ZIF socket to ease changing of PIC microcontroller.

d) 8 units of relay with maximum current of 10 Amp to control 4 brush motors bidirectional.

e) Improved with higher current clamping diode.

f) Additional protection against wrong polarity for motor power supply.

g) External driving port is available for high current application up to 30A with MD30A.

h) Designated I/O ports for driving 2 units of Oriental AXH series or LINIX series of DC brushless motor(speed, encoder and direction)

i) Designated I/O ports for driving ordinary DC brush motor (speed and direction).

j) Separated power supply for microcontroller circuit and brush motor to avoid electromagnetic interference.

k) 20 MHz external crystal oscillator for maximum processing speed.

l) Equipped with 6 Amp fuse for circuit and 10 Amp Fuse for relay protection.

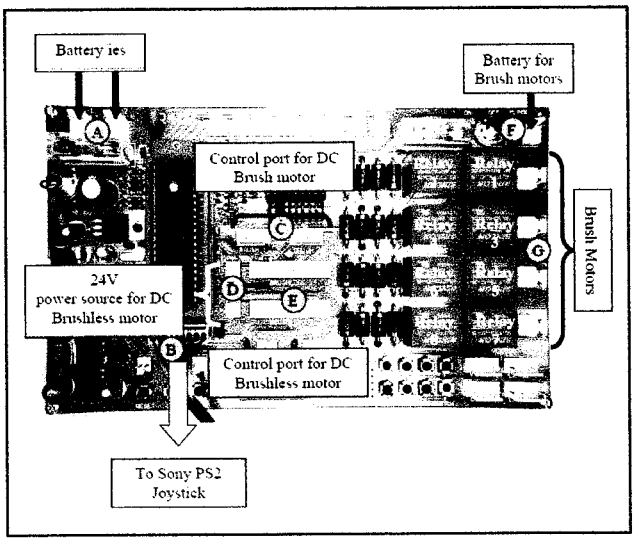

Figure 2.6: PS40B Manual Robot Controller

2.6.2.2 IFC-PS01 Interface Free Controller

IFC come with a brain card (main controller) where the main program is loaded. There are several cards available for robotics development such as control panel, 15A brush motor driver, brushless motor controller, counter and digital input, output card,

power card, analog input card and PS Controller card. PS Controller card, IFCPS01 has been designed with capabilities and features of [4]:

a) Industrial grade PCB.
b) Every component is soldered properly and tested before board is shipped.
c) Circuit power and busy indicator LED.
d) 6 set of 1x3 headers to select communication address.
e) 1 standard PS2 Controller adapter on each card.
f) Software readable of each button on PS2 Controller.
g) Single push button to test communication with PS2 Controller.
h) Vibrator motor is controllable.
i) Locked in analog mode for Joy-Stick.
j) Fully compatible with wired or wireless PS2 Controller.
k) Come with sample code and template to start.

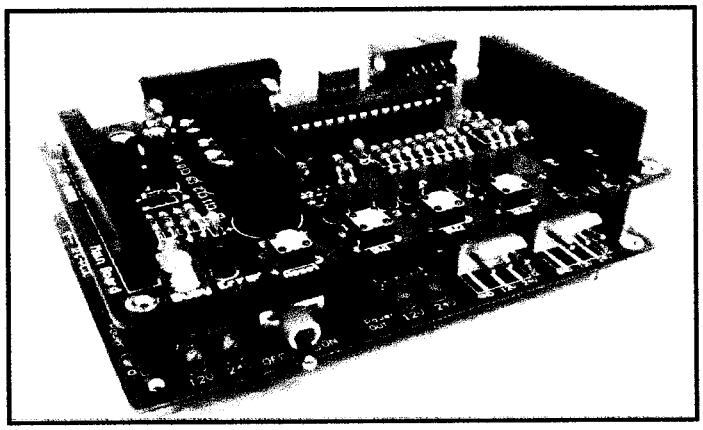

Figure 2.7: Main Board and Power Card, the minimum requirement cards needed when using IFC

2.7 ABU Robocon 2010

The Asia-Pacific Robot Contest (ABU Robocon) is an Asian Oceanian College robot competition. It was founded in 2002 by Asia-Pacific Broadcasting Union. In the competition robots compete to complete a task within a set period of time. The contest aims to create friendship among young people with similar interests who will lead their