# OBEJECT RETRIEVING AND PLACING USING AUTONOMOUS ARM

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This Report Is Submitted In Partial Fulfillment of Requirements For
The Bachelor Degree in Electronic Engineering (Computer Engineering)

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka

June 2014

**UNIVERSTI TEKNIKAL MALAYSIA MELAKA**
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

**BORANG PENGESAHAN STATUS LAPORAN**
**PROJEK SARJANA MUDA II**

**Tajuk Projek** : **OBEJECT RETRIEVING AND PLACING USING AUTONOMOUS ARM**

**Sesi Pengajian** : 1 3 / 1 4

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To my beloved parents and siblings

## ACKNOWLEDGEMENT

Praise to Allah S.W.T that with His blessings I'm able to finish this project in time successfully. I would like to express my greatest gratitude to my supervisor miss Siti Aisyah Binti Anas for their guidance, help and patience. My next deepest appreciation is dedicated to my parents and family for their money and moral support. Thanks to my friend who had helped me a lot in finishing this project. Last but not least to whom directly or indirectly contribute to this project.

## ABSTRACT

An Autonomous arm which is an automatic arm is needed to retrieve and place object automatically. The aims of this project were to design and construct a servo robot arm for paintball robot, to control the movement and position of robot arm automatically and to develop the algorithm for autonomous arm movement. This project was developed to overcome the problems faced when a manual controlled arm is used. These problems includes the process of flag insertion into the box was difficult and took more time as well as the arm was not strong enough to support the flag from falling to the ground during the match. The solutions for these problems were an automatic robot arm has to be developed with its own algorithm for the automatic movement of the robot arm. The designing process involved the designing the robot arm along with gripper and developing an algorithm by using Maestro Scripting Language software to control the movement and position of the servo robot arm. The final product was an autonomous arm with its algorithm successfully developed and it can be concluded that all the objectives have been meet.

# ABSTRAK

Lengan Autonomi atau lengan automatik berfungsi untuk mengambil dan meletakkan objek secara automatik. Tujuan projek ini adalah untuk merekabentuk dan membina sebuah lengan servo robot untuk robot paintball, mengawal pergerakan dan kedudukan lengan robot secara automatik dan untuk menghasilkan algoritma untuk pergerakan lengan autonomi. Projek ini dihasilkan bertujuan untuk mengatasi masalah yang dihadapi apabila lengan yang dikawal secara manual digunakan. Masalah ini termasuklah proses memasukkan bendera ke dalam kotak mengambil masa dan lengan yang digunakan tidak cukup kuat untuk menyokong bendera daripada jatuh ke tanah semasa perlawanan. Untuk menyelesaikan masalah yang dihadapi, lengan robot automatik perlu dihasilkan berserta dengan algoritmanya yang sendiri untuk pergerakan lengan robot secara automatik. Proses merekabentuk melibatkan merekabentuk lengan robot dan penggenggam serta penghasilan algoritma dengan menggunakan perisian 'Maestro Scripting Language' untuk mengawal pergerakan dan kedudukan lengan servo robot. Produk akhir adalah lengan autonomi dengan algoritma untuk mengawal lengan robot secara automatic telah berjaya dihasilkan dan sebagai kesimpulan semua objektif telah tercapai.

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# CHAPTER I

# INTRODUCTION

Chapter 1 covers the introduction part of this Final Year Project of Degree. It contains subchapters of objectives, problem statements, scopes of project and methodology.

## 1.1 Introduction of Project

Autonomous arm is an automatic arm that is used to retrieve and place object automatically. Autonomous arm is mechanical type which has almost similar function to human arm and it is programmed to place the object automatically to the specific place. It has several joint that has ability to retract and extend the arm. Since the arm has a few joints it can be imagine as human arm; shoulder, elbow, and wrist, and couple of finger. The end effector or the finger will be designed to perform a task to grip the flag. All the joints are made of servo motors in order to move every part of the arm.

Robotic arm has many types of manipulator configurations which has different movements and different functions. Robotic arm consists of a combination of the actuator connections which contains the components such as the 'base', 'upper arm', 'lower arm' and 'end-effector'. Connection method for each actuator will determine the configuration of the robot. Geometrical configuration can be defined

as 'work cell' or the robot coordinate system. Configuration of the robot depends on the connection method on each actuator. Robotic arm was built by using a combination of links connections that move alongside each other in a circular or linear motion. The combination of these connections will determine the geometrical configuration of the robot. The maximum minimum and minimum area that can be reach by a robotic arm known as the workspace. Robotic arm workspace is determined by the characteristics the following physical properties such as manipulator configuration of the robot, size and the length of robotic arm, and movement limit of each joint.

There are five types of manipulator configuration for robotic arm which are Cartesian, manipulator, cylindrical manipulator, spherical Manipulator, SCARA manipulator and revolute manipulator. This project will focused on revolute manipulator configuration as shown in figure 1.1 below which this kind of robotic arm has a joint that rotates on the base and two parts are connected as the shoulder and elbow. Its shape resembles a human hand. It can be adapted to various types of work. The workspace area is same as spherical voids. The performance of this type of manipulator configuration is good. Appropriate work of this type of robotic arm is lifting and stacking of materials at high levels, painting, welding points and edges, installation and operation of heavy material.

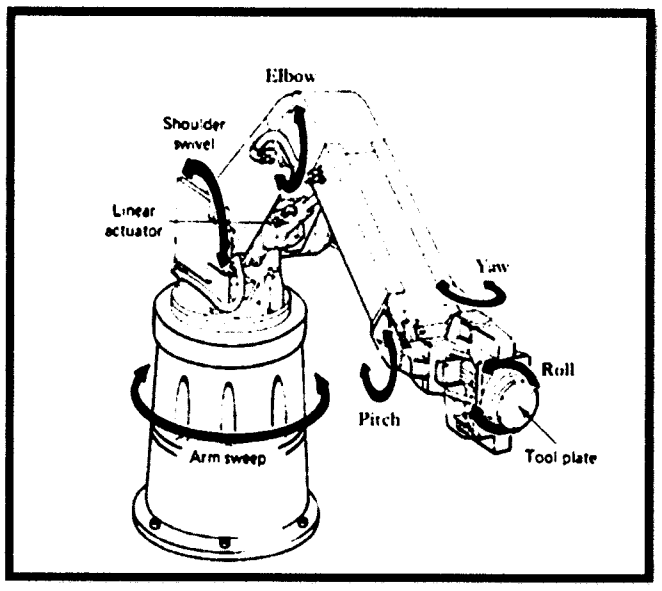


Figure 1.1: Example of revolute type of manipulator configuration

This project will be using 5 servo motors to design a simple structure of the arm. Servo motor is a complete package motor which include gearing, position sensor and control. Servo has been widely used in robotics because of their small size, high strength, and ease to use. Servo has many types, but most of the servo have a uniformly system with all servos are made to the same size specifications. The size categories include micro, mini, standard, and quarter / giant scale. In making the robotic arm, the most important factor is choosing a torque for servo at each joint. Torque for each joint should be compatible with the load that will be carried by the servo. Most of the servo motor has their limitation of rotation; some servos are limited to 180°. But it can be modify to 360° of rotation by following some procedure.

## 1.2 Objectives of Project

The objective of this project is:

1) To design and construct a servo robot arm for paintball robot.
2) To control the movement and position of robot arm automatically.
3) To develop the algorithm for autonomous arm movement.

## 1.3 Problem Statements

The robotic arm is one of the most crucial parts of paintball robot in order to place the flag into the flag station. However, the challenge is the robot has to be control manually in order to insert the flag into the flag station. This process is difficult because the user have to find the exact position of the hole to insert the flag. At the same time, the robot will be at the high risk to be attack by the enemy's robot. Another problem encountered, the arm is not strong enough to support the flag from falling to the ground during the match.

## 1.4 Scope of Project

Object Retrieving and Placing using Autonomous Arm is using 5 servo motor at every joint including gripper. The speed of this servo motor is 0.9 sec per 360 degree rotation and the torque is 30kg.cm. Micro Maestro 12-Channel USB Servo

Controller will be used to control the position and movement of the arm; it can control up to 12 servos. The gripper is specially design for the gripping purpose of the flag. The sensors that will be used to control the paintball robot automatically find the exact position of flag station is Sharp analog distance sensor which has working distance from 4cm to 30cm.

## 1.5 Project Significance

The autonomous arm provides a rigid body structure in order to support the flag from falling to the ground during the match. The autonomous arm is able to place the flag on the body of mobile robot so that the flag will be more stable and it can reduce the risk of the flag falling to the ground. This is because the autonomous arm is capable to extend and retract the arm.

Besides that, the autonomous arm is able to move automatically to the desired position for inserting the flag into the flag station without controlled by the user. Furthermore, the autonomous arm has been equipped with sensors to detect the distance between the mobile robot (paintball robot) with the flag station. So it can moves toward the exact position of flag station and insert the flag automatically.

## 1.6 Report Structure

The report consists of five chapters. Chapter 1 discusses the introduction of the project which includes the objectives of the project, problem statements, scope of the project, project significance and report structure.

Chapter 2 discusses about the Literature review. First part is the review on Six-servo Robot Arm. Then explanation on second literature review which is Autonomous Robotic Arm. Last but not least is about mobile robot with tactile arm.

The next chapter, chapter 3 discusses about Project Methodology of the project. The methodology involved system analysis, system design, system development and system testing.

Then, chapter 4 discusses about Result and Discussion of the project. It is about result and full decision after the completion of this project.

The final chapter is chapter 5 that explains about conclusion and recommendation for future work related to this project.

# CHAPTER II

# LITERATURE REVIEW

This chapter presents an overview on the related topic and the background related to this study of three different types of robotic arm.

## 2.1 Six-servo Robot Arm

The six servo robot arm was constructed by DAGU Hi-Tech Electronic Co.LTD and used six servo motor to drive every single joint of the arm. As human arm, it is similar to shoulder, elbow, wrist and couple of fingers. This six servo robot arm has a rigid mechanical structure which has 6 degree of freedom (DOF).

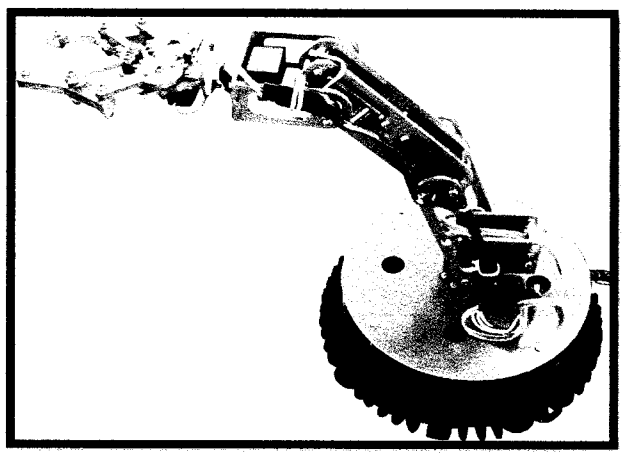

Figure 2.1: Six-servo robot arm

Based on the information provided by the DAGU Hi-Tech Electronic Co.LTD, There are three different types of servo used in this robot arm which are three pieces of 13 kg torque metal gear, a 3.2 kg, and two pieces of 2.3 kg of servo motor. The length of this robot is 390 mm length and use 32-way controller in order to control the movement of the arm robot.

The controller that used to control this arm robot is microcontroller board that use atmega168 MCU and computer RS232 COM communication. By using this servo controller, it can control 32 servo motors at the same time. This controller also can use a wireless control module to control the robot arm [2].

The Atmega168 shown in figure 2.2 below is one of the low-power CMOS 8-bit microcontrollers based on the AVR which is improved system of RISC architectures. The power consumption in active mode is only 250μA at 1MHz and 15μA at 32kHz. When power down mode is activated it will consume a power as much as 0.1μA only at 1.8V. It can execute powerful commands in a single clock cycle and ATmega168 can achieve throughputs close to 1 MIPS per MHz that allow the system designed to optimize more power consumption versus processing speed data.

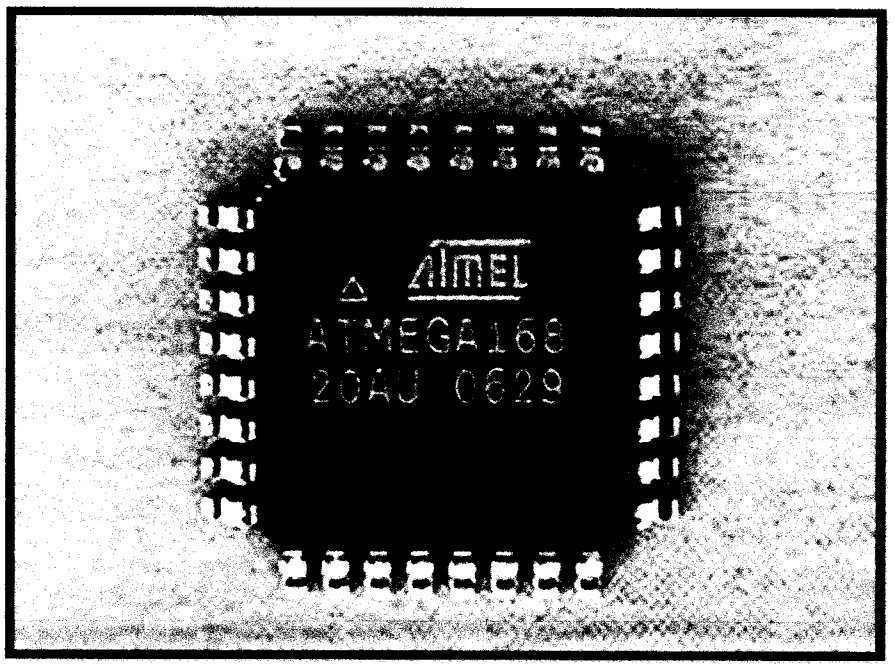


Figure 2.2: Atmel atmege168

AVR core has many instructions set with 32 general purpose working registers. All 32 pins or registers is connected to the Arithmetic Logic Unit (ALU) and it allows two independent registers to be accessed in one single instruction executed in one clock cycle. The produced architecture is more efficient can achieve throughputs almost ten times faster than conventional CISC Micro.

This device has been created by using Atmel's high density non-volatile memory technology which included with On-chip ISP Flash. It allows the program memory to be reprogrammed in the system using SPI serial interface, on-chip Boot program running on the AVR core or conventional non-volatile memory programmer. Boot program can be used on any interface for downloading the application program into the Application Flash memory.

One of the advantage of this microcontroller is the software in the Boot Flash will continue to run even if the Flash application that is updated as it provides Read-While-Write operation in their system. ATmega48/88/168 Atmel is one of the powerful microcontrollers by providing a very flexible and cost-effective solution for most of the embedded control applications because it combines 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip.

There is a lot of software that supported with a full suite of program and system development for Atmega168 microcontroller such as:-

- C compilers
- Micro assemblers
- Program debugger/simulators
- In-circuit emulators
- Evaluation kits

This Atmega168 microcontroller provides several ports as shown in figure 2.3 below which are Vcc, Ground, Port B, Port C, PC6, Port D, AVcc, AREF, and ADC7:6.

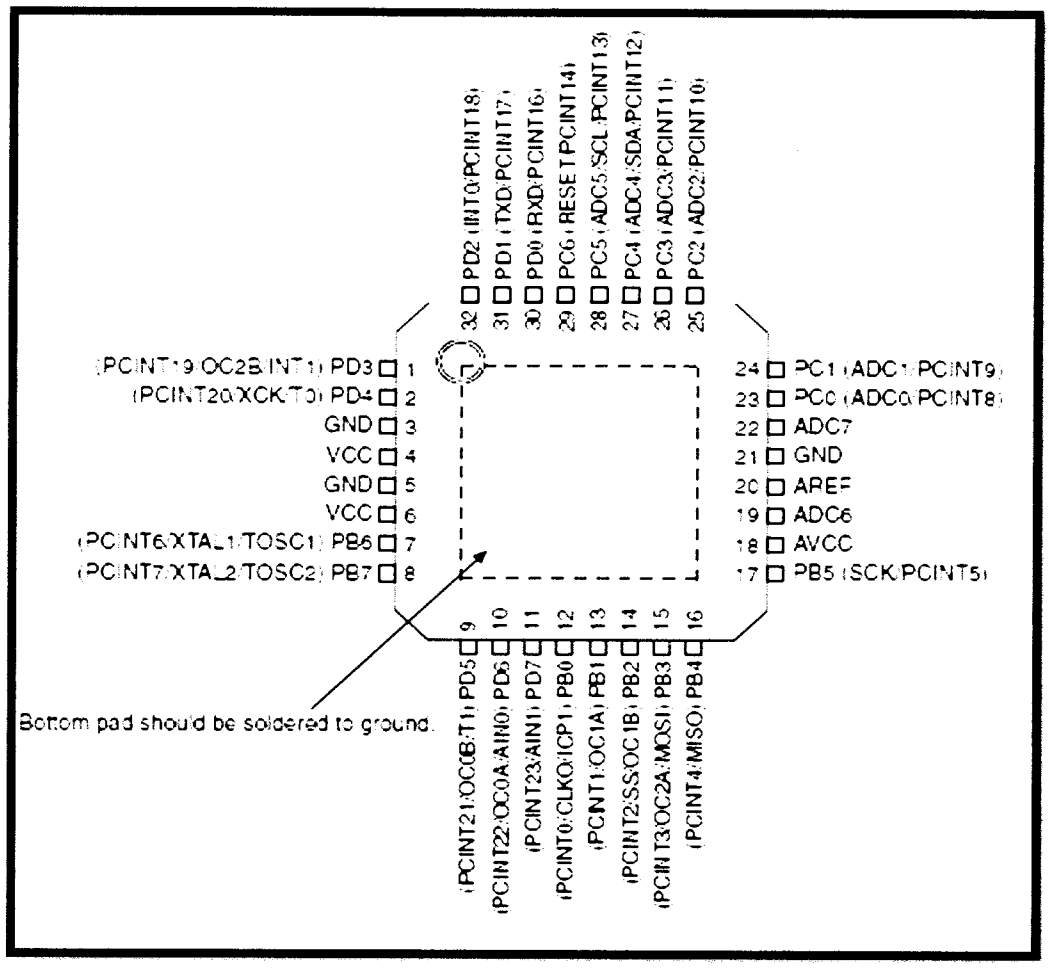


Figure 2.3: Atmel Atmega168 pin configurations

Table 2.1 below shows pin descriptions and the function of all the port provided in Atmel Atmega168 microcontroller.

Table 2.1: Pin descriptions

| Port | Description |
|---|---|
| Vcc | Input power supply. |
| Ground | Circuit grounding. |
| Port B | 8-bit bi-directional I/O with internal pull-up resistor. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. |

| | |
|---|---|
| Port C | 7-bit bi-directional I/O with internal pull-up resistor. As inputs, it same as Port B. |
| Port D<br><br>PC6/RESET | The common function is same as Port B. If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. If the RSTDISBL Fuse is unprogrammed, PC6 is used as a Reset input. |
| AVcc | AVCC is the supply voltage pin for the A/D Converter. |
| AREF | AREF is the analog reference pin for the A/D Converter. |
| ADC7:6 | Use as analog inputs to the A/D converter and powered from the analog supply and serve as 10-bit ADC channels. |

As shown in figure 2.4 below, it shows the microcontroller board that is used to control the robot arm. There is a lot of different port that provided in order to control the robot arm. At the top of the figure 2.4, it shows wi-fi module port that can be used to control manually the robot arm. Servo motor pin 1 to 16 is on the top and pin 17 to 32 is on the bottom. Each servo motor port has 3 pins which is power, ground and signal pin. The power inputs for this controller board has three which are MCU power input in the middle and the other two is servo power input. This controller board already has the voltage regulator to produce any input voltage into 5V so that 6V to 12V can be supplied [2].