ARTIFICIAL INTELLIGENCE CLIMBING ROBOT (AICR)

MOHD FADZLY WAHID B. MOHD ISHAK

MARCH 2005

I admitted that I have read this report and in my opinion this report are fullfillment the scope and quality for the Degree of Bachelor In Electrical (Power Industry) graduation.

SIGNATURE :.....

SUPERVISOR 1 :.....

DATE :.....

MUHAMMAD FAHMI BIN MISKON
Pensyarah
Fakulti Kejuruteraan Elektrik
Kolej Universiti Teknikal Kebangsaan Malaysia

11/3/2005

SIGNATURE :.....

SUPERVISOR 2 :.....

DATE :.....

ARTIFICIAL INTELLIGENCE CLIMBING ROBOT (AICR)

MOHD FADZLY WAHID B MOHD ISHAK

This Report Is Submitted In Partial Fulfillment Of Requirements Or The Degree of Bachelor In Electrical Engineering (Power Industry)

Fakulti Kejuruteraan Elektrik
Kolej Universiti Teknikal Kebangsaan Malaysia

March 2005

"I admitted that this project is written by me and is my own effort and that no part has been plagiarized without citations".

Signature : 

Name : MOHD FADZLY WAHID B MOHD ISHAK

Date : 10 MARCH 2005

For my beloved father and mother

Mohd Ishak Mohd Desa and Faridah Sulaiman

In appreciation of supported and understanding

ACKNOWLEDGEMENT

Alhamdulillah, thanks to the Almighty with his permission I have finally finished my Projek Sarjana Muda II in a whole semester's time. The report is the outcome of my project and it has been submitted following the due date time.

First of all, I would like to appreciate En Mohd Fahmi B Miskon, my supervisor for PSM I and PSM II that had helped me without ceasing in guiding me through the documentation and also updates with all the information needed. With the advice, comments and guidance, this project able to accomplish within the given time.

I also would like to thank my family members that had offered unlimited support during the time until the project is done. They had shown understanding and also morale support to me. Last but not least I wish to thank all my colleagues from KUTKM and also others that may not have been mentioned here. Without any of these supports, I would not have completed my project successfully.

ASBTRACT

This report present about developing of Artificial Intelligence Climbing Robot (AICR). The objective of this project is to design climbing robot by using servo gripper which has the capabilities to move across a pole. Resulting design consists of two grippers for gripping the pole which employs by servo motors. The whole climbing motion is achieved in six steps of motion and the climbing speed is determined from the movement of arm joint. The robot structures are made from aluminum bracket with pin joints through to allow for easy assembly. Microcontroller AX-11 board was used at this stage for the motion control. The climbing robot is made to climb at specific climbing environment which 69mm x 69mm soccer pole shape at speed of 6 step/sec. Several testing and analyses process is made to develop climbing efficiencies. Finally modifications for robot improvement are also shown.

ASBTRAK

Laporan ini menerangkan tentang kerja perlaksanaan "Artificial Intelligence Climbing Robot (AICR). Objektif utamanya ialah untuk merekabentuk robot memanjat dengan menggunakan pengcengkam servo yang berkeupayaan untuk bergerak di sepanjang tiang. Hasil rekabentuk mengandungi dua pengcengkam untuk mengcengkam tiang yang menggunakan motor servo. Keseluruhan pergerakan memanjat di capai dalam enam langkah memanjat dan pecutan memanjat di ambil kira daripada pergerakan sambungan struktur utama. Struktur robot diperbuat daripada penyambung aluminium dengan pin penyambung supaya mudah di pasang. Pada peringkat ini papan mirocontroller AX-11 digunakan sebagai peranti pengawal pergerakan robot. Robot ini di hasilkan untuk memanjat pada persekitaran terkawal yang berbentuk seperti tiang bola berdimensi 69mm x 69mm dan bergerak pada kelajuan 6 saat/pergerakan. Beberapa proses percubaan dan analisis telah dijalankan untuk menambah kecekapan pemanjatan. Akhir sekali beberapa modifikasi terhadap robot turut juga ditunjukkan.

TABLE OF CONTENT

LIST OF TABLE

LIST OF FIGURE

CHAPTER 1

INTRODUCTION

ARTIFICIAL INTELLIGENCE CLIMBING ROBOT (AIRC)

Nowadays, there are many activities that require access in the vertical direction. Climbing is one of the mean for accessing these matters. Whether indoors or outdoors the operating environment will be reflected in the climbing robot's design and ability to withstand different condition such as maintenance work for tower, pick the fruit, industrial solutions and many more. The design of robot will be determined by its intended applications.

1.1 Objectives and Project Scope

The objective of this project is to produce a climbing robot by using servo gripper that has the capabilities to climb a pole. Beside that the climbing robot also can be use as a study tools for student to learn about robotic movement and as implementation from related subjects such as robotics and mechatronics design. Furthermore, this climbing robot is designed to participate in a robot contest.

The design of robot is reliable and it can be used for out door and indoor environment. For whoever that having a problem with vertical height this AICR can solve their problem due to situation that it's implement to. For example TNB workers that need to climb electric pole can use this robot and do the job more easily.

1.2 Report Outline

In this project report there are has 6 chapters altogether. Chapter 1 gives some introduction and the objectives about this project. Chapter 2 provides some problem statement of the climbing robot that related in everyday lives.

The literature review of this project is reported in chapter 3. This chapter reviews the related work that has been done by other people. Chapter 4 is the main part of this report. It has four main sections which are:

a. Designing of the robotic part
b. Simulation
c. Hardware implementation
d. Testing and analyzing

Chapter 5 brings further discussion about the project and last but not least, chapter 6 gives the conclusion of this report.

CHAPTER 2

PROJECT BACKGROUND

Chapter 2 provides necessary background of this project such as the controller specifications and the basic principal and specification of motion microcontroller MC68H11 that will take over the role of AX-11 controller. A brief introduction to the concept of the closed loop system in a robotic manipulator application is given to provide basic understanding of the project.

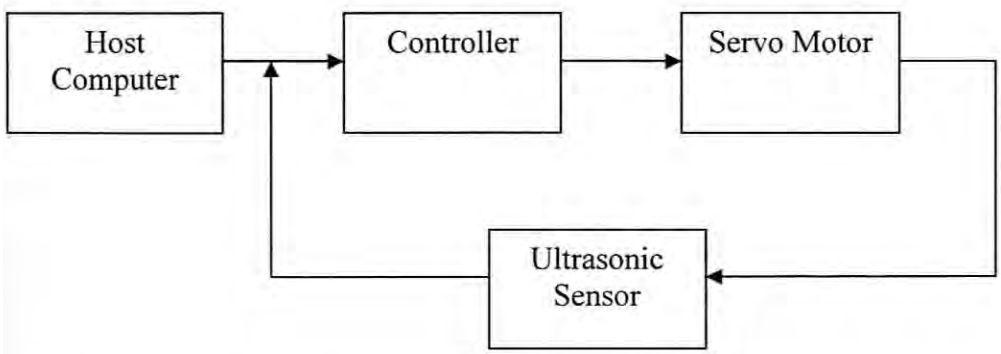

Figure 2.1: General closed loop of Artificial Intelligence Climbing Robot

The host PC functions as a user interface for human operator to operate the robot system. This is where normally the human operator does the programming of the robot and executes the program. If there any modification on programming for the robot is needed, all the work required is done here. All programs related then will be sent to controller part for next processes.

The controller part functions as the brain of the system. It processes all the input from the host computer and from the feed back error, and provides an appropriate output based on the sequence and logic of the program made by the user. In the existing system, the controller part or the central processing unit is the AX-11 microcontroller beard. It controls everything in the whole system including its own visual display to make programmed and give instruction to the controller.

The next block after the controller is the servo motor. The output of controller is fed into the servo motor to process the input signal from the controller so that it suits the required motion needed by the motor of each joint of the robot. Ultrasonic sensor uses two acoustic transducers. A transducer is a device that converts signal from one form to another. The transmitting transducer is instructed, by the attached to send out a short burst of high frequency sound waves [5]. The sound waves pass easily through air but are bounced back as an obstacle by solid objects. The returning sound waves are detected by the receiving transducer and converted into a signal [5]. The application of this component in Artificial Intelligence Climbing Robot (AICR) as detector for sensing an obstacle when climbing motion occurs.

A further detail about the original architecture of AICR will be discussed in section 2.1. The modification that will take place in the old design is described later in section 2.2, with the detailed specification of the new part that will replaced some part of the old design.

2.1 The Original Architecture Design

This section of chapter 2 describes the overall background of the old architecture design, some of which need to be replace and the rest is to be combined with the new parts. Figure 2.3 shows all the parts proposed in the original architecture. The Artificial Intelligence Climbing Robot (AICR) control software, which is based programmable

logic controller as it interface are designed .The PLC work as the brain for the robot movement. All the signals to and from the robot will pass through the PLC first before distribute to the other parts. Although PLC easy to control, reliable and also can found in the lab, some problem need to be consider and related with the other part of robot system. PLC only can be used with the other industrial parts such as compressor, industrial relay, sensor, pneumatic cylinder and some more to make sure it can control properly. After some consideration reviews, a modification in controller section needs to be done and explained briefly in next section of this chapter.

Gripping parts for Artificial Intelligence Climbing Robot (AICR) also requires some modification and improvement. In the original architecture, the gripping element or parts for AICR is using parallel type pneumatic gripper. The gripper is efficient, heavy duty and can holding force up to 58 Newton [10]. Disadvantage of this part are it is too expensive. Due to cost factor, a consideration to replace it with other grippers is made.

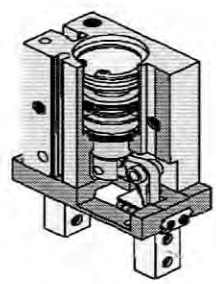

Figure 2.2: Parallel Type Pneumatic Gripper

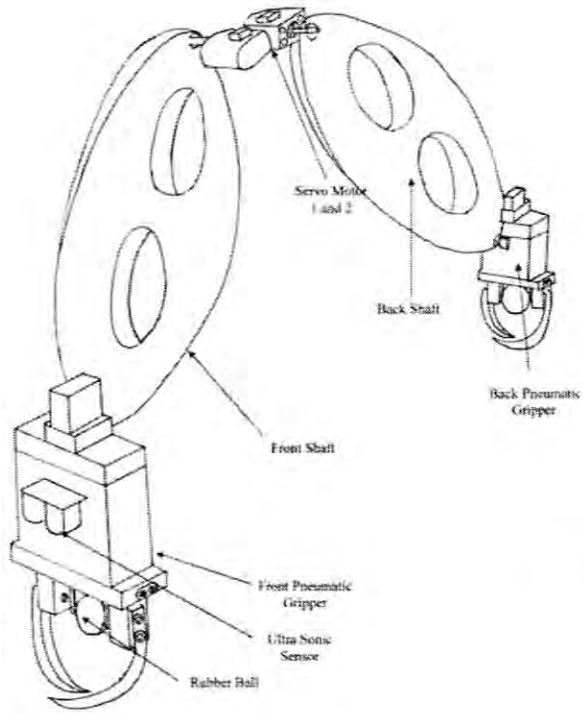

Figure 2.3: Original Architecture of Artificial Intelligence Climbing Robot (AICR)

2.2 The Modified Design

This section stated about modification on AICR from previous proposed design. Some modification needs to be done due to problem related that can effect project flows. In this new modification design, the features of AICR are completely different from the previous one. After all consideration on cost of part, structure and reliability again is calculated, some part needs to match required specification standard to get a good result.

Concept of climbing motion still based on 6 step climbing motion but 3 new part such as servo gripper, servo motor and aluminum structure body are introduce to make sure that this robot can achieve its objective . Selection of each part later reviews in chapter 4.

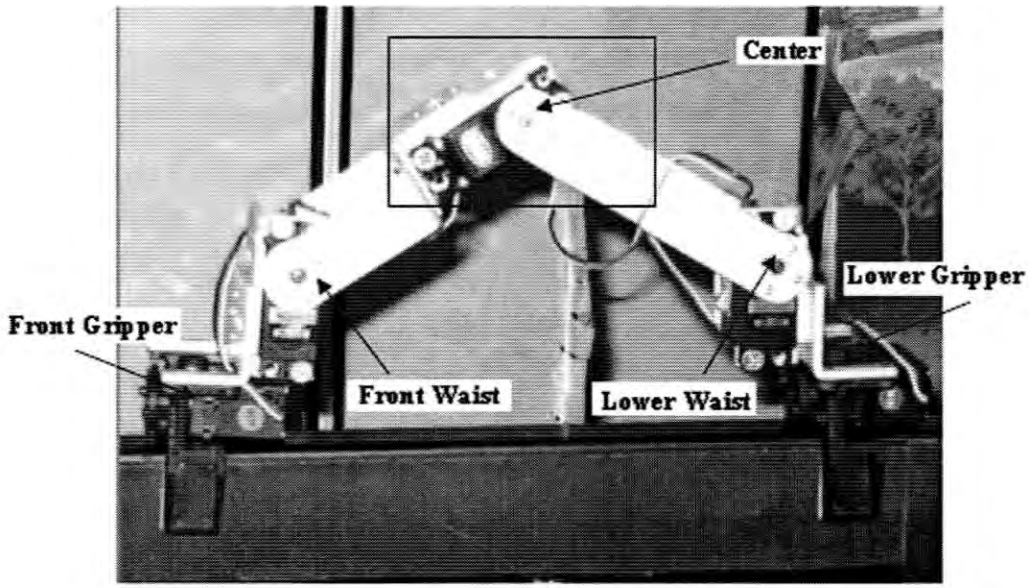

Figure 2.4: Modification Architecture of Artificial Intelligence Climbing Robot (AICR)

CHAPTER 3

LITERATURE REVIEW

This chapter reviews existing project created to get an idea about the project design, conception, specification and any information that related to improve the project. In later of this chapter, some review about climbing robot that proposed to fulfill this project will also be reported.

3.1 Previous Climbing Robot

Literature search on the internet indicates various types of robots available which supports manufacturing, construction and scientific exploration. However, mainly the climbing aspect mainly tackles geometrically uniform obstacles which include wall (the CLAWAR, climbing and walking robot), rough surfaces, pipes (inside), and frame structure similar to oil drilling platforms.

Zaidi Mohd Ripin, Tan Beng Soon, A.B Abdullah and Zahurin Samad [1] have produced pole climbing robot before but with the name of Low-Cost Modular Pole Climbing Robot. The purpose of their project is produced a robot that can help to harvesting palm oil fruit in palm oil sector. In design method, basically this robot has two arms and two grippers. The structural component of the robot are clustered according to the importance functional parts which include the structure of gripper, the

arm orientation control mechanism, the shape of pinchers and the pivot point design. The difference of this robot is at their central body that consists of three functional parts which are pivot point control part, the arms orientation control mechanical linkages and two arms. Although the design, fabrication and assembly of this robot are good, there are some related weaknesses that have been stated. It is about the design that has some inherent weakness in sense of center gravity such relatively far from the climbing surface, creating turning moment at gripping point. Other related weakness is this robot using arm orientation in its walking movement. Although this concept is reliable but there are problem when the robot come to crooked surface where it does not works.

Another example of climbing robot is created by M.Rachkov [2] from Moscow State Industrial University that has produced a Climbing Robot for Rough Surface. This robot provides the solution problem of motion across rough surface at any angle [2]. The robot has a control system that ensures a sealing mode of pedipulator motion and a light skeleton body with a combine vacuum gripper system that covers extended area of motion surface. The design of the transport module of this robot consists of translation part and rotation part. The main differential that spotted from this robot is by using vacuum fixation of the translation part grippers and rotation part grippers to motion surface. In the rotation part robot, pneumatic actuator has been used is forced capabilities coupled with the small sizes compared to electric driven manipulator. There are some weakness that detected from their recently robot design. In term of cost effectiveness the concept by using pneumatic actuator can be eliminated for Artificial Intelligence Climbing Robot (AICR). Furthermore the payload of this robot is 20kg and the weight without equipment for this robot about 6.3kg, this criteria not accepted in terms of efficiency due to purpose of Artificial Intelligence Climbing Robot (AICR) that to produce a light weight robot.

In other article, Tim Bret, Stephen Rock, Jean-Claude Latombe, Brett Kennedy, and Hrand Aghazarian [3] from California Institute of Technology had introduced four limbed robot, LEMUR II B (Legged Excursion Mechanical Utility Rover) that can free climb vertical rock surfaces. This robot consists of four identical limbs attached to a

circular chassis. Each limb contains three revolute joints, providing two in plane and one out of plane degrees of freedom. In this project they also introducing new method called one step motion to determine whether the stance is reachable and if so, they need to construct a continuous path to reach it. Although this robot has sophisticated control and sensing techniques, there are some difficulties remain to be addressed integration of local visual and tactile sensing, implementation of hybrid force motion control, and consideration of dynamic motion.

George Vastianos [4] from Technological Educational Institute of Piraeus, Greece in his research has produced SLOTH Rope Climbing Robot. The purpose of this robot is for rope climbing. In the construction there are three small servos and controlled through an SSC II serial servo controller. The first two servos used for the up and down grippers and the third are for the body. SLOTH robot can be used as a tele presence robotic system by carrying a small video camera to offered "visual access" in places where access by human presence is difficult and dangerous (like earthquake affected buildings, poisonous and toxic gas trapped rooms). In design and conception method, this robot is similarly same with Artificial Intelligence Climbing Robot (AICR) but the main differential is this robot using serial servo controller as it control interface, rope gripper set and body structure.

3.2 Conclusion of Review

From the journal research that shown above; there are some similarities between four robot creations that implement concept of climbing. In this literature review, only Low-Cost Modular Pole Climbing Robot [1] and SLOTH Rope Climbing Robot [4] are using 6 step climbing motion concepts in their movement of robot. This conception also shared in Artificial Intelligence Climbing Robot (AICR) because this is most efficient step in produce vertical climbing kinematics. In the design method, there are some necessary upgraded factors is made to sure that these climbing robot have its own

identity and much improve than the others. The challenge is to complete such a motion (autonomously) without falling so pneumatic gripper is preferable in gripping part to give more grasp due to vertical pole but because of costing problem servo gripper is more preferable. Ultra sonic sensor (sonar) is an artificial intelligence component that used for detecting distance of obstacle during the motion take place. In motion part, DC servo motor is used to move the front and back shaft accurately. Specific selection about usage parts will review later in chapter 5.