ROPE CLIMBING ROBOT

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ABSTRACT

The objective of this project is to build a hardware and software of a Rope Climbing Robot and to study the motion of a robot that can climb rope. The robot can climb up via the rope. The robot weight must be not too heavy because it has to climb up via a rope to get the target. The research of the project has been done using a Peripheral Interface Connection (PIC) software. The programming about the motion of the robot has been built using the software developed. PicBASIC Pro-compiler and MicroCode studio from Microchip has been used to design a programming and compile the program. The PIC 18F4550 has been used as a microcontroller of the robot. The robot has a gripper at the top, in the middle and at the bottom of the robot’s body which sequentially alternate between gripping and releasing the pole while moving upwards. Type HITEC HD7150 M DC Servo Motor from Cytron Technologies Sdn. Bhd has been choose as a gear to move each pair of robot arms.
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LIST OF NOTATIONS

$\theta$  robot angle

$\rho$  Density

$M$  Mach number

$\varepsilon$  Epsilon

$\omega$  Omega

DC  Direct Current
CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The project was named as a Rope Climbing Robot because the application of the robot is to climb across the rope line. The design of the robot use a Mechatronic design which is the design is a combination of electrical and mechanical engineering studies by applying the application. The robots use a movement and the control of the motion technique to move through the rope. For the Rope Climbing Robot, the voltage and current will be given to the DC Servo Motor to move the robot by gripping the rope. As an output device, the DC Servo Motor was used. The motor was used to move the robot. The PIC18F4550 was used as a microcontroller and the PICBASIC Pro-Compiler or MicroCode studio from Microchip Corp. has been used for the robot programming and as a compiler. After the program was and has been burned on the PIC18F4550 using a PIC2Kit burner, the compiler is needed to open the programming. Lastly, the program will be run and the robot will be move as we need.
According to Karel Capec who was introduced a robot is one of a basic study in Mechatronic Engineering field at 1920’s that play Rossum Universal Robot. Karel Capec is one of the Czech playwright. According to him, a word robot comes from the word robota which is means simply work. A robot was designed to help human in the world to have an easier job in a life. A robot was introduced to help human to get some object that cannot be pick by hand such as at the hot place, at the top and so on. Robot also can be used in a life days to help a housewife to keep clean their house without waste their energy and strength. A robot has no feeling like a human so that the robot will not tired when doing some work without rest. A robot can do the job for a whole day as long as human want. Practically, a robot is distinguished from electromechanical motion equipment by their dexterious manipulation capability in that robot can work, position and move tools and other objects with far greater dexterity than other machines found in the factory.

According to Ben- Zion Sandler in his book entitled Robotics, Designing The Mechanism For Automated Machinery, 1999, an industrial robot is defined as "a programmable mechanical manipulator, capable of moving along several directions, equipped at its end with a work device called the end effectors (or tool) and capable of performing factory work ordinarily done by human beings. The term robot is used for a manipulator that has a built-in control system and is capable of stand-alone operation. According to the Robotics International Division of the Society of Manufacturing Engineers, a robot is a reprogrammable multifunctional manipulator designed to move materials, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks by the definition."
1.2 **OBJECTIVE:**

In the rope climbing robot project, there is a few of main objective that would like to achieve. The main objective is to build hardware of Rope Climbing Robot and to test a Rope Climbing Robot.

1.3 **SCOPE OF PROJECT**

The scope of this project is to investigate the robot application by using a software and hardware development. The main focus or scope in this research project may include the aspects of hardware building for a rope climbing robot, a firm use for climbing robot and to test a motion of the robot via a rope track.

1.4 **EXPECTED OUTCOMES**

As an expected outcome, the project research would like to expect a prototype of a rope climbing robot at the end.
1.5 SIGNIFICANCE OF THE STUDY

The studies of the Rope Climbing Robot is significant to have a quality product of a climbing robot that will help us in life such as save cost in daily life. The robot also can save more time that we have to finish.

1.6 PROBLEM STATEMENT

While designing the Rope Climbing Robot, there were a few problems has faced. The problem is to choose what the type motion of the robot. The type of robot’s motion is very important in the research so that the result will be fulfilled the design. Then, it is very important thing to understand what is suitable material that we will be use to build the robot. The material used also known as hardware of the robot. The PIC microcontroller also should be to study and to understand because the robot programming will use a PIC18F4550 microcontroller and programming. At last, the project must to make sure that a programming using PICBASIC Pro-Compiler and MicroCode Studio is suitable to move the robot properly.
CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

According to the N. Ranasinghe et al, 2000, when the robots tied horizontally, the design known as “horizontal rope climber”, while a gait for climbing rope tied vertically known as “vertical rope climber”. A few modules of the robot needed for the horizontal line climb to perform a twisting action at each end. For the vertical rope case, a different attachment is required. There is only two modules are necessary since we no longer require the twisting action. The tension of the rope also varies in the climbing method and is a function of the location of the robot along the length of the rope. If the robot is low on the rope, the tension it experiences is low but if the robot is high on the rope, the tension is higher because the entire weight of the rope below it is exerting a
force. Further, the weight of the robot adds tension as well. If the top attachment is gripping the rope, the bottom attachment will not experience the tension created by the robot weight. However, if the bottom attachment is gripping the rope, the top attachment will still experience the tension caused by the robot weight. In addition, by creating the friction further distorts the rope by locally, the twisting of one pipe is needed. The twisting one rope also needed for create unwanted friction on the other pipe that is supposed to be loose.

According to Jong-Hoon Kim from B.E., Seoul National University of Technology in Seoul, South Korea, 2005, December 2008, the caterpillar tracks used to help the robot to distribute its weight evenly over a larger surface of the track, when compared to the wheel-based robot. The ability used to be the tracked robot moves forward the segment which is used for the track is laid out flat on the ground at the front and picked up again at the back. So this feature of the caterpillar track helps the robot to handle the uneven surfaces much efficiently. To take up the additional load of the robot, the rollers was used at the front and back of the robot. The complete rolling track of the robot will help the robot in handling the movement smoothly in loose areas, where the wheel-based robot of the same potential would fail to do the job.

According to Wei Wang, Kun Wang and Hauxiang Xiang from a Robotics Institute, School Of Mechanical Engineering and Automation in their journal, according to the gaits of their model, Crawling gaitz realization of the mini-modular climbing caterpillar robot, the gait of a caterpillar robot engages a changing kinematic chain, open chain-closed chain-open chain, while the inchworm robot only moves in an open-chain state. According to their journal, the other characteristic of their model, when the caterpillar robot climbing, it will transmit a wave along its body, and the middle joints will repeat similar control rules with certain phase differences, there is no wave transmitting along the body of inchworm robot, and the control rules of its three joint are different.
3.1 INTRODUCTION

In this chapter, we will introduce about a hardware design that was designed after all to build the robot. In the hardware design, a mechanical design will be constructed start from a head to tail of the robot. In designing the hardware, the head, body, tail and gripper is an important part for the robot. At the head of the robot, the linear actuator 1 will be connected to the head while the other one of the linear actuator will be connected to the tail of the robot. A gripper will be constructed, one at the head of robot that state in front of the linear actuator, while the second one at the body of robot and the last gripper will be connected to the tail of robot. The second linear actuator will be connected to the tail of robot. The linear actuator function is to forward and reverse the gripper before the robot will grip the rope. The DC servo motor was used in designing the robot. The motor that connect with the gripper use to control the angle of the gripper want to go.
3.2 HARDWARE DESIGN

3.2.1 Mechanical Design

![Head of robot → Body of robot → Tail of robot → Gripper → Last prototype of robot]

Figure 3.2.1.1: Head of the Robot
Figure 3.2.1.2: In The Middle Of Robot

Figure 3.2.1.3: Tail of the Robot

Figure 3.2.1.4: Hole for Rope Enter
Figure 3.2.1.5: Last Prototype of Robot

Figure 3.2.1.6: Tool using to cut aluminium

Figure 3.2.1.7: Aluminium trunk
Figure 3.2.1.8: G-clamp

Figure 3.2.1.9: Teflon from the top view

Figure 3.2.1.10: Teflon from the top view and side view
3.2.2 Electrical & Electronic Design

BATTERY (12V) → PIC18F4550

→ DC SERVO
→ DC SERVO
→ DC SERVO

→ RELAY 1(PORTA)
    HIGH
    LOW

→ RELAY 2(PORTB)

    HIGH    LOW
Circuit operation

A battery 12VDC has been used to give a power supply to the circuit. A relay 1 will be connected to the PIC18F4550 at port A0 and the one of relay that connected to port A0 also will be connected to linear actuator 1 for the reverse (LOW digital input at the programming declaration) function. The relay 3 that connected to the port A1 connected to the PIC18F4550 for the forward (HIGH digital input at the programming declaration) function. It's same as for the relay 1, 2 and 3 at the port B. one of the relay at Port B7 declared the forward while port B6 declared as reverse function. The servos motor connected to the pin RB3, RB4 and RB5 at the PIC18F4550. A 12VDC power supply from the battery will be given to the servos motor so that it can function. A voltage regulator has been used in the circuit operation to
The Microchip PIC18F4550 is the mother of the board. The robot will not function if the PIC18F4550 is not connected to the board because the main function of the robot's motion was interfaced onto the PIC.

REGULATOR IC 7805

Based on the commercial IC7805 voltage regulator, the +5V was supplied to the circuit. The voltage regulator accepts any input voltage between 8 to 18 volts that contains all circuitry needed. It is also produce a steady +5 volt output, accurate to within 5% (0.25 volt). To protect the IC from damaged in case of excessive load current
by reduce its output, the circuit need to contain a current-limiting circuitry and thermal overload protection.

![7805 Pin out](image)

**Figure 3.2.2.3: 7805 Pin out**

**CRYSTAL OSCILLATOR**

According to Aleena Emmanuel et al, a crystal oscillator is used to provide the clock for the PIC that has a very stable Q equivalently to RLC circuit. The crystal provides 8 MHz clock oscillates at its resonating frequency to the PIC. It requires resistors and capacitors and oscillates properly.