HUMANOID ROBOT DEVELOPMENT

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This report is submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Computer Engineering) With Honours

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Dedicated to my beloved family especially my parents

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ABSTRACT

This project target is to design and develop a humanoid robot where it can walk on two feet. Seen from past projects, many humanoid robots are basically build biped only. There is no body and arms, only legs. The robot also needs to be build with high stability so that it doesn't fall easily. The main objective of the project is to build a humanoid robot that is able to have at least walking function. The design and development of the robot is using Lego Mindstorms. The most important thing to consider in designing the robot is the lower half of the body or the leg segment. This is because the leg segment controls the movement of the robot when walking. Determining which type or style of walking for the robot is crucial because it affect its stability and speed movement. The completed project will be operated on a flat terrain where the robot will move on it as it is programmed.

ABSTRAK

Tujuan projek ini adalah untuk merekabentuk sejenis robot humanoid yang mampu berjalan di atas dua kaki. Setelah dikaji dari projek-projek yang sebelumnya, dilihat bahawa kebanyakan robot yang dibina adalah jenis biped atau dua kaki sahaja. Robot jenis ini tidak mempunyai badan dan tangan. Untuk membina robot ini, rekaannya mestilah stabil dan tidak mudah hilang imbangan. Objektif utama projek ini adalah untuk mereka sejenis robot yang mempunyai sekurang-kurangnya fungsi untuk berjalan. Robot ini dibina dengan menggunakan Lego Mindstorms. Perkara utama yang perlu diambil perhatian dalam mencipta robot ini adalah bahagian bawah robot, iaitu kaki. Hal ini adalah kerana bahagian kaki memainkan peranan terpenting dalam fungsi berjalan pada robot ini. Mengenalpasti teknik dan cara untuk robot ini bergerak juga adalah penting kerana ia member kesan kepada kestabilan dan kelajuan robot berjalan. Projek yang telah selesai akan beroperasi di atas permukaan yang rata dan robot akan dibiarkan bergerak seperti yang telah di programkan.

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LIST OF ABBREVIATIONS

CAD – Computer Assisted Design

CoG – Center of Gravity

CPU – Central Processing Unit

DC – Direct Current

DOF – Degrees of Freedom

GUI – Graphical User Interface

IR – Infrared

NQC – Not Quite C

CHAPTER 1

INTRODUCTION

This chapter describes the introduction for the project. The topic that will be covered is the description of the project, objectives, problem statement and the project scope.

1.1 Project Description

Humanoid robot is becoming widely popular among consumer electronic fields. As its can function as similar to a human, many researcher has developed walking robot to mimic human movement. To functionalize the walking ability, the kinematic aspect of the robot must firstly be studied. This is important as to ensure that the robot will have better stability while walking.

This project is basically a development on humanoid robot where the robot is capable walking properly as a human. The development of the robot is concentrated on using Lego Mindstorms. On the robot sensors and motors will be placed as means for movement and detection.. The movement of the robot will be control by the Lego Mindstorms brick. The programming language that will be used for this project is NQC (Not Quite C).

1.2 Project Objectives

1.2.1 Humanoid robots development using Lego Mindstorms platform.

All of the robot's part will be used from the Lego Mindstorms kit. This includes the control unit which is the RCX Brick, sensors and motors.

1.2.2 A fully functional robot with walking capabilities.

The robot will be able to walk normally on a flat surface without any problem with a certain speed.

1.2.3 To apply kinematics on the robot so that it could have a smooth and stable movement.

Kinematics and basic mechanical principal is used in building the robot so that it will have a smooth and stable movement.

1.3 Problem Statement

1.3.1 Past robots have difficulties stabilizing during walking. The most important feature in having a robot walking is not to let it fall easily. This is to ensure of having a smooth movement without any occurrences of difficulties.

1.3.2 The speed of movement for the robot. Having a lot of load will give a toll on the motor that will reduce the movement speed. The robot should be light enough or having much powerful motor.

1.3.3 An existing past project about a walking robot. The walking robot only imitates the lower part of a human that is the leg only.

1.4 Project Scope

1.4.1 Humanoid robot that is capable of walking on flat terrain.

The robot is capable to walk on a flat terrain where there is no obstacle. Basically, the robot will move forward on a flat surface.

1.4.2 Development using at least 2 sets of Lego Mindstorms.

This means that, the development of the robot will used at least 2 set of RCX Bricks. In every RCX Bricks contain 3 ports for inputs and 3 ports of output. So, literally the robot will have at most 6 motors for its movement and 6 input sensor as means for detection.

1.4.3 Brickcc and programming software and by using NQC Language.

This software is used to program the RCX Bricks. The software used the NQC language for programming. The software helps to run and simulate the RCX Bricks.

1.4.4 LeoCAD, MLCad, LDraw and Lego Digital Design are used for the purpose of designing and prototyping.

The CAD design software helps in designing the robot. The importance of the CAD is that the list of equipment in the CAD helps in for searching the best parts for designing and developing the robot.

CHAPTER 2

LITERATURE REVIEW

In this chapter, the background study or the literature review will be discuss and explain in detail. The concept of the project, the theory, and the base of idea for the project will be discussed in detail. The explanation will be also be followed by figures and model appropriate.

2.1 Overview

In robotic, the most important aspect that needs to be considered is the mechanics. This is because robots are basically a mechanical device that uses electronic system as its controller. This means that the study of mechanical must first to be learned, while the electronics comes later. This is to ensure that the development of the robot will go smoothly without any hiccups. It also helps in designing the kinematic of the robots.

2.2 Past Project

The past projects of the humanoid robot are mostly the build of the lower part of the body which is the leg. This natural to see because of the most important feature of a humanoid robot is to walk. After having some research done, the result was that I discovered that the most favorite technique used in walking movement is the center of gravity shifting.

2.2.1 Center of gravity shifting method

The center of gravity (CoG) shifting method is basically a method where the robot is tilted to a side. This will result in having the robot to stand on one foot, practically making the other hanging. The hanging foot then will move forward in mid air and the robot is tilted back to normal state. The procedure is repeated vice versa and this will make robot as it is moving forward.

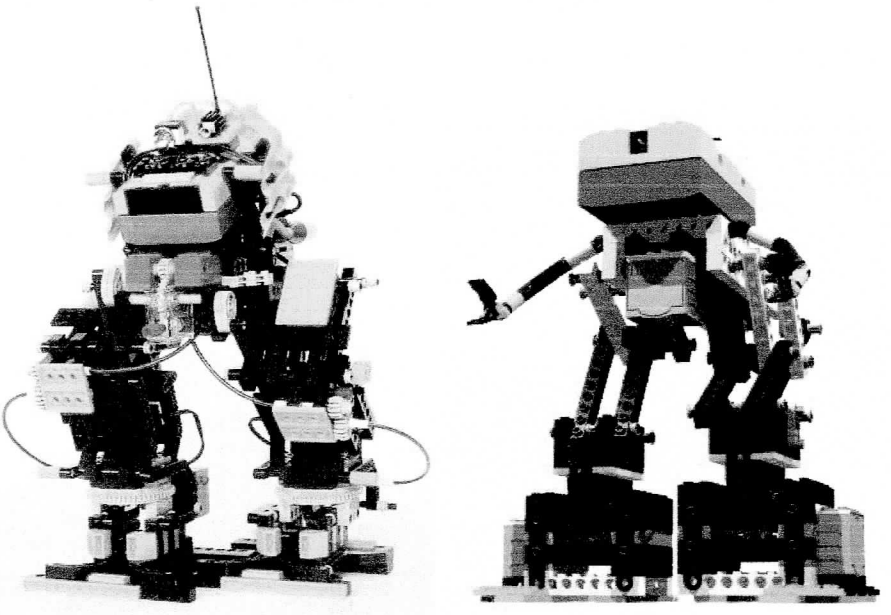

Figure 2.1: Past project Model

2.3 Degrees of Freedom

In mechanics, degrees of freedom (DOF) are the set of independent displacements that specify completely the displaced or deformed position of the body or system.

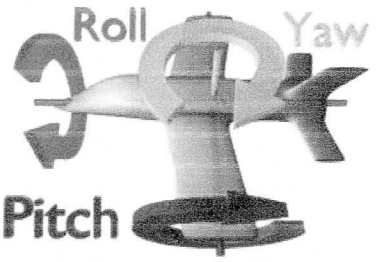

Figure 2.2: DOF Movement

A system with several bodies would have a combined DOF that is the sum of the DOFs of the bodies, less the internal constraints they may have on relative motion. A mechanism or linkage containing a number of connected rigid bodies may have more than the degrees of freedom for a single rigid body. Here the term *degrees of freedom* are used to describe the number of parameters needed to specify the spatial pose of a linkage.

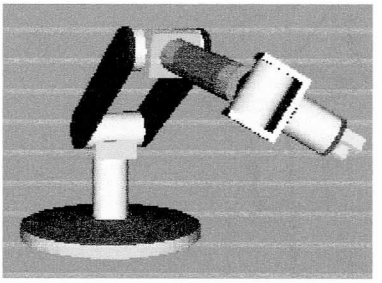

Figure 2.3: Arm system Model

A specific type of linkage is the open kinematic chain, where a set of rigid links are connected at joints; a joint may provide one DOF (hinge/sliding), or two (cylindrical). Such chains occur commonly in robotics, biomechanics and for satellites and other space structures. A human arm is considered to have seven DOFs. A shoulder gives pitch, yaw and roll, an elbow allows for pitch, and a wrist allows for pitch, yaw and roll. Only 3 of those movements would be necessary to move the hand to any point in space, but people would lack the ability to grasp things from different angles or directions.

A robot (or object) that has mechanisms to control all 6 physical DOF is said to be holonomic. An object with fewer controllable DOF than total DOF is said to be non-holonomic, and an object with more controllable DOF than total DOF (such as the human arm) is said to be redundant.

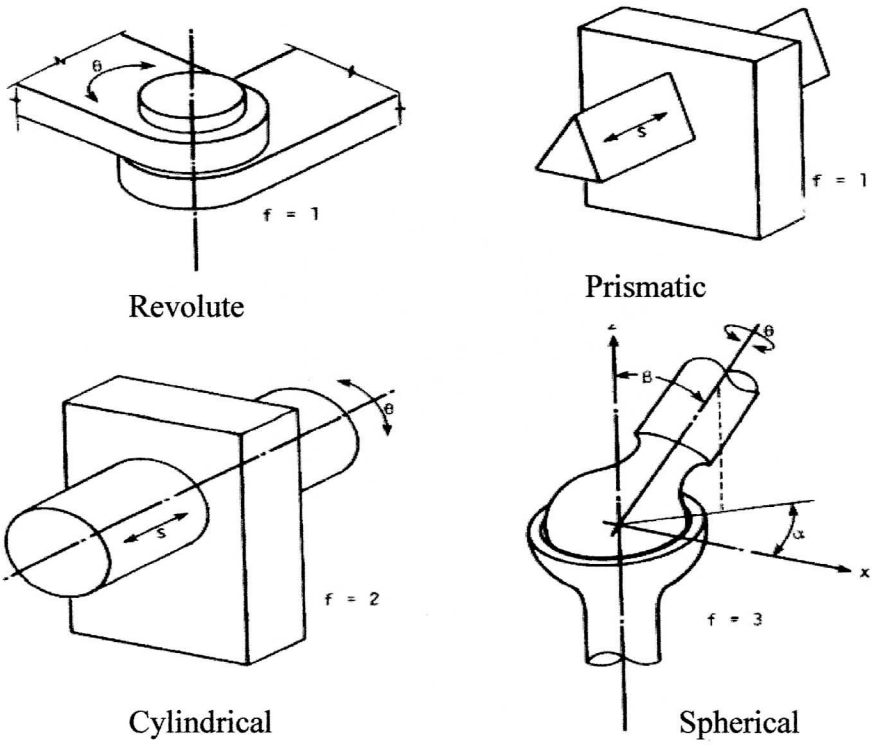

Figure 2.4: Example of DOF

2.4 Gearing

A gear is a device where it uses rotational force to move another gear or device connected to it. Gears have teeth that are use as means for moving another gear that mesh to it. The teeth of the gear provide good force transfer as it avoids slippage.

2.4.1 Types of gear

2.4.1.1 Spur Gear

Spur gears are the simplest, and probably most common, type of gear. Their general form is a cylinder or disk (a disk is just a short cylinder). The teeth project radials and the leading edges of the teeth are aligned parallel to the axis of rotation. These gears can only mesh correctly if they are fitted to parallel axles.

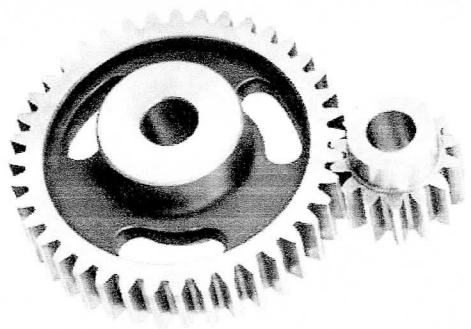

Figure 2.5: Spur Gear