HUMANOID ROBOT DEVELOPMENT

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DEDICATION

Special dedicated to my beloved parents, family and fellow friends, who had strongly encouraged and supported me in my entire journey of learning.

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ABSTRACT

This project is to design and build robot that are capable of bipedal motion. Bipedal motion is a complex motion in humans, and even harder to simulate exactly using mechanical structures. The main objective of the project is to build a humanoid robot that is able to stand and walk. Electronic and mechanical skills provide the knowledge to create a feasible design using LEGO Mindstroms and is programmed by NQC languages. The robot is build with a high stability and balance so that it does not fall easily. The most important thing in the design is the lower part of the body or the leg segment. This is because the leg segment controls the movement of the robot when walking and standing. The type or style of walking for the robot is crucial because it affect its stability and movement speed.

ABSTRAK

Projek ini bertujuan merekabentuk dan membina robot berkaki dua yang mampu bergerak. Pergerakan robot berkaki dua adalah pergerakan manusia yang kompleks dan sukar untuk dipersembahkannya mengunakan struktur mekanikal. Objektif utama projek ini adalah untuk mereka sejenis robot yang mampu berdiri dan berjalan. Kemahiran elektronik and mekanikal memberi pengetahuan untuk merekebentuk robot yang fleksibel dengan menggunakan LEGO Mindstroms dan diaturcara menggunakan bahasa NQC. Robot ini dibina dengan kestabilan yang tinggi dan seimbang agar tidak mudah jatuh. Bahagian yang paling penting dalam merekabentuk adalah bahagian yang paling bawah atau kaki robot tersebut. Ini kerana bahagian kaki yang menampung berat atau mengawal pergerakan robot tersebut ketika berdiri dan berjalan. Cara – cara berjalan juga perlu ditentukan kerana ia mempengaruhi kesatabilan dan kelajuan pergerakan.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLE

LIST OF ABBREVIATIONS

NQC	**-**	**Not Quite C**
IR	**-**	**Infrared**
DC	**-**	**Direct Current**
CoG	**-**	**Center of Gravity**

CHAPTER I

INTRODUCTION OF PROJECT

1.1 Introduction

Robot is a machine whose behavior can be programmed. Basically, robots have five fundamental components such as a brain to controls the robot's action and respond to sensory input, a robot's body is simply the physical chassis that hold the other pieces of the robot together, actuators (motor) to allow the robot to move, sensors to give a robot information about its environment and a power source supplies to run the brain, actuators and sensors.

This project is basically a development on humanoid robot where the robot is capable walking properly as a human. Designing the kinematics that describes the motion of objects without consideration of the circumstances leading to the motion and programming of a full-fledge humanoid robot. The system will be developed using a minimum 3 sets of LEGO Mindstorms. The set comes with a robot brain (controller) called the RCX (Robotic Command Explorer). It has three input ports, three output ports, four push-buttons and an infrared (IR) serial communication interface. The robot is using sensors and motors as detector and for the robot's movement. The movement of the robot will be control by the LEGO Mindstroms bricks. The programming language that will be used is Not Quite C (NQC).

1.2 Objectives

1) Design and develop humanoid robotic system using LEGO mindstorms.
2) To develop a model of human movement, structure to mimic walking movement.
3) To utilize sensors and motors that act as human joint to performs the movement.

1.3 Problems Statements

1) Most of the robot not stable enough, it will fall easily when it make a movement. It because the robot have no balancing (Dynamic systems).
2) Problems of control and execution are concerned with correcting deviation from references trajectories and dynamically modifying these trajectories during execution to avoid unexpected obstacles.

1.4 Scope of Project

1) Using 3 brick LEGO MindStorms to create the humanoid robot that could stand and walk.
2) It uses RCX brick as a controller or robot's brain.
3) The robot also uses a sensor to measures some attribute like position, orientation, speed and surrounding environment.
4) DC motors is used for motion in the robot such as muscles and joints.

1.5 Report Structures

1.5.1 Chapter 1

Chapter 1 provides a plan for the creation of the LEGO Humanoid Robot. It does this by listing the objectives, problem statement, scope, and the methodology of the project.

1.5.2 Chapter 2

Chapter 2 details how bipedal and humanoid robots have been develop in the past and what can be learnt from those efforts. Chapter 2 also provides background information on the human form including bone structure and how they combine within the human skeleton.

1.5.3 Chapter 3

Chapter 3 details the process of how the robot was created and also provides background information on the parts and materials that are going to be used in the design of the LEGO humanoid robot.

1.5.4 Chapter 4

Chapter 4 details the result that obtained based on the methodology that used. The obtained result will be analyze and based on the objectives and problem statement.

1.5.5 Chapter 5

Chapter 5 is about the discussion and summary of project achievement. It also includes the conclusion and recommendation that can be taken for future improvement of the project.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter deals with the work done by other researchers who have investigated about mechanical design of a humanoid. The concept behind the commencement of the program was to create a robot that could coexist and cooperate with human beings, by doing what a person cannot do and cultivating a new dimension immobility both of which would add value to society.

2.2 The Honda Humanoid

The Honda Humanoid Robot, *The Honda Humanoid Robot*, research began in 1986 with a development program. The Honda P2 and P3 biped robots shown in figure 2.2a is some of the very few that closely resemble a human structure and performance. Honda began its research towards humanoid robots in 1986. At the time, knowledge on legged locomotion was sparse and Honda started by studying bipedal walking mechanisms. Their aim was to develop a robot able to coexist and collaborate with humans and to perform tasks that humans cannot.

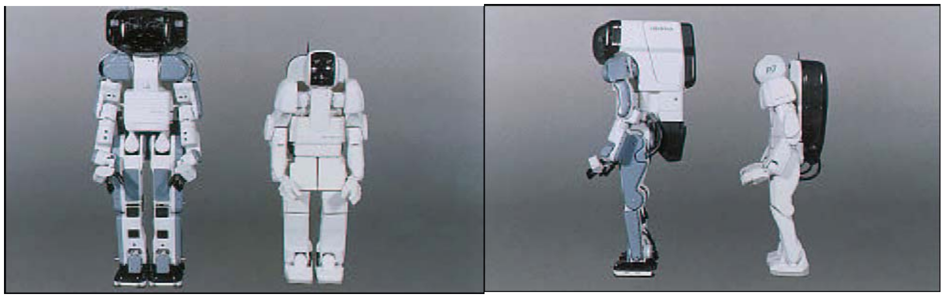

Figure 2.1: Front and Side view of P2 and P3. P3 is some 22 cm shorter and 80 kg lighter.

The engineers at Honda began their research on the .foot/leg walking mobile function; which corresponds to basic human mobility.

The studies that were conducted were:

1) Movement of leg/foot joints when walking
2) Joint alignment
3) Dimensions, weights and centre of gravity of each leg and foot
4) Torque application to the joints when walking
5) Sensor systems required for walking
6) Landing impact when walking

For the data gathered from the research into these areas the Honda Engineers were able to develop a model for stable walking. The model for stable walking worked by applying pressure to a part of the plantar to avoid falling while walking and at standstill. If the sensors judged that the pressure is not enough to keep the robot stable, the movement of mechanical limbs would alter the centre of gravity.

2.3 PREAMBLE

This robot is a single-RCX biped with the ability to turn within its own footprint. It's also first foray into doing a 'tough-looking' robot, as opposed to one that is purely functional.

Turning works by advancing the robot until the leg that leads the turn is in front (e.g., the right leg is forward for a right turn). To make a right turn, the robot takes its weight on the right foot (left leg off the ground) and turns the right ankle turntable about 15° to the right; it then takes half a step back onto the left foot, raising the right foot so that it can straighten the right ankle. It then moves its weight forward onto the right foot again, turns the ankle another 15°, and so on. This procedure can repeated until the robot has turned the desired amount. The advantage of turning in this way is that the robot turns pretty much within its own footprint, no requirement for maneuvering in large-diameter circles.

2.3.1 Mechanics

The lower (belly) motor drives a worm-24t gearbox. The axle from the 24t gear connects to two cams, one for each leg, offset 180°, lifting and moving the legs alternately to provide a walking action.

The two motors mounted high on the rear supply power to rotate the large Technic turntables which form the ankles; one motor for each ankle. The power is transferred to the ankles via Znap flexible axles; for each leg, one link runs from the motor to a small double-bevel gear at the 'knee' and drives a medium double-bevel gear is flexi-linked to the worm screw at the back of the 'ankle'. Having heavy legs is really the death of chicken-walker robots like Biped_II because the legs tear off after 10 or so paces -- the Znap flexy-drive links allowed me to put all the weight in a well-braced position at the center of the robot, rather than having the weight of the motors down at the ankles.

Figure 2.2: Preamble robot

The position of the moveable elements is monitored by three rotation sensors: one each for the ankles and one for the drive motor. The ankle sensors each have a 24t gear which is driven by an 8t gear on the same axle as the worm gear that turns the ankle turntable. The drive motor sensor has a pair of 12t gears driven by the 24t gear that is connected to the walking cams.

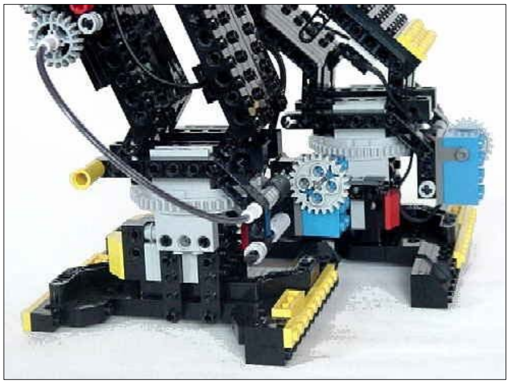

Figure 2.3: Rotation sensors

Figure 2.4: There has been much research into bipedal locomotion and humanoid robots.

2.4 Human Characteristics

There is a wealth of information relating to both the anatomy of a human and human motion. Therefore this was a good starting point in trying to model the walking characteristics of the humanoid robot. The first point to investigate is how the human body is constructed. The next point to investigate was how human walk in a bipedal fashion.