EXPLORING AND DESIGNING ACTUATOR FOR NEONATAL BABY'S LEG SIMULATOR

NURUL FARIHAH BT MUSA

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

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka

JUNE 2015

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : **EXPLORING AND DESIGNING ACTUATOR FOR NEONATAL BABY'S LEG SIMULATOR**

Sesi Pengajian : 1 4 / 1 5

Saya **NURUL FARIHAH BINTI MUSA** mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (√) :

☐	SULIT*	*(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD**	**(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
√	TIDAK TERHAD	

Disahkan oleh:

(TANDATANGAN PENULIS)

(COP DAN TANDATANGAN PENYELIA)

SANI IRWAN BIN MD SALIM
Pensyarah Kanan
Fakulti Kejuruteraan Elektronik & Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka
Hang Tuah Jaya
76100 Durian Tunggal
Melaka

Tarikh: 8 JUN 2015

Tarikh: 8 JUN 2015

"I hearby declare that I have read this report and in my opinion this report is sufficient in terms of the scope and quality for the award of Bachelor of Electronic Engineering (Electronic Industry) with honours"

Signature : ....

Author : NURUL FARIHAH BT MUSA

Date : 8TH JUNE 2015

"I / we hereby declare that I have read this in my / our work is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering (Industrial Electronics)."

Signature	: ....
Name of Supervisor	: EN. SANI IRWAN BIN MD SALIM
Date	: 8 JUNE 2015

This thesis is dedicated to my beloved family,My friends and My supervisor
For the support and inspire me throughout my journey of education.

ACKNOWLEDGEMENT

First of all, many thanks to Almighty God for giving me the strength and motivation to finish the task that given to me. I like to thank my parent for the support, understanding and encouragement to fulfil my task of completing the PSM and this thesis. I also would like to sincerely thank my supervisor, En. Sani Irwan Bin Md Salim, for his guidance and support throughout and especially for his confidence. Forgive me if there is wrong doing that I have done in the time you supervising me. I also indebted to Universiti Teknikal Malaysia Melaka (UTeM) library for the assist on supplying the knowledge and relevant research to accomplish my project. To all my friends, thank you for the support, understanding, motivation and encouragement in the way of accomplishing this project. Thank for giving the ideas and borrowing any equipment that was used to complete the project. Your friendship makes my life wonderful. Lastly, I like to thank all people that contribute directly or indirectly to accomplish my project. My God bless you all for the help given

ABSTRACT

Actuators are one of the key components contained in any industrial system. The current implementation of the manikin is huge and the accuracy of movement is far from the real experiences. For that, need actuators which fit into the very small space inside the body. These actuators need to generate the leg movements. For this leg, power consumption, and size major issues.The servo motor is used to "move" in a robot-like legs, arms and ankles.Making the right choice for the actuator and a mechanism that allow the movement required is not a straightforward task. The premature baby's leg is moving around 45 degrees. This is because premature baby's are weak in motion. Usually premature baby not doing more movement because they are born too early means that not matured like a normal baby. Micro servo is chosen because of its smaller size compared to the stepper motor in the market. Besides through investigation of the requirement can be theoretically deduced, a good amount of practical experience in mechanical design is needed to bring the task to a good end.

ABSTRAK

Penggerak adalah salah satu komponen penting yang terkandung dalam mana-mana sistem perindustrian. Oleh itu, projek ini menerangkan secara ringkas dan mudah mengenai reka bentuk, penggerak untuk kaki bayi baru lahir, pergerakan simulator menggunakan penggerak ke dalam kaki bayi. Pergerakan bayi yang biasa dengan ketepatan pergerakan bayi pramatang jauh dari pengalaman sebenar. Untuk itu, sebuah penggerak yang perlu dimuatkan ke dalam ruang yang sangat kecil di dalam kaki robot. Penggerak ini perlu menjana pergerakan kaki. Untuk kaki ini, penggunaan kuasa, saiz dan sebagainya adalah utama. 'Micro servo' digunakan sebagai penggerak di dalam robot seperti kaki, lengan, dan pergelangan kaki. Membuat pilihan yang tepat untuk mencari penggerak yang sesuai yang membolehkan kaki bayi bergerak dan bersaiz kecil adalah ttidak mudah. Kaki bayi pra-matang yang bergerak kira-kira 45 darjah. Ini kerana bayi pramatang masih lemah dalam gerakan. Biasanya bayi pra-matang tidak melakukan pergerakan lebih kerana mereka dilahirkan terlalu awal bermakna tidak matang seperti bayi normal. 'Micro servo' dipilih kerana saiz yang lebih kecil berbanding dengan motor stepper di dalam pasaran. Selain melalui penyiasatan boleh disimpulkan secara teori, pengalaman praktikal yang baik dalam mereka bentuk mekanikal yang diperlukan untuk membawa tugas untuk akhir yang baik.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURE

CHAPTER I

INTRODUCTION

1.1 Introduction

This section discusses the overall project, including project background, problem statement, project objectives and scope of the project.

1.2 Background

A newborn baby's first movements may appear jerky and random. However, usually the newborn baby moves in a pattern or rhythm. For example, if the newborn baby is active and alert, the baby will tend to start moving her arms and legs, then slow down and stop, and repeat the process after a second or minute. Some newborn babies move more or less frequently than others. They may move in rhythm with their mother's voice.

The smaller the size of the baby at birth, or the lower the birth weight, the baby more to need support to develop survive at all. According to the WHO, babies born weighing less than 2500 grams is defined as low birth weight babies.Although the majority of premature babies develop into healthy children, there are many different types of problems associated with prematurity. Even when everything is "normal", prematurity itself has many challenges.Additionally, premature babies are somewhat more fragile than term babies. Though is not usually a problem, a premature birth exposes the baby to more injury sources, including possibly the birth itself. Premature babies have small size and light weight. A newborn baby's will move his legs and his hands first. If the baby was moving actively, the movement his hands and legs will be more aggressive and will sometimes slowly and sometimes stop. Then he would repeat it after one or two minutes. Muscle baby is one factor in the development of motor skills baby premature. The normal babies have normal muscle. With arm and legs tucked into the body, premature baby able to keep his movement in a nice flexible position.

Actuators are one of the key components contained in any industrial system. Electromechanical actuator is used in the industry for a variety of applications. Therefore, well describes and simple briefly about the design, actuators for neonatal baby's leg, movement simulator using actuator are integrated into baby legs. In this chapter also include the problem statement that needs actuators which fit into the very small space to inside the body.These actuators need to generate the leg movements. Hence, to build the micro motor, we need a small actuator to put in a robot. The servo motor is used to "move" in a robot-like legs, arms, ankles and fingers. The generator is like a muscle robot, the parts that convert stored energy into movement. The most popular actuators are electric motor that drives a remote control car, remote control television and gear for use in the development of robotics in industries. In addition, arm and chest also require an actuator to move it.

1.3 Problem Statement

The current implementation of the manikin is huge and the accuracy of movement is far from the real experiences. For that, need actuators which fit into the very small space inside the body. These actuators need to generate the leg movements. For this leg, power consumption, size and so on is major issues.

1.4 Objective of the project

The aim of this project:

1. To study the neonate's baby's movement, especially the legs.
2. To design an actuator for baby's leg, movement simulator.
3. To analyze leg muscle in term of movement, power consumption and size.

1.5 Project Scope

The scopes of the software are as follows.

i. Write and control program is based on the programming language C.

. The scope of the hardware is as follows:

i. Arduino MotoDUINO used in this project as the main medium in driving two servo motors with an Arduino board and control the motor speed.
ii. The leg movement involves 2 DOF.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

Background research projects have been carried out before the start of the project with information about the movements of the neonate's especially baby’s leg. Among the things that should be emphasized is the type of technology, methodology and methods of control used. This chapter will discuss and review available literature on.

This section describe an actuator as a mechanical device for controlling a mechanism or system to create movement in the robot such as electrical motor, pneumatic actuator and hydraulic actuators. Actuators are like muscles in human bodies. Without the actuators, the baby's leg robot cannot make a movement. There are some types of actuators in industries, but only electric motors are used in this project. There are comparisons of some actuators. Following the comparison an actuator was made on the method of actuator for the baby's leg robot.

2.2 Hybrid Actuator for Robot Manipulators: Design, Control and Performance.

This journal purposes a new method used two available actuation technologies, DC servo motors and polymer bladder type actuators. Through a suitable control applied to the hybrid actuator, independent control of joint torsional stiffness, and joint position is made possible. DC servo motors are used to cover for muscle actuator length changes; hence the joint position is not affected. The computed torque technique has been implemented with the hybrid actuator in place, utilizing high gain feedback on the servo motors, to achieve the stated goals. However, the currently is underway to formulate control strategies that do not depend so heavily on knowledge of the subsystem dynamic parameters. [1]

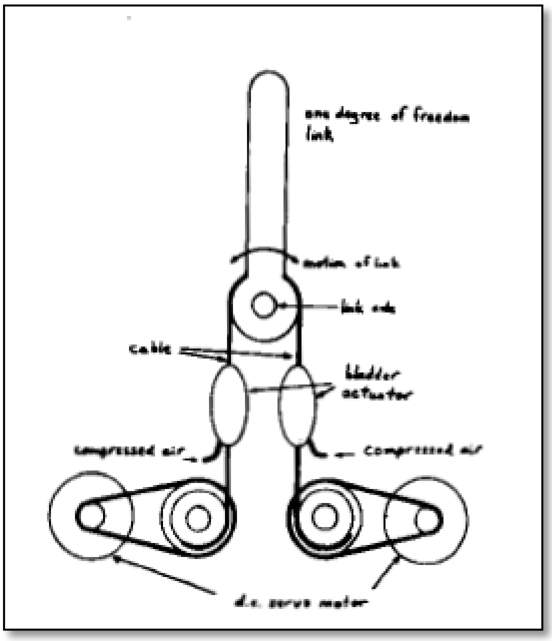


Figure 2.2.1: Proposed hybrid actuator

The Figure 2.2.1 shows the journal discussed about a linear relationship between bladder stiffness coefficient and internal air pressure. This is because the actual performances of stiffness coefficient are more complicated.

2.3 Design and Control of a Manipulator Arm Driven by Pneumatic Muscle Actuators.

This journal used the pneumatic artificial muscles (PAMs) as are methodical in the experiment. Figure 2.3.1 shows the operating principle of PAM. Pneumatic systems are very commonly used in industrial robotics because their power to weight ratio and simplicity. Pneumatic muscle is able to pulling actuator operated by gas pressure. Powered by compressed gas, artificial muscle actuator contracts lengthwise when expands and convert the radically expansive force into axial being contracted force. Various types of pneumatic actuators used in industrial environment are cylinders, pneumatic motors, pneumatic stepper motors and bellows. The problem statement in this paper is problems connected to the accuracy of control and the nonlinearities of pneumatic systems have prevented their widespread use in high precise servo systems and advanced robotic systems. For the experiment results have shown good in dynamic performances of the closed loop system, but steady-state error might not satisfy some advanced controlled systems. In order to get better positional accuracy, some advanced control approaches can be used. Pneumatic artificial muscles are undoubtedly very suitable actuators for new types of industrial robots. [2]

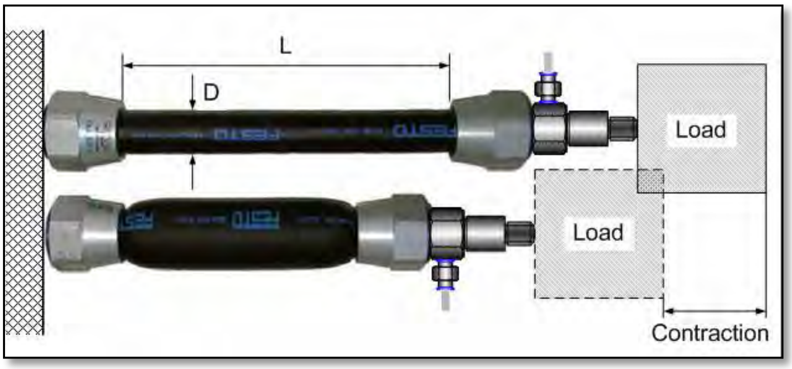


Figure 2.3.1: Operating principle of PAM.

These methods are used in this journal similar with McKibben artificial muscles. [3] From the studies, it consists of an inflatable and flexible membrane (closed rubber tube) and two connection flanges along which they power some mechanical load.

2.4 Improvement of Operation Speed for The legged Robot With Wheels by Intelligent Motion Control.

Build a robot that can move worthy of using wheels and should move in a stable on the floor who doesn't mind using the wheeled legs. The creeping movement is more excellent compared with walking at the point of simplicity and stability of gait. But to build the robot using a creeping movement, the speed of the robot is slow. Moreover, by subtracting the weight of the robot can power-up of the actuator can increase the movement of the robot. Therefore, maximum torque, efficient usage of actuator and velocity changes need to be recorded. They proposed to improvement torque ratio, so;

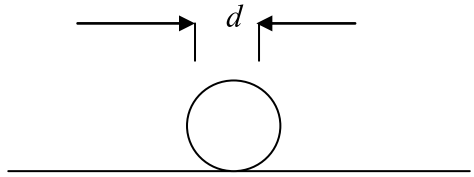
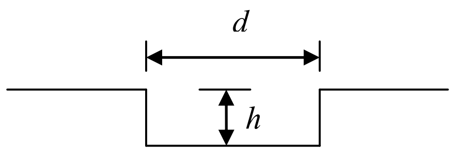
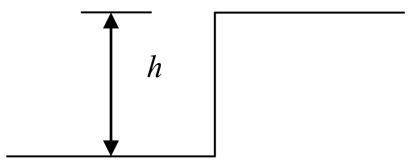
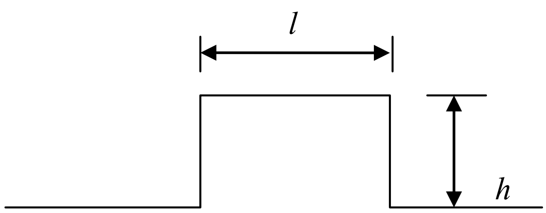
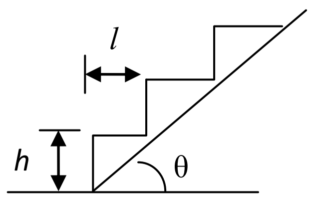
$$\frac{T_{max}}{T_{rat}}$$

T_{rat} : Motor rating torque

T_{max} : Motor maximum torque [Nm]

This journal used five different types of flooring to take decisions record distance for a robot. The Figure 2.4.1 shows the 5 types of floor and the results show this method is successful. The involves that not necessarily a robot without high powered motor cannot go a long distance. [3]

Table 2.4.1: Five Types Of Floor

1) Pipe		*d* = 50mm
2) Slot		*d*= 50 mm *h*= no limit
3) Step		*h*= 100 mm
4) Convex		*h* = 100mm *l* = 200mm
5) Stair		*h* = 250 mm *l* = 250 mm $\theta = 45^o$

2.5 Design and Control of a Two-Wheel Self-Balancing Robot using the Arduino Microcontroller Board.

Arduino is open-source with a large user community and up-to-date discussion forums. This allows students to study other users' codes, compare results, and make modifications according to the project's needs. Arduino boards are low-cost and expandable, where optional peripherals called shields can be purchased as and when needed. The Figure 2.5.1 shows the balancing robot and this journal reviewing a student project about the design, construction robot and control two-wheeled self-balancing robot. The Robot uses two DC motors and Arduino ATmega 2560, proportional-integral-differential (PID) and linear-quadratic regulator (LQR) as control design. LQR control can be implemented as a PI-PD controller and the PID control is chosen because it is easy to learn and implement, for which text book design methods are available. Motor selection for the balancing robot emphasizes torque output instead of velocity, because it has to oppose the rotational moment that gravity applies to the robot. Hence, the motors need to provide enough torque to correct the robot's body pose back to a balanced state. In the result, the design has been successfully done to offset the self robot using low cost components. The PID control is chosen because it is easy to learn and implement, for which textbooks design methods are available. [4]

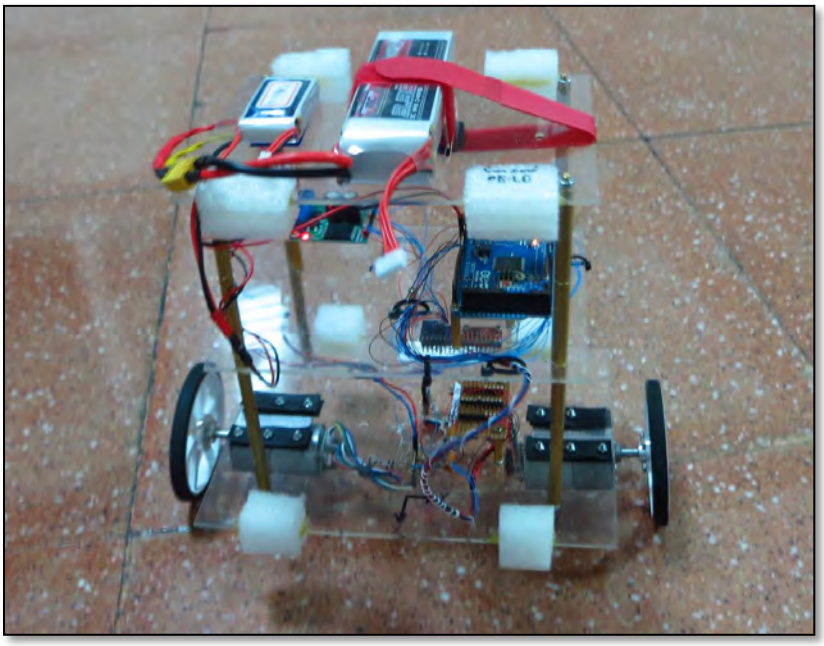


Figure 2.5.1: Balancing robot

2.6 Measurement and Modelling of McKibben Pneumatic Artificial Muscles.

This journal reviewing about the McKibben artificial muscle. It is developed in the 1950's, but was too complicated to control until the 1990's. McKibben muscles are an actuator which converts pneumatic (or hydraulic) energy into mechanical form by transferring the pressure applied to the inner surface of its bladder into the shortening tension. The Figure 2.6.1 shows the model of McKibben muscle. Energy efficiency is most important in driving energy efficiency. So, some simulation in describing the high efficiency can be introduced. According to thermodynamics, mechanical energy is transformed into gas internal energy or heat when a gas is compressed, and gas internal energy or heat is transformed back to mechanical energy when gas is expanded (except a free expansion). Besides that, the actuator can produce positive net mechanical work if it shortens at higher pressure under larger tension and lengthens at lower pressure under smaller tension (if the tension in shortening and in lengthening is the same, there will be no network produced). However, the actual energy efficiency of the actuator will be lower due to additional non ideal energy losses. For the conclusion, the pneumatic system, which provides control and power to the actuator, still needs a lot of improvement. [5]

Figure 2.6.1: McKibben Muscle