EXPLORING AND DESIGNING ACTUATOR FOR NEONATAL BABY'S CHEST SIMULATOR

AHMAD WITRY QUAYUM BIN MOHD NOR

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

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 CHEST SIMULATOR**
Sesi Pengajian	:	1 4 / 1 5

Saya **AHMAD WITRY QUAYUM BIN MOHD NOR** 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

DECLARATION

I hereby, declare that this report EXPLORING AND DESIGNING ACTUATOR FOR NEONATAL BABY'S CHEST SIMULATOR is the result of my own research expect as cited in the references.

Signature : ....

Author : AHMAD WITRY QUAYUM BIN MOHD NOR

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

DEDICATION

This thesis is dedicated to my beloved family,my friends and my supervisor for the support and motivation.

ACKNOWLEDGEMENT

First of all, much 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 FYP 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 person that contribute direct 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. Therefore, well describes and simple briefly about the design, actuators for neonatal baby‟s chest, movement simulator using actuator are integrated into baby chest. 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 chest movements. For this chest, power consumption, size and so on is major issues.The servo motor is used to "move" in a robot chest. Making the right choice for the actuator and a mechanism that allow the movement required is not a straightforward task. 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 are choosen 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 dada robot bayi pramatang. Pergerakan simulator digunakan bagi menggerakkan penggerak dalam dada bayi. Pergerakan bayi normal dengan ketepatan pergerakan bayi pramatang adalah berbeza. Oleh itu, sebuah penggerak yang mampu dimuatkan ke dalam ruang yang sangat kecil di dalam dada robot direka. Penggerak ini perlu menjana pergerakan dada. Untuk dada ini, penggunaan kuasa dan saiz adalah factor utama. „Micro servo" digunakan sebagai penggerak di dalam robot dada. Dengan membuat pilihan yang tepat untuk penggerak dan mekanisme yang membolehkan pergerakan yang dilakukan bukan merupakan satu tugas yang mudah. Ini kerana bayi pramatang adalah lemah untuk bergerak. Biasanya bayi pramatang tidak melakukan banyak pergerakan kerana minggu kelahirannya terlalu awal dan tidak matang seperti bayi normal. „Micro servo" dipilih kerana saiz yang lebih kecil berbanding dengan motor stepper dalam pasaran. Melalui penyiasatan, boleh disimpulkan secara teori bahawa, pengalaman praktikal adalah lebih baik dalam mereka bentuk sesuatu mekanikal yang diperlukan untuk mendapatkan hasil yang berkualiti.

TABLE OF CONTENTS

List of Table

List of Figure

CHAPTER I

INTRODUCTION

1.1 Introduction

Chapter one covers the introduction part of this project. It is contains of background, objectives, problem statements and scopes of the project.

1.2 Background

Prematurity is the term used to describe when a baby is born early. For most women, pregnancy lasts around 40 weeks. Babies that are born between 37 and 42 weeks are considered full-term and babies born before 37 weeks are considered premature In Australia just over 8% of all babies are born prematurely and approximately 15% of all babies need admittance into a Newborn Intensive Care Unit or Special Care Nursery.

According to the latest Australia's Mothers and Babies report, of all premature babies born in Australia, approximately:

- 79% were born between 32 and 36 weeks of gestation.
- 10% were born between 28 and 31 weeks of gestation.
- 11% were born at less than 28 weeks of gestation.

Other terms often used for prematurity include „premmie", „prem" and „pre-term". Pre-term birth is associated with a higher risk of neonatal problems.

With the advancement of science and technology, rapid development of robotic has been increasing from year to year. Robot is a re-programmable, multi-functional manipulator (or device) designed to move materials, parts, tools or specialized devices through variable programmed motion of a variety task.

Actuator for neonatal baby's chest simulator is an actuator that capable of movement in chest for robot baby. Micro servo can be used to move the baby chest. The project develops a manikin of premature born baby for medical simulation. For that an actuator is needed which fit into the very small space inside the body. These actuators must be capable generate the chest movement of the baby.

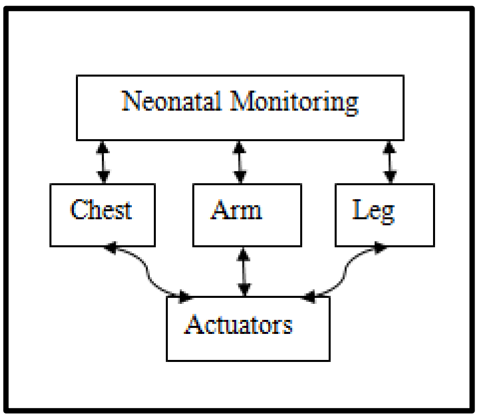

Figure 1.1: Block diagram of manikin construction of premature baby.

Referring to figure above, there are other areas involving manikin construction of premature baby.

1.3 Objectives of project

The main objectives of this study are:

(a) To investigate the neonate‟s baby‟s movement specify in chest movement.
(b) To analyze manikin baby‟s chest muscle in term of movement, power consumption and size.
(c) To construct an actuators for baby‟s chest‟s movement simulation.

1.4 Problem statement

Current implementation of premature baby manikin is not accurate and not mimicking the real experience.

1.5 Scope of the project

The scopes of the software are as follows.

(a) To write and control program is based on the programming language C.

The scope of the hardware is as follows:

(a) Arduino UNO used in this project as the main medium in driving a micro servo motor and control the pulse with modulation.
(b) Chest movements involve breathe-in and breathe-out.

CHAPTER II

LITERATURE REVIEW

2.1 Chapter Overview

This chapter presents an overview on the related topic and the background related to this project. This chapter covers servo motors literature review. Several journals and reports have been analysed carefully in order to improve the effectiveness and quality of this project. By analysing the previous projects, the possibilities that affect the quality in their project can be analysed and review. In previous project, there are some methods or strategies that could be done to improve the project"s outcome. Throughout analysis at the beginning of the project, the special feature in this project is determined and the components are used in this project are decided.

2.2 Electro-Pneumatic Pressure Servo-Control for a Miniature Robot with Rubber Actuator. [1]

This paper presents a new system of pneumatic system robot using rubber actuator.

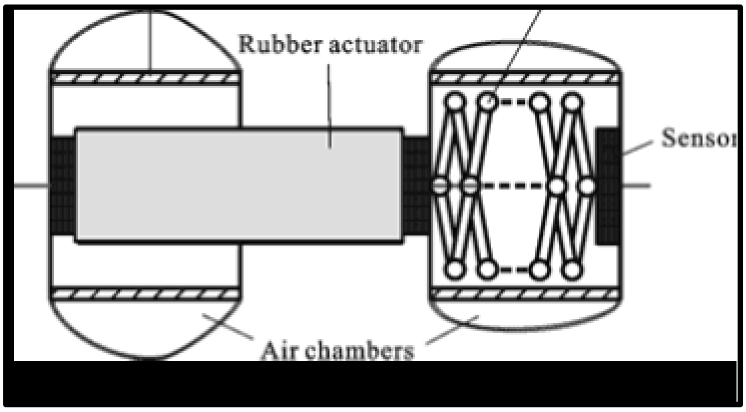

Figure 2.1: Structure of the robotic pneumatic pressure control system.

Figure above shows the structure of a flexible miniature robot system which can move in human cavities. It makes inchworm-like movement driven by a 3-DOF pneumatic rubber actuator and holds its positions by air chambers. The driving characteristic models in axial and bending directions of the actuator were set up, and an electro pneumatic pressure control system for the locomotion of the robot was designed. The nonlinear characteristics of pneumatic pressure-position servo-control system were analyzed; the fluid flow characteristic equation in pipe and the electromagnetic valve on-off characteristic equation were set up. Experiments proved the pressure in all air chambers of robot system can be controlled more accurately by adopting the PWM (Pulse Width Modulation) technique, and the robot could move smoothly through the electro-pneumatic pressure control system. The study is the base of effective control for the locomotion of the miniature pneumatic robot.

Structure of the pneumatic robot is composed of three parts: the front holder, the driving part and the rear holder. In moving state, the holders are used to hold the position of the system body and the driving part is used to change the positions of the holders. The two holders are designed with cylindrical structure and covered with air chambers outside. Each holder has two interconnected air chambers; when charged, the two chambers are kept in the same pressure, and hold tightly against the inner wall. The driving part is a pneumatic rubber actuator made of fiber- reinforced rubber with three degrees of freedom. The actuator rubber tube is divided into three identical sector chambers. When the three chambers of the actuator are charged with the same air pressure, the actuator will stretch in axial direction, and when only one of them is charged, the actuator will bend to the direction opposite to the other chambers. So the actuator can drive in axial and any bending directions.

Figure 2.2: Rubber used in an actuator.

Figure above shows the structure of the rubber actuator is shown. The rubber tube is made of copper thread-reinforced rubber and the inner tube is divided into three identical sector chambers. The thread is in spiral shape, and the angle between the spiral and the rubber tube axis is about 80 degree.

2.3 A Physiological Torso Model for Realistic Breathing Simulation. [2]

For the convincing modeling of virtual humans, realistic breathing is an important aspect. This paper is about the simulation of breathing, based on anatomical and physiological principles. The paper has built a torso, including a thorax, a deformable belly, and muscles. This results in a model with two independent breathing systems, namely abdominal and chest breathing, which gives a high degree of realism in simulating breathing. The generated spiral grams, diagrams of lung volume changes, are comparable to normal human ones according to a medical expert. The generated image show convincing breathing sequences at various frequencies. The model itself is made available for public use.

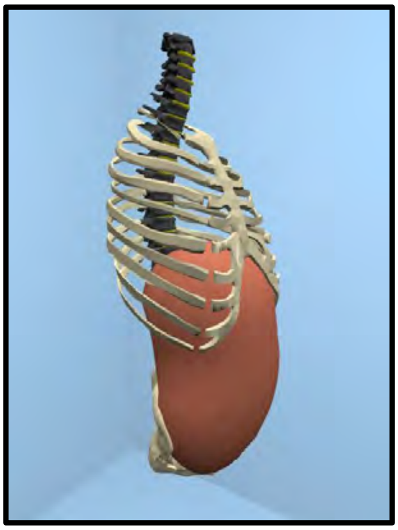

Figure 2.3: Rib-cage from the breathing animation.

From this simulation, it can take as an example of human breathing system. Even though it is only a simulation in other software but it helps to imagine and design the situation of lung. This journal suggested placing a rubber as a lung in this project. And the other will support the rubber to be fit and comfortably in manikin robot baby.

In order to alleviate the shortcomings of previous models, a physiological torso model have designed a new model that better combines the abdominal and chest breathing, resulting in more natural spiral grams and animations. As an initial basis we used a torso from 3D Cafe .This model have divided this polygonal into its constituent parts: ribs, dorsal vertebra, hip, shoulder blade, and collarbone, which are made rigid, so that constraints can be applied.

2.4 Active Variable Stiffness Elastic Actuator: Design and Application for Safe Physical Human-Robot Interaction. [3]

In classical robotic applications, robotic systems consist of servo motors, high-ratio reduction and rigid links; mechanical designers prefer to design robotic applications as stiff as possible to make robots manipulate with remarkable speed and precise position movements. However, these robotic applications can hardly interact with people and environments under safety constraints. It poses the very fundamental problem of ensuring safety to humans and protecting the robot. This paper presents an Active Variable Stiffness Elastic Actuator (AVSEA) that is designed and application for safe physical human robot interaction. The AVSEA consists of two DC-motors: one is used to control the position of the joint and the other is used to adjust the stiffness of the system. The stiffness is generated by a leaf spring. By changing the effective length of the leaf spring, AVSEA has the ability to minimize large impact forces due to shocks, to safely interact with the user and/or to become as stiff as possible to make precise position movements or trajectory tracking control easier.

In this section, experiments were conducted to evaluate the properties and abilities of the Active Variable Stiffness Elastic Actuator (AVSEA). The picture of the AVSEA which consists of two DC-motors, one ball screw and a leaf spring. The rotation of the axis is measured by an encoder which is fixed on the output link. Dimensions of the AVSEA, design parameters and some detailed specification are listed in the Table below.

Table 2.1: The Specifications of AVSEA

PARAMETERS	Value
Mass (include two motors)	2.2 kg
Length*Width*Height	120*110*90 mm
DC-motor	2
Max. Output Torque	29 Nm
Max. Output Speed	60 rpm
Max. Stiffness	Equivalent to rigid joint stiffness
Min. Stiffness	0.085Nm/deg
Motion Space	±150*
Leaf spring (thickness* width)	3*10 mm
Max. Output Link Deflection	±40*

* The input motors used in this prototype design are Faulhaber DC-micro motor 3863W024CR with 38/2 gear head of which reduction ration is 1:14.

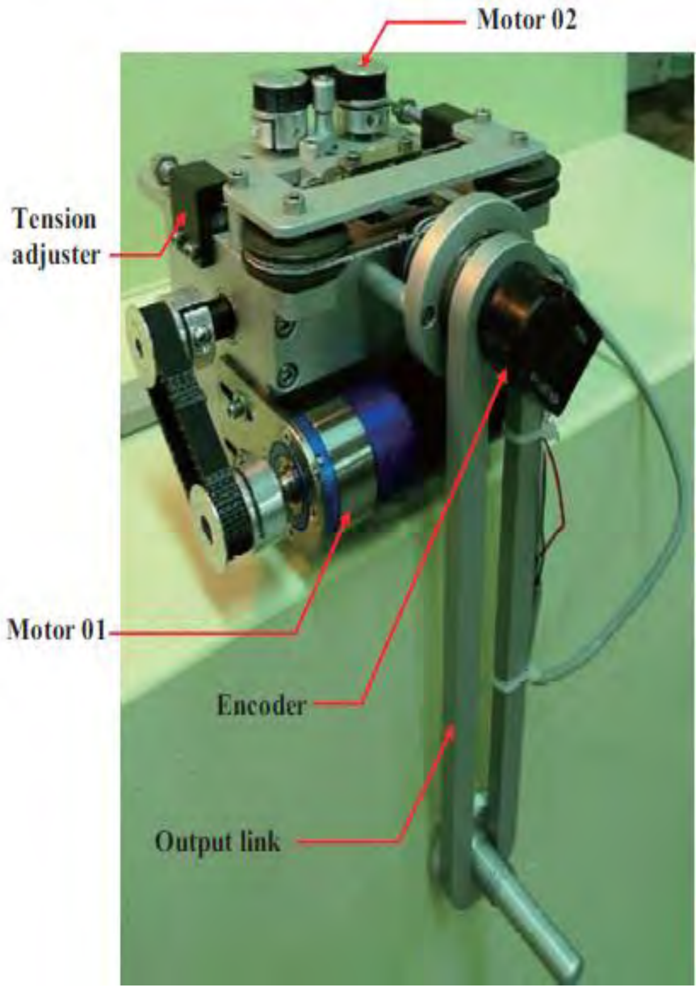

Figure 2.4: Active Variable Stiffness Elastic Actuator (AVSEA).

Adaptive Compliant Property, an experiment was designed to interpret the adaptive compliant property of the AVSEA. The experiment comprises four stages. First, by using a simple PID controller, the output link of the AVSEA was rotated and kept in a vertical direction. Second, the output link of AVSEA was manually deflected in a counterclockwise direction away from the 0° (equilibrium point) with the situation whereby the motor was still working. Third, the output link was deflected in a clockwise direction. Fourth, the link was released. The result is a plot of the angle with time and the photograph shows the beginning and finishing position