



Faculty of Manufacturing Engineering

**DESIGN OF MECHANICAL DEVICE FOR STROKE
SYNDROME AFTER REHABILITATION**

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**Master of Manufacturing Engineering (Industrial
Engineering)**

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**DESIGN OF MECHANICAL DEVICE FOR STROKE SYNDROME AFTER
REHABILITATION**

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**A thesis submitted
in fulfillment of the requirements for the degree of Master of Manufacturing
Engineering (Industrial Engineering)**

Faculty of Manufacturing Engineering

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DECLARATION

I declare that this thesis entitled “Design Mechanical Device for Stroke Syndrome after Rehabilitation” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

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Date : **December 2018**

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Manufacturing Engineering (Industrial Engineering)

Signature :

Supervisor Name : **Dr. Rosidah binti Jaafar**

Date : **December 2018**

DEDICATION

A special dedication to,

My beloved father, Zainal Abdin bin Mat Noor

My beloved mother, Siti Zabedah binti Fakeh Mokhti

My lovely wife, Azurawani binti Abdullah,

My first Son, Muhammad Arsyad,

My second Daughter, Nurain Umairah,

My third Son, Muhammad Asyraaf,

My forth Daughter, Nurin Aqilah,

Also to all lecturers,

Thank you very much,

Dr. Rosidah binti Jaafar

For the good support and tolerate in this Master Thesis.

To all my best friend,

Thanks for all your support and cares,

Give support to me,

In order to successfully graduate

‘Alhamdulillah’

ABSTRACT

Technologies had a major role in medicine becoming more specialized. Many medical technologies allowed specific parts of the body to be studied, diagnosed or treated. This led to doctors who specialized in certain organs. Without doubt, medical technology is indispensable to people's health and improved quality of life. It also contributes billions of dollars to the economy. There are many benefits that innovative technology brings to the table when it comes to healthcare. Technology today affects every single aspect of modern society. In fact, there isn't an industry out there that hasn't been affected by the hi-tech revolution. Whether we are talking about transportation, communication, security, banking or healthcare, they all rely on technology in one way or another. But nowhere is this immense impact more apparent than in the field of medicine and healthcare. Modern technology has changed the structure and organization of the entire medical field. From widespread adoption of electronic medical records, to advances in bio-medical engineering and technology, modern healthcare and its delivery methods are changing at an ever increasing rate. Nowadays, application of technology automation system gives a lot of contributions to the advancement of science and engineering. This project focus as on how technology automation can assist Stroke Syndrome patient in their rehabilitation process. Through designed which include the appropriate engineering analysis, automation control system development and the corresponding hardware arrangement, we can aid the patient of this syndrome get a better treatment. This system treatment designed base on the traditional method of rehabilitation with an addition to the automation technology. The automotion system is more comfortable to all the patient. This project can make more easier and suitable condition especially to the all patient Stroke Syndrome.

ABSTRAK

Teknologi mempunyai peranan utama dalam bidang perubatan menjadi lebih khusus. Banyak teknologi perubatan dibenarkan mengkaji bahagian-bahagian tertentu badan, diagnosis atau dirawat. Tanpa ragu-ragu, teknologi perubatan adalah amat diperlukan untuk kesihatan manusia dan kualiti hidup yang lebih baik. Ia juga menyumbang berbilion-bilion dolar kepada ekonomi. Terdapat banyak manfaat bahawa teknologi inovatif membawa ke hadapan, apabila ia datang kepada penjagaan kesihatan. Teknologi hari ini memberi kesan kepada setiap aspek kehidupan masyarakat moden. Malah, tidak ada satu industri di luar sana yang tidak terjejas oleh revolusi teknologi tinggi. Sama ada bercakap mengenai pengangkutan, komunikasi, keselamatan, perbankan atau penjagaan kesihatan, mereka semua bergantung kepada teknologi dalam satu cara atau yang lain. Tetapi tidak ada adalah kesan yang besar, ini lebih jelas daripada dalam bidang perubatan dan penjagaan kesihatan. Teknologi moden telah mengubah struktur dan organisasi bidang perubatan keseluruhan. Dari penggunaan meluas rekod perubatan elektronik, kemajuan dalam kejuruteraan bio-perubatan dan teknologi, penjagaan kesihatan moden dan kaedah penyampaiannya berubah pada kadar yang semakin meningkat. Pada masa kini, penggunaan sistem automasi teknologi memberikan banyak sumbangan kepada kemajuan sains dan kejuruteraan. Fokus projek seperti ini ialah bagaimana automasi teknologi boleh membantu pesakit Stroke Syndrome dalam proses pemulihan mereka selepas pembedahan. Melalui masalah ini ia direka, termasuk menganalisis yang sesuai terhadap kejuruteraan, pembangunan sistem kawalan automasi dan susunan perkakasan yang sama, boleh membantu pesakit sindrom ini mendapatkan rawatan yang lebih baik. Ini rawatan sistem yang direka berdasarkan kaedah tradisional pemulihan dengan tambahan kepada teknologi haptic, realiti maya. Sistem teknologi automotion lebih selesa untuk semua pesakit. Projek ini boleh membuat lebih mudah dan sesuai terhadap keadaan terutama kepada semua pesakit Stroke Syndrome.

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LIST OF SYMBOLS

D, d	-	Diameter
F	-	Force
g	-	Gravity = 9.81 m/s
I	-	Moment of inertia
l	-	Length
m	-	Mass
N	-	Rotational velocity
P	-	Pressure
Q	-	Volumetric flow-rate
r	-	Radius
T	-	Torque
Re	-	Reynolds number
V	-	Velocity
w	-	Angular velocity
x	-	Displacement
z	-	Height
q	-	Angle
r	-	Density

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CHAPTER 1

INTRODUCTION

1.1 Background

A stroke is a medical emergency. Prompt treatment is crucial. Early action can minimize brain damage and potential complications. A stroke occurs when the blood supply to part of your brain is interrupted or reduced, depriving brain tissue of oxygen and nutrients. In the minutes, brain cells begin to die.

The good news is that strokes can be treated and prevented. Recovery and rehabilitation are among the most important aspects of stroke treatment. In some cases, undamaged areas of the brain may be able to perform functions that were lost when the stroke occurred. Rehabilitation includes physical therapy, speech therapy and occupational therapy. This type of recovery is measured in months to years.

Physical therapy involves using exercise and other physical means (e.g., massage, heat) and may help patients regain the use of their arms and legs and prevent muscle stiffness in patients with permanent paralysis.

- Speech therapy may help patients regain the ability to speak.
- Occupational therapy may help patients regain independent function and relearn basic skills (e.g., getting dressed, preparing a meal and bathing).

Apart from this traditional rehabilitation technique, there is a growing need to study the new concept of rehabilitation for stroke syndrome. (J.S. Balami R.L. Chen. 2013)

1.2 Problem Statement

Modern treatments for ischemic and haemorrhagic stroke have reached an advanced state of development in the modern era of digital and device technology. Neurointerventional treatments enable surgical procedures in the brain without the need to open the skull surgically and provide excellent treatment alternatives for all forms of stroke and cerebrovascular disease. These developments are timely, occurring in an era when stroke incidence is on the rise as the population ages.

The main concept of this rehabilitation activity is to make the hand move against certain predefined resistance repetitively. The simplest rehabilitation activity is squeezing a rubber ball, therapy putty, arm peddlers and arm skates. However, such traditional activities are becoming less popular. With the emergence of automation technology, the alternative rehabilitation activities to replace the traditional rehabilitation techniques. Therefore, it is a must that a study on developing the new concept of rehabilitation for stroke syndrome using automation technology.

1.3 Objective of the Study

Objective of the Study are:

1. To study the requirement from survey for the design of device that support stroke rehabilitation after stroke treatment or surgery.
2. To design the device automation technology for rehabilitation process after stroke syndrome treatment or surgery.
3. To validate the design automation technology of the device for safety by testing device and part of material.

1.4 Scope of Study

The scopes of this project are:

1. The design automation technology for stroke syndrome rehabilitation device after surgery.
2. The main part of the device must be fully mechanical or aided by mechanical actuators and control by electronic device.
3. The design can be connected to the latest automation technology.
4. Design of control circuit for actuator not to be include.

1.5 Significance of the Study

Although currently there is a simple rehabilitation activity such as squeezing a rubber ball, therapy putty, arm peddlers and arm skates there is a demand to bring the automation technology into this activity. The findings of this project will help the stroke syndrome patient get a new concept of rehabilitation which will make them eager to do the activity. Furthermore, with this project carried out, it will make this community alert about this symptom and more extensive studies could be planned for the future.

1.6 Research Planning

Activity planning of this research is outlined in Gantt Chart.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This section will explain about the Stroke Syndrome, treatment for Stroke Syndrome, the type of surgery offered and the rehabilitation method after treatment or surgery. It also explains about human anthropometric study. Other than that, this section will discuss about automation technology and how we can make use of this technology to treat Stroke Syndrome patient.

2.2 Stroke Syndrome

A stroke syndrome is a set of symptoms that helps to identify which part of the brain has been injured in stroke. The earliest classical syndromes were described in the 19th century and since then many new stroke syndromes have been discovered. Recent advances in neuroimaging have allowed many of the classical stroke syndromes previously described on clinical pathological basis or during autopsy to be confirmed. (Schmidtd. Classical Brain Stem Syndrome, 2000).

A stroke may be caused by a blocked artery (Ischemic Stroke) or the leaking or bursting of a blood vessel (Haemorrhagic Stroke) (Feigin VL, Rinkel GJ, Lawes CM, Algra A, Bennett DA, van Gijn J, Anderson CS (2005)). Some people may experience only a temporary disruption of blood flow to the brain (transient ischemic attack, or TIA) that doesn't cause permanent damage.

2.2.1 Ischemic stroke

About 80 percent of strokes are ischemic strokes. Ischemic strokes occur when the arteries to your brain become narrowed or blocked, causing severely reduced blood flow (ischemia) (Stam J (April 2005)). The most common ischemic strokes include:

- **Thrombotic stroke.** A thrombotic stroke occurs when a blood clot (thrombus) forms in one of the arteries that supply blood to your brain. A clot may be caused by fatty deposits (plaque) that build up in arteries and cause reduced blood flow (atherosclerosis) or other artery conditions.
- **Embolic stroke.** An embolic stroke occurs when a blood clot or other debris forms away from your brain, commonly in your heart and is swept through your bloodstream to lodge in narrower brain arteries. This type of blood clot is called an embolus (Donnan GA, Fisher M, Macleod M, Davis SM (May 2008)) .

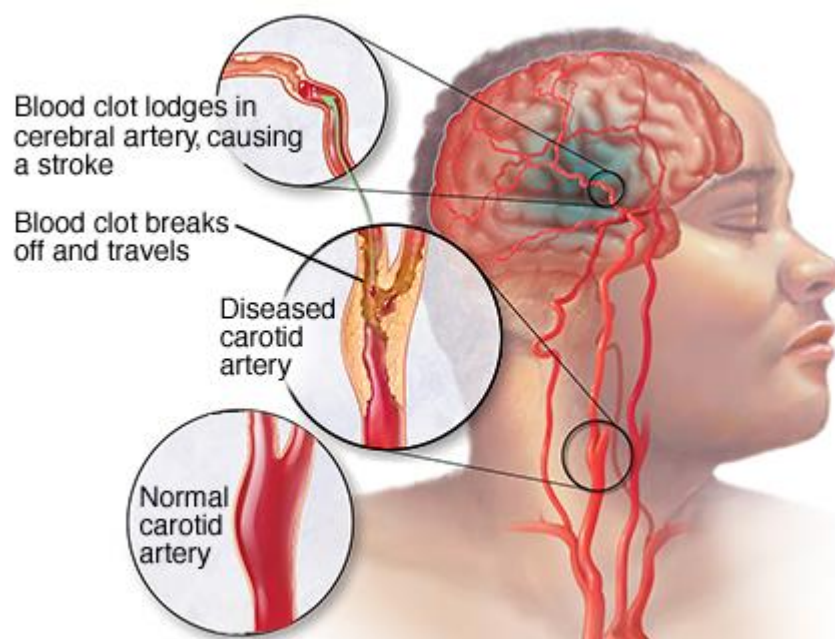


Figure 2. 1 : Stroke Syndrome (Ischemic Stroke)
(Source : *MAYO Foundation For Medical Education and Research*)

2.2.2 Haemorrhagic Stroke

Haemorrhagic stroke occurs when a blood vessel in your brain leaks or ruptures. Brain haemorrhages can result from many conditions that affect your blood vessels. These include:

- Uncontrolled high blood pressure (hypertension)
- Overtreatment with anticoagulants (blood thinners)
- Weak spots in your blood vessel walls (aneurysms)

A less common cause of haemorrhage is the rupture of an abnormal tangle of thin-walled blood vessels (arteriovenous malformation) (Hanley DF. 2009). Types of haemorrhagic stroke include:

- **Intracerebral haemorrhage.** In an intracerebral haemorrhage, a blood vessel in the brain bursts and spills into the surrounding brain tissue, damaging brain cells. Brain cells beyond the leak are deprived of blood and are also damaged. High blood pressure, trauma, vascular malformations, use of blood-thinning medications and other conditions may cause an intracerebral haemorrhage. (Steiner T, Vincent C, Morris S, Davis S, Vallejo-Torres L, ChristensenMC. 2011)
- **Subarachnoid haemorrhage.** In a subarachnoid haemorrhage, an artery on or near the surface of your brain bursts and spills into the space between the surface of your brain and your skull. This bleeding is often signalled by a sudden, severe headache. A subarachnoid haemorrhage is commonly caused by the bursting of a small sack-shaped or berry-shaped aneurysm. After the haemorrhage, the blood vessels in your brain may widen and narrow erratically (vasospasm), causing brain cell damage by further limiting blood flow. (Astri Luoma. 2013)

2.2.3 Transient Ischemic Attack (TIA)

A transient ischemic attack (TIA), sometimes known as a ministroke, is a temporary period of symptoms similar to those you'd have in a stroke. A temporary decrease in blood supply to part of your brain causes TIAs, which may last as little as five minutes.

Like an ischemic stroke, a TIA occurs when a clot or debris blocks blood flow to part of your nervous system, but there is no permanent tissue damage and no lasting symptoms.

Seek emergency care even if your symptoms seem to clear up. Having a TIA puts you at greater risk of having a full-blown stroke, causing permanent damage later. If you've had a TIA, it means there's likely a partially blocked or narrowed artery leading to your brain or a clot source in the heart.

It's not possible to tell if you're having a stroke or a TIA based only on your symptoms. Even when symptoms last for under an hour, there is still a risk of permanent tissue damage.(Albers GW, Caplan LR, Easton JD, Fayad PB, Mohr JP, Saver JL, Sherman DG, 2002)

2.3 Symptom of Stroke Syndrome

The range and severity of early stroke symptoms vary considerably, but they share the common characteristic of being sudden. Warning signs may include some or all of the following symptoms:

- Dizziness, nausea or vomiting
- Unusually severe headache
- Confusion, disorientation or memory loss
- Numbness, weakness in an arm, leg or the face, especially on one side

- Abnormal or slurred speech
- Difficulty with comprehension
- Loss of vision or difficulty seeing
- Loss of balance, coordination or the ability to walk

2.4 Who Has Higher Risk?

Many factors can increase your stroke risk. Some factors can also increase your chances of having a heart attack. Potentially treatable stroke risk factors include:

2.4.1 Lifestyle Risk Factors

- Being overweight or obese
- Physical inactivity
- Heavy or binge drinking
- Use of illicit drugs such as cocaine and methamphetamines

2.4.2 Medical Risk Factors

- Blood pressure readings higher than 120/80 millimetres of mercury (mm Hg)
- Cigarette smoking or exposure to second-hand smoke
- High cholesterol
- Diabetes
- Obstructive sleep apnea
- Cardiovascular disease, including heart failure, heart defects, heart infection or abnormal heart rhythm
- Personal or family history of stroke, heart attack or transient ischemic attack.

2.4.3 Other Factors Associated With A Higher Risk Of Stroke Include:

- Age - People age 55 or older have a higher risk of stroke than do younger people.
- Race - African-Americans have a higher risk of stroke than do people of other races.
- Sex - Men have a higher risk of stroke than women. Women are usually older when they have strokes, and they're more likely to die of strokes than are men.
- Hormones - use of birth control pills or hormone therapies that include estrogen, as well as increased estrogen levels from pregnancy and childbirth.

Table 2. 1 : Prevalence of stroke by age and sex, NHANES 1998 – 2002.

Age, y	Men, %	Women, %
20-34	0.4	0.3
35-44	1.1	0.8
45-54	1.2	2.1

(Source: The Official Journal of the American Academy of Neurology. Aneesh B. Singhal, MD, José Biller, MD, Mitchell S. Elkind, MD, MS, MPhil, Heather J. Fullerton, MD, Edward C. Jauch, MD, Steven J. Kittner, MD, Deborah A. Levine, MD, MPH, and Steven R. Levine, MD)

Table 2.2 : A Typical Stroke Syndrome.

Nonlocalizing symptoms
Neuropsychiatric symptoms
Acute confusional state/delirium
Depressed level of consciousness
Abnormal movements
Chorea
Hemiballismus
Dystonia
Unilateral asterixis
Hemifacial spasm
Alien hand syndrome/deafferentation
Limb-shaking TIAs
Seizures secondary to stroke
Cranial neuropathies
Acute vestibular syndrome
Acute hearing loss
Ischemic optic neuropathy
Horner syndrome
Third nerve palsy
Seventh nerve palsy
Other cranial neuropathies
Isolated symptoms
Isolated dysarthria
Isolated dysphagia/stridor
Isolated facial paresis
Monoparesis of arm or leg or a part of limb or distal extremity
Isolated sensory symptoms
Isolated visual loss
Isolated headache
Headache

(Source: Adapted from The Lancet Neurology, 10, Edlow JA, Selim MH. A typical presentations of acute cerebrovascular syndromes.)