



Faculty of Electrical and Electronic Engineering Technology



DEVELOPMENT OF AI BASED POST STROKE REHABILITATION



Bachelor of Electronics Engineering Technology with Honours

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DEVELOPMENT OF AI BASED POST STROKE REHABILITATION

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in partial fulfillment of the requirements for the degree of
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Faculty of Electrical and Electronic Engineering Technology

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I declare that this project report entitled “Development of AI Based Post Stroke Rehabilitation” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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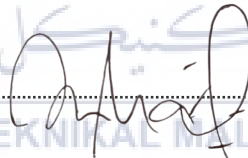


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DEDICATION

I am honored to dedicate my final year project to all of you who have supported me and believed in me throughout my academic journey. Your encouragement and guidance have been invaluable to me, and I am forever grateful for your love and support.

To my family, thank you for always being there for me and for your endless love and patience. Your sacrifices and belief in me have allowed me to pursue my dreams and I am so grateful for everything you have done for me.

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Sincerely, Amirul Aiman Bin Lokmanul Hakim

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ABSTRACT

Stroke is the most common cause of long-term impairment in developed countries. In addition, it becomes a major health issue with a high rate of death and morbidity. Rehabilitation is crucial to regain premorbid functionality of the patient. Thus, this project entitled “Development of AI Based Post Stroke Rehabilitation” that aims to develop an AI program to detect a correct posture when doing a rehabilitation exercise. This project utilizes PyCharm, MediaPipe pipeline and OpenCV that essential which can create an Artificial Intelligence and machine learning. The MediaPipe library and OpenCV is imported PyCharm software to calculate the keypoint of human joint to detect the correct posture by using an image as reference. After the posture from image is detected, the angle of the posture will be use for detecting the patient posture from computer camera. As the result, this project has been convert into a file program that can be run from a compter. When the program is run, it will turn on the camera and detect the human body keypoint through the camera and identify the correct posture of user in rehabilitation exercise. If the posture of patient is detected, it will show the percentage of correct posture from 0 to 100 percent. When the value is 100, the posture is in a correct angle of starting posture. The value will change according to the angle of the posture. When the value is 0 percent, that mean the angle has met the correct final angle posture. After the final value that is 0 percent is met, a counter value will start to count up and a timer will started. The timer has been set for 1 minutes. After the timer had finished, it will screenshot the screen and saved in a file. In a nut shell, the development of this project could help the patient to do a rehabilitation correctly at home.

ABSTRAK

Strok merupakan salah satu punca kemerosotan kepada sesebuah negara membangun dalam jangka masa panjang. Tambahan lagi, ia menjadi satu isu kesihatan yang mempunyai kadar kematian dan pesakit yang tinggi. Rehabilitasi amatlah penting untuk mendapatkan semula fungsi badan sebelum terjadinya stroke. Oleh itu, projek ini dinamakan “Development of AI Based Post Stroke Rehabilitation” bertujuan untuk membina sebuah program komputer untuk mengenalpasti postur badan yang betul ketika melakukan proses rehabilitasi. Projek ini menggunakan PyCharm, Mediapipe dan juga OpenCV yang amat penting untuk menghasilkan kecerdasan buatan (AI) dan pembelajaran mesin. Fungsi Mediapipe akan dan OpenCV akan dimasukkan ke dalam PyCharm untuk mengira kedudukan titik sendi dan mengenalpasti postur badan yang betul dengan menggunakan gambar sebuah senaman sebagai rujukan. Selepas postur badan dikenalpasti daripada gambar, sudut setiap postur badan itu ada digunakan untuk mengenalpasti postur badan pesakit melalui kamera komputer. Sebagai hasil, projek ini telah ditukar kepada satu bentuk fail program yang boleh dijalankan dari komputer. Apabila program ini dijalankan, ia akan menghidupkan kamera komputer dan mengesan titik badan manusia melalui kamera tersebut dan mengenalpasti postur yang betul pengguna ketika melakukan senaman rehabilitasi. Jika postur pesakit dikesan, ia akan menunjukkan peratusan postur yang tepat daripada nilai 0 hingga 100 peratus. Apabila nilainya ialah 100, ia menandakan postur badan adalah tepat dan berada pada permulaan postur senaman. Nilai peratusan akan berubah mengikut sudut postur pesakit. Apabila nilai ialah 0 peratus, ia bermakna sudut postur sudah dicapai bagi kedudukan postur terakhir senaman. Selepas nilai terakhir iaitu 0 peratus telah dicapai, pengiraan akan dibuat dan pengiraan masa akan dibuat untuk jangka masa 1 minit. Selepas masa telah tamat, paparan skrin tersebut akan ditangkap dan disimpan ke dalam fail. Kesimpulannya, pembangunan projek ini dapat membantu pesakit untuk melakukan rehabilitasi dengan betul ketika berada di rumah.

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LIST OF SYMBOLS

- ° - Degrees
- % - Percent



LIST OF ABBREVIATIONS

AI	-	Artificial Intelligence
Apps	-	Application
IoT	-	Internet of Things
IDE	-	Intergrated Development Environment
VE	-	Virtual Environment
API	-	Application Programming interface
2D	-	Two Dimensional



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CHAPTER 1

INTRODUCTION

1.1 Background

Stroke is the most common cause of long-term impairment in developed countries. Up to 85% of stroke survivors have arm weakness, with just 20%–56% regaining total motor function after 3 months. Not surprisingly, the degree of motor function recovery had the biggest impact on subjective wellbeing at 1 year after stroke [1]. The symptoms of a stroke vary depending on which parts of the brain are affected. Motor impairment is by far the most frequent stroke complication, affecting 80% of patients and characterized by paralysis of the face, arm, and leg on one side of the body [2]. Stroke is the greatest cause of long-term disabilities among Thailand's elderly. Every year, almost 250,000 new people experience a stroke, a number that is likely to climb in the future years as the frequency of stroke rises with age [3]. Following the stroke treatment, it is critical to begin the rehabilitation procedure in order to rehabilitate lost upper-limb paresis abilities and eventually achieve total recovery[4].

For facial paralysis is a common clinical disease, affecting 20 to 25 persons per 100,000. Nerve injury is the most common cause of this condition. If patients do not receive prompt and appropriate treatment, serious consequences may result. Patients with facial muscle and nerve problems may have distorted facial expressions. The condition has a significant impact on the patient's regular life, job, and socialization in today's "face-to-face" society; thus, the patient's need for rehabilitation is quite urgent. However, there are currently 62 million patients in China that require facial rehabilitation therapy. China, on the other

hand, is one of the countries most affected by facial paralysis. According to the three-tenths of a million-incidence rate, 450,000 new cases are predicted to be added each year. Year after year, the trend continues to rise. The high number of patients makes rehabilitation of facial paralysis challenging [5].

1.2 Problem Statement

Currently, patients that for post stroke rehabilitation need to be monitored face to face from a doctor or medical assistant to do a physical check up. The problem would occur when there is nobody who could help the patient to go to the hospital for an appointment. Moreover, having a face to face check up will drain the patient physically and mentally, which could result in more health problems. Patient also need to use a lot of money and time to do a check up on the hospital [5]. By using an Artificial Intelligence (AI) application, patients can be more flexible on time management for rehabilitation sessions.

1.3 Project Objective

The main aim of this project is:

- a) To develop an Artificial Intelligence application to detect the movement of patient joints through the computer camera.
- b) To identify the correct posture of rehabilitation using camera.
- c) To validate the system to prove the functionality of the application.

1.4 Scope of Project

To avoid any uncertainty of this project due to some limitations and constraints, the scope of the project is defined as follows:

- a) Using camera as the sensor to detect the joint of human body part.
- b) Using MediaPipe Library as the body detection framework.
- c) Using PyCharm to design and produce the interface.
- d) Using OpenCV function for processing the input images and video.



CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the important information and details which are found by several studies and research from related previous study. Therefore, the discussion begins with the study of what rehabilitation is and what effects it. It is important to research these topics because they are the main objective of this project. Furthermore, as this project involves Artificial Intelligence (AI) technology and, it is vital to study the concepts of the technology to have a clear vision of the scope. In summary, this chapter ends with the comparison of the related previous projects and the type of implementation that will be fit in this project.

2.2 Stroke Definition

In today's modern society, stroke is becoming a major health issue with a high rate of death and morbidity. A stroke occurs when something blocks blood supply to part of the brain or a blood artery in the brain, it will cause the blood vessel to burst. Although recent medical developments have resulted in lower fatality rates, the long-term effects of stroke remain detrimental. Post-stroke therapy improves patient outcomes by lowering the risk of subsequent complications and increasing the patient's ability to function independently despite their disabilities. An interdisciplinary team with experience in the recovery process provides post-stroke rehabilitation. During this phase, certain focal areas are established to ensure a holistic approach. Early discharge planning is critical for making the transition from inpatient rehabilitation to the patient's home environment as smooth as possible. Because

stroke recovery is varied and complex, it's difficult to predict post-stroke results with certainty. However, the value of early intervention and continued outpatient rehabilitation could be stressed.

2.3 The Concept of Rehabilitation

Post-stroke rehabilitation is a patient-centered, goal-oriented approach that aims to help individuals with a range of stroke-related disorders achieve maximum functional independence. The primary goal of post-stroke rehabilitation is to help stroke survivors return to premorbid functionality (or as close to it as possible) within their family, community, and, if possible, work environments. Rehabilitation might take place either in a hospital or in a community setting. In the context of South African healthcare, inpatient rehabilitation is preferred to outpatient rehabilitation, as the latter lacks the intensity of the former. Although admission criteria vary per rehabilitation facility, a stroke patient usually qualifies for inpatient rehabilitation if they require three modalities of therapies or are unable to transfer alone. According to Bryer et al., the majority of stroke patients are treated in public hospitals [6]. Efforts have been made to increase the availability and quality of home-based care and rehabilitation, as well as community-based rehabilitation services, due to a scarcity of inpatient stroke rehabilitation resources in this sector.

Post-stroke rehabilitation usually consists of an interdisciplinary team of healthcare experts which work together to achieve clear, shared goals for a patient's rehabilitation. This is the most successful and efficient method of delivering post-stroke therapy. A more holistic approach is possible with constant and effective communication between team members and patients. Individual experts can also use their skills to complement the experience of another team member thanks to effective team communication. Nurses, medical professionals, physiotherapists, occupational therapists, speech and language therapists, social workers,

and dietitians are frequently part of an interdisciplinary team. Other professions, such as a psychologist or trauma counsellor, may be included to the rehabilitation team in addition to these disciplines, depending on the requirements and preferences of particular patients [1].

2.3.1 Conventional Approach of Post Stroke Rehabilitation

Stroke rehabilitation is divided into two stages: "active" rehabilitation and "preventive" therapy. To obtain the highest potential functional outcome, active rehabilitation encourages intrinsic and adaptive recovery. Early treatment and prevention of problems, and risk factor modification are all part of preventive rehabilitation. A stroke patient's active rehabilitation starts as soon as any disability is detected. The paretic limb must begin passive range of motion exercises as soon as possible. Contractures can be avoided by moving each joint through its full range of movement at least once per day. Occupational therapists start teaching single-handed feeding, grooming, and dressing procedures as early as the first week, depending on the patient's degree of attention and physical condition. These exercises help to prevent issues from immobility and to enhance activities of daily living abilities as soon as possible. The healthy side of the body can be fully utilized to achieve functional independence. There are two types of exercises: passive range of motion exercises and active joint-by-joint workouts. The therapist or caregiver moves various joints through their complete range of motion in passive range of motion exercises [7].

However, going to the hospital for rehabilitation therapy on a regular basis is time-consuming and expensive for patients. Meanwhile, existing medical resources are insufficient to meet the training needs of a significant number of patients. The effectiveness of rehabilitation is poor, and the current treatment regimen ignores the patient's psychological state while undergoing treatment, resulting in a treatment effect that falls short

of their expectations. For doctors, supervising patient rehabilitation training is routine work that consumes a significant number of outpatient visits and reduces the number of patients admitted to the hospital. Furthermore, present diagnosis and treatment are based on the subjective judgements of doctors. The standards of various doctors vary. Additionally, the physical therapist monitors and evaluates the given postures from the exercises throughout the rehabilitation of stroke patients. Nonetheless, a physical therapist may only monitor one patient at a time [5]. Furthermore, teaching and evaluating the corrected postures takes a long time.

2.3.2 Modern Approach of Post Stroke Rehabilitation

The primary principle of modern rehabilitation is task-specific exercise with a high number of repetitions, which is a powerful stimulus for motor learning. More therapy has been linked to improved motor recovery, according to studies on the dose-response relationship. Despite this, traditional therapies are seldom administered as intensively or regularly as they should be due to price, patient fatigue, and therapist availability.

As an example of modern rehabilitation for improving arm motor recovery, a variety of robot-assisted systems have been created, including unilateral, bilateral, proximal arm, and distal arm training devices. In a highly motivating environment, robots encourage high repetition of movements with minimal supervision. Robotic devices should deliver therapy that is relevant to users and follow traditional therapeutic concepts. They should be simple to set up, appealing to users, requiring minimal therapist monitoring, and preferably capable of assessing motor function and therapy effects. According to a recent study, robotic devices may improve upper-limb motor control after stroke but not necessarily functional abilities. Despite the fact that robot devices have the potential to improve upper-limb capabilities after a stroke, the quality of evidence in favour of them is still lacking. For stroke patients with

moderate arm weakness, a few basic and low-cost robotic devices have been tested. In moderately impaired chronic stroke patients who participated in a telerehabilitation program utilizing a simple robotic device, improvements in kinematic and clinical results were recorded. Patients got a minimal therapist monitoring showed high levels of interest, enthusiasm, and satisfaction, according to the study [2].

Another example of related past research on post stroke rehabilitation for upper limb post stroke is by using a Virtual Environment (VE). Given the number of opportunities that Virtual Environments (VE) comprehending serious games may contribute to well-established therapies, their usage for Motor Rehabilitation has risen into a significant topic of attention. In up to 66 percent of instances, stroke-related deficits occur mostly on one side of the patient's body (hemiparesis), rendering the corresponding upper limb weak. Motor rehabilitation therapies are often rigorous and involve several repetitions of key exercises in order to assist the patient in regaining some lost daily functions. According to research, patient enjoyment during training pushes them to accomplish more and more repetitions, which, predictably, leads to a faster and better recovery[8].

In the medical industry, the usage of smartphones apps is becoming more frequent. Furthermore, mobile applications can be utilised for hand rehabilitation, with the limitation that some apps are paid, and others only work on a certain mobile operating system such as Android [9]. Current smartphones have sensors such as a gyroscope, accelerometer, GPS, magnetometer, and many others. These sensors can be used to collect patient data without requiring a lot of equipment, which cuts down on the time it takes to set up home monitoring systems. The built-in accelerometer sensor in a smartphone is used for activity and movement detection, in sync with the Internet of Things (IoT) for observation and signal classification [10]. Meanwhile, to provide an IoT-based upper limb rehabilitation evaluation,