

**AN IMPROVED CNN FOR REHABILITATING PARKINSON'S FREEZING
OF GAIT**



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN

JUDUL: AN IMPROVED CNN FOR REHABILITATING PARKINSON'S FREEZING OF GAIT

SESI PENGAJIAN: 2022 / 2023

Saya: Michelle Tang

mengaku membenarkan tesis Projek Sarjana Muda ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka dengan syarat-syarat kegunaan seperti berikut:

1. Tesis dan projek adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan Fakulti Teknologi Maklumat dan Komunikasi dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan Fakulti Teknologi Maklumat dan Komunikasi dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. * Sila tandakan (✓)

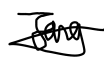
SULIT

(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



(TANDATANGAN PELAJAR)

Alamat tetap: 43, Jalan Kolek, Taman Kapal Layar, Tongkang Pechah, 83010, Batu Pahat, Johor



(TANDATANGAN PENYELIA)

TS. DR. WAN MOHD YA'AKOB BIN WAN BEJURI

Nama Penyelia

Tarikh: 14/9/2023

Tarikh: 14/9/2023

AN IMPROVED CNN FOR SELF REHABILITATING PARKINSON'S FREEZING
OF GAIT

Michelle Tang



This report is submitted in partial fulfillment of the requirements for the
Bachelor of Computer Science (Software Development) with Honours.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022/2023

DECLARATION

I hereby declare that this project report entitled
**AN IMPROVED CNN FOR SELF REHABILITATING PARKINSON'S FREEZING OF
GAIT**

is written by me and is my own effort and that no part has been plagiarized
without citations.

STUDENT

:



(Michelle Tang)Date : 14/9/2023
اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

I hereby declare that I have read this project report and found
this project report is sufficient in term of the scope and quality for the award of
Bachelor of [Computer Science (Software Development)] with Honours.

SUPERVISOR

:


(Ts. Dr. Wan Mohd Ya'akob Bin Wan Bejuri)Date : 14/9/2023**DECLARATION**

DEDICATION

I would like to dedicate this project to my beloved parents, Mr. Tang Hock Seng and Mrs. Ng Lee Peng, whose support will serve as my greatest source of motivation to complete this project. Not only that, I want to thank my supervisor, TS. Dr. Wan Mohd Ya'akob Bin Wan Bejuri, for providing me with guidance, support, and suggestions and counsel for completing this project. Lastly, I dedicate this project to my friends, who have always provided me with patience, unwavering support, and care while working on it.



ACKNOWLEDGEMENTS

I would like to thank my supervisor, TS. Dr. Wan Mohd Ya'akob Bin Wan Bejuri, for his guidance, suggestions, and feedback on this project. The feedback provided is extremely beneficial as I write the report and complete the assignment.

I would also like to thank my beloved parents, who have provided me with mental support and motivation throughout the duration of this project. They restored my energy and encouraged me to continue working on the project.

I would like to thank all of my friends who provided extensive feedback during the project's development; their contributions have enhanced its quality.



ABSTRACT

As the freezing of gait symptoms worsen in a patient with Parkinson's disease, the motion of the extremities becomes increasingly sluggish, one of the most noticeable changes in the freezing of gait symptoms. The symptoms of freezing of gait are currently incurable, and the only method for delaying the progression of the disease is training. The cumulative number of falls rises, resulting in psychological and physical injuries. In addition, the majority of Parkinson's patients who visit the facility for training must make an appointment in advance because therapists can only accept one patient at a time, resulting in inefficiency. This results in a decline in training, which accelerates their condition, while freezing of gait causes their extremities to become increasingly sluggish. Most patients' family members frequently have their occupations and lack patient care training. To address these problems and develop this system, it must be able to predict patient falls, alert, and evaluate the patient's posture during training. During training, this system can assist the therapist in monitoring the patient's walking posture. A warning can be issued immediately when a fall is imminent, and the patient's posture can be evaluated for the therapist's reference. This would reduce therapists' burden and allow them to simultaneously treat multiple patients. This will enhance efficiency. This can reduce the incidence of falls and injuries caused by falls among Parkinson's patients. In addition, the system can be installed in the patient's residence to assist the patient's family members in monitoring and training the patient at home, which can significantly reduce the incidence of falls and monitor and evaluate the patient. In this study, CNN is used to educate the system to predict falls with an accuracy of 95%. This system is anticipated to be able to assist therapists who treat Parkinson's patients in the hospital as well as non-therapist family members.

ABSTRAK

Seiring gejala pembekuan berjalan semakin parah pada pesakit penyakit Parkinson, pergerakan anggota badan semakin lembap, menjadi salah satu perubahan paling ketara dalam gejala pembekuan berjalan. Gejala pembekuan berjalan ketika ini tidak dapat diubah, dan satu-satunya kaedah untuk melambatkan perkembangan penyakit adalah dengan latihan. Jumlah kumulatif jatuh meningkat, menyebabkan kecederaan fizikal dan psikologi. Tambahan pula, majoriti pesakit Parkinson yang mengunjungi fasiliti untuk latihan perlu membuat janji temu terlebih dahulu kerana jururawat hanya mampu menerima seorang pesakit pada satu masa, menyebabkan ketidakcekapan. Ini mengakibatkan penurunan dalam latihan, yang mempercepatkan keadaan mereka, sementara pembekuan berjalan menyebabkan pergerakan anggota badan mereka semakin lembap. Kebanyakan ahli keluarga pesakit sering mempunyai pekerjaan mereka sendiri dan kurang latihan penjagaan pesakit. Untuk menangani masalah ini dan membangunkan sistem ini, ia harus mampu meramalkan jatuh pesakit, memberi amaran, dan menilai postur pesakit semasa latihan. Semasa latihan, sistem ini dapat membantu jururawat memantau postur berjalan pesakit. Amaran dapat dikeluarkan dengan segera apabila jatuh akan berlaku, dan postur pesakit dapat dinilai untuk rujukan jururawat. Ini akan mengurangkan beban jururawat dan membolehkan mereka merawat beberapa pesakit secara serentak. Ini akan meningkatkan kecekapan dan mengurangkan kejadian jatuh dan kecederaan akibat jatuh di kalangan pesakit Parkinson. Selain itu, sistem ini boleh dipasang di tempat tinggal pesakit untuk membantu ahli keluarga memantau dan melatih pesakit di rumah, yang dapat secara signifikan mengurangkan kejadian jatuh dan memantau serta menilai pesakit. Dalam kajian ini, CNN digunakan untuk mendidik sistem untuk meramalkan jatuh dengan ketepatan 95%. Sistem ini dijangka dapat membantu jururawat yang merawat pesakit Parkinson di hospital serta ahli keluarga bukan terapis.

TABLE OF CONTENTS

	PAGE
DECLARATION.....	II
DECLARATION.....	II
DEDICATION.....	III
ACKNOWLEDGEMENTS.....	IV
ABSTRACT.....	V
ABSTRAK.....	VI
TABLE OF CONTENTS.....	VII
LIST OF TABLES.....	XIII
LIST OF FIGURES.....	XIV
LIST OF ATTACHMENTS.....	XVI
CHAPTER 1: INTRODUCTION.....	1
1.1 Introduction.....	1
1.2 Problem Statement(s).....	2
1.3 Objective.....	2
1.4 Scope.....	3
1.4.1 Target User.....	3
1.4.2 Target Platform.....	3

1.5	Project Significance	3
1.6	Expected Output.....	4
1.7	Conclusion	4
CHAPTER 2: LITERATURE REVIEW AND PROJECT METHODOLOGY . 5		
2.1	Introduction.....	5
2.2	Facts and findings	5
2.2.1	Domain	5
2.2.1.1	Predictive model for falling in Parkinson disease patients.....	6
2.2.1.2	Incidence and prediction of falls in Parkinson’s disease.....	7
2.2.1.3	Fall prediction and prevention systems	8
2.2.1.4	The prevention of falls in patients with Parkinson’s disease within home monitoring using a wearable system.....	9
2.2.1.5	Preventing falls: the use of machine learning for the prediction of future falls in individuals without history of fall.....	10
2.2.2	Existing System	11
2.2.2.1	Deep learning to predict falls in older adults based on daily life trunk accelerometry.....	11
2.2.2.2	Machine learning applied to fall prediction and detection using wearable sensors	12
2.2.3	Technique	12
2.2.3.1	Convolutional Neural Network.....	13
2.2.3.2	Decision Tree.....	13
2.2.3.3	Support Vector Machine (SVM)	15
2.3	Project Methodology.....	16

2.3.1	Planning	17
2.3.1.1	Data Collection	17
2.3.1.2	Data Pre-processing	18
2.3.2	Design	19
2.3.3	Development	19
2.3.4	Implementation	20
2.3.5	Testing	20
2.3.6	Deployment.....	20
2.4	Project Requirements	21
2.4.1	Software Requirements.....	21
2.4.1.1	Visual Studio Code	21
2.4.1.2	MySQL	22
2.4.2	Hardware Requirements	22
2.4.2.1	Laptop.....	22
2.4.2.2	Webcam	23
2.4.2.3	Camera stand	23
2.4.3	Other Requirements	23
2.4.3.1	Import Library	23
2.4.3.2	Environment	24
2.5	Project Schedule and Milestones	25
2.6	Conclusion	26
CHAPTER 3: ANALYSIS.....		27
3.1	Introduction.....	27
3.2	Problem Analysis	27

3.3	Requirement analysis	29
3.3.1	Data Requirement	30
3.3.2	Functional Requirement.....	30
3.3.3	Non-functional Requirement	31
3.3.4	Other Requirement.....	31
3.4	Conclusion	32
CHAPTER 4: DESIGN		33
4.1	Introduction.....	33
4.2	High-Level Design.....	33
4.2.1	System Architecture for expert system / DSS/ simulation	33
4.2.2	User Interface Design for expert system / DSS / simulation	35
4.2.2.1	Navigation Design	36
4.2.2.2	Input Design for expert system / DSS / simulation	37
4.2.2.3	Technical Design	37
4.2.2.4	Output Design	39
4.2.3	Database Design	39
4.2.3.1	Conceptual and Logical Database Design	39
4.3	Detailed Design.....	40
4.3.1	Software or Hardware Design	41
4.3.2	Physical Database Design.....	42
4.4	Conclusion	42
CHAPTER 5: IMPLEMENTATION.....		43
5.1	Introduction.....	43
5.2	Software Development Environment setup	43

5.3	Software Configuration Management.....	44
5.3.1	Configuration environment setup	45
5.3.1.1	Visual Studio Code Environment Setup	45
5.3.1.2	Flask Environment Setup.....	46
5.3.2	Version Control Procedure	46
5.4	Implementation Status	47
5.5	Conclusion	48
CHAPTER 6: TESTING		49
6.1	Introduction.....	49
6.2	Test Plan.....	49
6.2.1	Test Organization.....	49
6.2.2	Test Environment.....	50
6.2.3	Test Schedule.....	51
6.3	Test Strategy	51
6.3.1	Classes of tests	52
6.4	Test Implementation	52
6.4.1	Experimental / Test Description	53
6.4.2	Test Data	54
6.5	Test Results and Analysis	54
6.5.1	Tracking Fall Pose Prediction Test.....	54
6.5.2	Tracking Fall Evaluation Test	55
6.5.3	Database Module Test	56
6.5.4	Accuracy Test	57
6.6	Conclusion	60

CHAPTER 7: CONCLUSION	61
7.1 Observation on Weakness and Strengths.....	61
7.2 Propositions for Improvement	61
7.3 Project Contribution.....	62
7.4 Conclusion	62
REFERENCES	63



LIST OF TABLES

	PAGE
Table 2.1 Disease severity and rating scales	7
Table 2.2 Physiotherapy assessment and falls	7
Table 3.1: List of Hardware and Software	31
Table 5.1: Implementation Status for Development	47
Table 5.2: Implementation Status for Analysis	47
Table 6.1: Roles and Responsivities in the Testing Process	50
Table 6.2: Testing Environment	50
Table 6.3: Test Schedule	51
Table 6.4: Classes of tests	52
Table 6.5: Test Description.....	53
Table 6.6: Tracking Fall Pose Prediction Test	55
Table 6.7 Tracking Fall Evaluation Test	56
Table 6.8: Database Module Test	56
Table 6.9: Accuracy Test	58

LIST OF FIGURES

	PAGE
Figure 2.1 ROC curve for discrimination between faller and non-faller by means of the application of purposed multivariate model in 59 Parkinson’s patients....	6
Figure 2.2 Interaction between various fall risk factors.....	9
Figure 2.3: Example of CNN Architecture	13
Figure 2.4 Composition of the decision tree	14
Figure 2.5 Example of SVM Hyperplane.....	15
Figure 2.6 Example of SVM Hyperplane.....	16
Figure 2.7 Waterfall.....	17
Figure 2.8 Visual Studio Code Logo.....	21
Figure 2.9 MySQL.....	22
Figure 2.10 Environment for Evaluate Parkinson’s Patient.....	24
Figure 2.11 Gantt Chart	25
Figure 3.1 Break Stage in Parkinson’s Disease	28
Figure 3.2 Convolutional Neural Network (CNN) Process Diagram	28
Figure 3.3 Flowchart of the system.....	29
Figure 3.4 Sample of the Dataset for Training Model.....	30
Figure 4.1 Transfer Learning Model.....	34
Figure 4.2 Convolutional Neural Network (CNN) Architecture	34
Figure 4.3 Optimizer Layer Model.....	35
Figure 4.4 Specific Settings for Network Training	35
Figure 4.5 Navigation of the Website	36
Figure 4.6 Pseudocode of the Convolutional Neural Network Algorithm	38
Figure 4.7 Database Entity Relation Diagram (ERD)	39
Figure 4.8 CNN Layer Summary.....	40

Figure 4.9 Data Flow Diagram (DFD) of Website.....	41
Figure 4.10 Store Dataset in Disk	42
Figure 5.1 Software Development Environment Overall.....	44
Figure 5.2 Visual Studio Code Layout	45
Figure 5.3 Visual Studio Code Content Layout	46
Figure 6.1 Feedback About the Prediction Function from the Users.....	55
Figure 6.2 Feedback About the Evaluation Function from the Users.....	56
Figure 6.3: Successfully Record a Evaluate Result.....	57
Figure 6.4: Tester Test the Progress Function Accurately.....	57
Figure 6.5: Accuracy of the Each Algorithm.....	59
Figure 6.6: Precision Score of the Each Algorithm.....	59
Figure 6.7: Recall Score of the Each Algorithm.....	59
Figure 6.8 F1 Score of the Each Algorithm	60



LIST OF ATTACHMENTS

		PAGE
Appendix A	Turnitin Result	83
Appendix B	Website Login Page	83
Appendix C	Website Sign Up Page	84
Appendix D	Website Home Page	84



اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CHAPTER 1: INTRODUCTION

1.1 Introduction

Parkinson's disease is a neurological disorder characterised by a gradual loss of motor control, tremors, stiffness, and difficulties with balance and coordination. In most cases, symptoms manifest progressively and worsen over time. As the disease progresses, patients may have trouble walking and communicating, if not immobility. Currently, the disease cannot be treated and is fatal. To prevent an accelerated progression of the disease, regular physical activity is required. The primary objective of the programme is to assist patients with Parkinson's disease during the development of a monitoring system that will be trained to operate in a controlled environment without interference. This is to enhance the accuracy of any results generated by the system. Parkinson's disease increases the probability of stumbling while exercising. This will result in additional physical and mental damage to them. Moreover, because therapists can only treat one patient per session, the system primarily facilitates the therapists and nurses. Nonetheless, the primary purpose of this programme is to aid the therapists from the hospital and the nurse from home. The system will emit a warning sound to alert the therapist and patient if the patient is about to collapse. One system will be able to assist a therapist in supervising a single patient, while multiple systems will be able to superintend multiple patients simultaneously during a single session. The system will, among other things, assist nurses who care for patients at home in monitoring patients 24 hours a day while they are at home. When nurses are performing their personal responsibilities, the system can alert them to accidents with an audible alert. In addition, while monitoring, the system can score the patient's

training circumstance, which can be used by therapists and nurses caring for patients at home.

1.2 Problem Statement(s)

The problem statement that influences the project's motivation is the ability to solve the described issue. For this project, the problem statement as follows:

- i. Parkinson patients cannot be cared for 24 hours a day at home because everyone has their own jobs.
- ii. The therapist only treats one patient at a time due to the need to pay attention to the patient's training posture to prevent accidents.
- iii. Patients need to take turns as the therapist can only treat 1 patient in 1 session.

1.3 Objective

The main objective is to construct a more advanced CNN for the prediction of the freezing of gait that is characteristic of Parkinson's disease patients. As a result, the following should be considered the objective of the sub-objective:

- i. To investigate the characteristics of walking training in patients with Parkinson's disease and the precursors to falls.
- ii. To develop a fall prediction and fall warning system for patients with Parkinson's disease.
- iii. To evaluate the walking posture of Parkinson patients.

1.4 Scope

In order to ascertain the specific user and platform, the target user and target platform of the Project's scope are formulated. It is crucial for the undertaking to consider user experience and environmental factors. Target user and target platform are described in detail below.

1.4.1 Target User

The main target users of the system developed in this project are Parkinson's disease patients, nurses, and therapists. The nurse here refers to the person who takes care of Parkinson's patients at home, such as the patient's mother, family members, etc.

1.4.2 Target Platform

This system's target platform are the house and hospital. Platform includes home because it can aid in the care of Parkinson patients at home and increase their safety when they're alone. In the hospital, therapists are responsible for assisting the patient's posture and providing assessment references.

1.5 Project Significance

The initiative primarily benefits people with Parkinson's disease, as the effort primarily helps therapists and nurses. It could monitor Parkinson's patients continuously as they move and walk, decreasing their risk of falling. When the system detects that a patient with Parkinson's is about to fall, an alarm can be issued to enable the patient to immediately correct their posture or to remind the therapist and nurse. This will enable therapists to work more efficiently and provide nurses with assistance at home so they can care for patients while performing their own duties. In addition, it can assist therapists and nurses by prompting them to respond in time to prevent patient

injury. In addition, the system can assist the therapist by detecting the patient's walking posture and providing a score that enables the therapist to refer to and better comprehend the patient's symptoms. This can also assist nurses at home understand the patient's condition by filling in their posture.

1.6 Expected Output

This project aims to assist therapists and nurses at home when they treat or care for Parkinson's patients, prevent or reduce sports-related injuries, provide therapist reference patients' symptoms to improve treatment, and aid nurses in monitoring Parkinson's patients at home at all times. The initiative heavily relies on machine learning to compute and analyse Parkinson's patients' behaviour and assessments. And this algorithm must use the camera as its medium, allowing the camera to perform calculations while capturing images of the patient in real time. When images are captured, machine learning determines when a patient is about to collapse, triggering an alarm to alert the patient and carers. We employ three distinct AI algorithm categories. The system's primary algorithm will be determined by comparing the three algorithms and selecting the one with the highest degree of precision. Simultaneously, the system will be trained in a fixed environment, as the training environment for patients is fixed by nature. This will increase precision and drastically reduce errors.

1.7 Conclusion

The initial objective of the project is to be able to assist people with Parkinson's disease, assess their walking posture, and predict whether they will fall. These are the necessary steps to develop the system. The next step is to develop an algorithm that can accurately predict the patient's walking posture prior to a fall and whether the patient will fall.

CHAPTER 2: LITERATURE REVIEW AND PROJECT METHODOLOGY

2.1 Introduction

This chapter consists primarily of a literature review on fall prediction in Parkinson's disease and fall prediction systems, as well as research-related information on fall prediction using machine learning, in order to provide context for the project's content. Additionally, design a project methodology that adheres to the project system.

2.2 Facts and findings

The purpose of the facts and findings section is to find articles related to project management systems. This section is divided into three parts, as shown in the diagram below: Domain, Existing Systems, and Technology.

2.2.1 Domain

This part is to study the field with related project system. Predicting falls, preventing Parkinson's disease patients from freezing their stride, and using machine learning are all components of this study. The following is a collection of articles that are connected to the project, and the subject matter of each article is focused on a certain aspect of the system's domain.

2.2.1.1 Predictive model for falling in Parkinson disease patients

This article focuses primarily on the causes of falls in Parkinson's disease patients and identifies a model that can predict Parkinson's disease patients' falls and identify related factors. This is because the rate of falls reported in the community for Parkinson's patients is twice as high. In this study, multiple parameter classifications were used to identify the primary reason why subjects would fall and to compare falls to non-falls. In this test, their physical and psychological analysis revealed that 40.7% of the 59 patients were between the ages of 6 and 67. 30.5% of participants fell, and at least 6 had a history of more than one fall or a current fear of falling, did not exercise for more than 24 hours per week, and at least 54% had anomalous axial posture or body freezing. According to these findings, the final fall prediction model primarily distinguishes three categories, including gender, movement disorder, and aberrant axial posture.

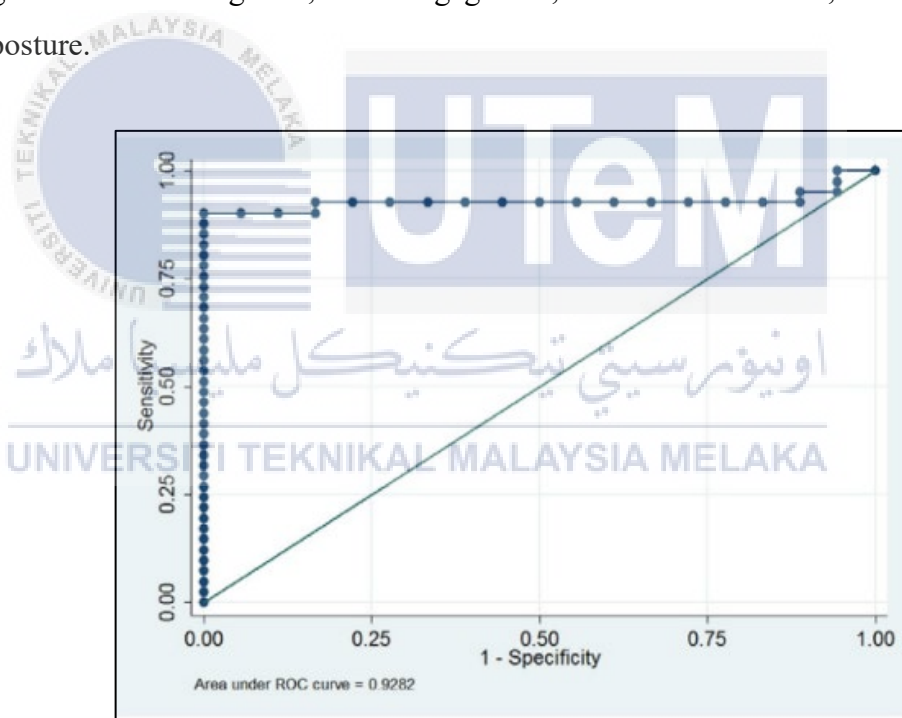


Figure 2.1 ROC curve for discrimination between faller and non-faller by means of the application of purposed multivariate model in 59 Parkinson's patients