UNIVERSITI TEKNOLOGI MARA

GAIT ANALYSIS AND CLASSIFICATION USING FRONT VIEW MARKERLESS MODEL

AHMAD PUAD BIN ISMAIL

Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Electrical Engineering)

Faculty of Electrical Engineering

March 2018

ABSTRACT

Gait abnormality recognition would be very useful in medical monitoring and surveillance systems. The analysis can be used as one of the surveillance methods, medical rehabilitation monitoring and early detection in possible gait related symptoms. Existing manual observation can only be done by professionals and might cause misidentification on the real condition or situation of the subject. Additionally, gait laboratory utilises very costly motion systems for gait acquisition as research database. Hence, there is a need to produce a low cost abnormal gait detection method. In this research, analysis of front view human gait silhouette was done to investigate the possibility of a method to be developed in recognizing abnormality on proposed model-based approach. The model based which utilised the pendulum and hexagonal theorem as feature extraction method were used to produce the vertical angles of both hip and knee for 70 image sequences as feature vectors for both legs for one complete gait cycle sequence. Consequently, 280 features generated based on four parameters from the lower limb of human body for gait abnormality detection. On top of that, the gait features extracted from different gait patterns namely normal, drunken, dragging and tiptoed were classified as either normal or abnormal using four different classifiers namely ANN, KNN, SVM and Bayesian. Results attained showed that the proposed method was indeed suitable as gait abnormality recognition based on human gait pattern with the result of SVM as 90.9 percent leading the other classifier for pendulum features, whilst both ANN and SVM classification rate shows the highest for hexagonal features with also 90.9 percent after normalization and feature selection. Further, the proposed method namely the markerless front view modelling for abnormal gait detection was evaluated using hardware based. The hardware utilised a Linux based embedded board such as Raspberry Pi and Beaglebone, with Python software programming for recognising the differences between normal and abnormal gait based on gait image as input sequences captured from camera. Classification rate obtained were similar using these two boards namely 84.21% for SVM and 89.47% for KNN classifiers. In addition, processing time taken using Beaglebone Black board was higher that was approximately one minute as compared to Raspberry Pi that required longer time.

ACKNOWLEDGEMENT

Firstly, I wish to thank God for giving me the opportunity to embark on my PhD and for completing this long and challenging journey successfully. My gratitute and thanks go to my supervisor Professor Dr. Nooritawati Md. Tahir. Thank you for the support, patience and ideas in assisting me with this project. I also would like to express my gratitude to the Universiti Teknologi Mara Pulau Pinang, for providing the facilities, knowledge and assistance.

My appreciation goes to Ministry of Higher education and all staff members of the IPSIS of UiTM Shah Alam, Selangor who provided the scholarship and assistance during my studies. Special thanks to my colleagues and friends for helping me with this project.

Finally, this thesis is dedicated to my lovely wife, Nazirah binti Mohamat Kasim and family, Hanan Nafeesa, Khairun Nafees, Lutfan Hazmi, Muhammad Danial and Ahmad Raif Naufal, and caring mother, and the loving memory of my very dear late father, Ismail bin Haji Abdul Rani for the vision and determination to educate me. This piece of victory is dedicated to both of you. Alhamdulillah.

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 Introduction

The thesis explores the implementation of image processing by detecting abnormality patterns in human gait using a markerless model method. Gait is known as "the anthropomorphic upright self-displacement, in an alternating stepping of two feet with no additional fulcra, keeping at least a point of support at every time on a horizontal or slightly inclined surface" as defined in [1]. This chapter provides the aims, background of the research and rationale for the study. It also provides the research problem, problem statement, research objectives, scope and limitation of study and finally the significance of the study.

Previously, abnormality recognition was carried out by the professional or medical officer through the observation of the patient's behaviour and mostly done manually. This might cause misidentification of the real condition of the patient and will encounter difficulties in treatment with subsequent therapies. With gait analysis technology nowadays, the gait database can be stored as references for gait monitoring. With the patient gait data, it can be utilized as a rehabilitation method in the improvement of gait pattern and early detection of other disease symptoms related to gait. Additionally, gait abnormality such as fall and injuries possibilities can be detected earlier through daily walking activities in the medical aspect that can detect strange movements in the surveillance system.

Consequently, an existing method that uses marker based for gait analysis needed markers to be attached directly to the human body would usually cause a problem on mobility and limit the usage in a laboratory environment only. Apart from that, it is also quite costly with the number of markers attached and a certain length of wiring needed which may result restricted movements. It will also be more complicated when analysis involving an underage child patient and several types of uncontrolled behaviour such as autism, cerebral palsy and others related syndrome.

Through observation, there were very few researchers who utilized the markerless method in their based on appearance which is cheaper but lacked accuracy