THE COMPARATIVE STUDY OF MODEL-BASED AND APPEARANCE BASED GAIT RECOGNITION FOR LEAVE BAG BEHIND

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Dedicated to my beloved father and mother, Zainol Bin Hashim and Norizan Binti Daud for their endless moral and financial support from the beginning until the end of this Master's Dissertation.

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ABSTRACT

Nowadays, the increasing number of crimes and violence in the world has become a concern of modern society. This is why the need for criminal recognition using gait used for civilian and forensic analysis applications has evoked considerable interest. The literature accurate the result can be found in gait recognition by leave bag behind detection especially in the critical area examples airport and shopping mall environment. This is important because the method used capable of identifying the subject based on their gait and can be presented as the most probable subject as a strong evidence for criminal identification. This research limited to leave the bag behind detection on gait recognition. In this research, the analysis performed using two methods which are Model-Based approaches and Appearance-Based approaches. The selected methods were implemented in MATLAB R2014a and R Studio and tested with a standard dataset from the Chinese Academy of Science (CASIA) and tested using two classifiers which is Support Vector Machine (SVM) and KNN (K nearest Neighbour) based on accuracy and misclassification rates (MER) metrics. The experiment results show that the accuracy and misclassification rate (MER) of Appearance-based approaches obtained is 93.66% and 6.33% respectively tested on SVM classifier then the accuracy and misclassification rate (MER) of Appearance-based approaches is 97.66% and 2.33% respectively tested on KNN algorithm. Meanwhile, the accuracy and misclassification rate (MER) of Model-based approaches obtained is 97.00% and 3.00% respectively tested on SVM classifier then the accuracy and misclassification rate (MER) of Model-based approaches is 99.00% and 1.00% respectively tested on KNN algorithm. It can be concluded from experiments conducted by Model-based approaches better than Appearance-based approaches because Model-Based approaches higher precision value as well as low misclassification.

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ABSTRAK

Kini, semakin banyak jenayah dan keganasan di dunia kini menjadi kebimbangan masyarakat moden. Itulah sebabnya keperluan pengiktirafan jenayah yang menggunakan kegunaan yang digunakan untuk aplikasi analisis awam dan forensik telah menimbulkan minat yang besar. Sastera yang tepat hasilnya dapat dijumpai dalam pengenalan pengesanan gait dengan *leave bag behind* terutamanya dalam kawasan kritikal seperti lapangan terbang dan pusat membeli belah. Ini penting kerana kaedah yang digunakan mampu mengenal pasti subjek berdasarkan gaya mereka dan mungkin boleh dijadikan sebagai bukti kukuh untuk siasatan jenayah. Penyelidikan ini terhad untuk pengesanan pengiktirafan gait untuk *leave bag behind*. Dalam kajian ini, analisis dilakukan menggunakan dua kaedah iaitu *Model Based Approaches* dan *Apprearance Based Approaches*. Kaedah yang dipilih telah dilaksanakan di MATLAB R2014a dan R Studio dan diuji dengan dataset standard dari Chinese Academy of Science (CASIA) dan diuji dengan menggunakan dua klasifikasi iaitu Mesin Vektor Sokongan (SVM) dan KNN (K *nearest neighbour*) berdasarkan ketepatan dan *misclassification* metrik kadar (MER). Keputusan eksperimen menunjukkan bahawa pendekatan berdasarkan ketepatan dan salah klasifikasi (MER) yang diperolehi adalah 93.66% dan 6.33% masing-masing diuji pada pengelas SVM maka pendekatan ketepatan dan salah klasifikasi (MER) pendekatan Rupa adalah 97.66% dan 2.33% pada algoritma KNN. Sementara itu, kadar ketepatan dan *misclassification* (MER) untuk *Model Based Approaches* yang diperoleh adalah 97.00% dan 3.00% masing-masing diuji pada pengelas SVM maka kadar ketepatan dan salah klasifikasi (MER) pendekatan berasaskan *Model Based Approaches* adalah 99.00% dan 1.00% masing-masing diuji pada algoritma KNN . Ia dapat disimpulkan dari eksperimen yang dijalankan oleh pendekatan berasaskan Model yang lebih baik daripada pendekatan berasaskan rupa dengan membawa nilai ketepatan yang lebih tinggi serta *misclassification* yang rendah.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Biometrics has become a very important field of science because of several factors, the growing demand for security in various situations is one of those factors. Some types of biometric identification systems, such as the use of the retina, are very accurate. But generally, in order for such a system to identify features that are available on the subject, the subject must enroll voluntarily in a central database. So that, the stored data can confirms the identity of the subject.

Hence, the subject usually needs to interact closely with their system in order to check their identity as a sample runs until the retinal scanner makes the recognition. Obviously, someone with malicious intent will prevent the identification process. So, if the subject you want to watch out for suspicious or dangerous individuals from a distance, the system will not help. Gait recognition is a biometric technology that can be used to monitor subjects without their cooperation.

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As an individual running towards the system, they are bombarded by invisible radio waves. Walking speed and style of each individual will make the waves rise slightly different. The result is a kind of composite signature that characterizes the overall feel of their walk.

The information obtained cannot choose who is wanted by the authorities if they wandered into the area of crime. However, this recognition can be used to track moving subjects with a suspicious manner, such patterns are repeated walking or movement does not appear natural physical given subject. The recognition system is used to verify the identity of the subject and may even prevent an impostor.

Biometric forensics is a scientific discipline involving the use of biometric technology to determine whether the identity of the suspect detained during a criminal event is either identifiable or it is excluded by a similar process in the suspect's list of biometric biometric data.

This biometric feature can be used in forensic analysis which is eye, face, ear, speech, and lifestyle. However, this biometric feature is to identify suspects who are very limited to forensic experts to analyze them.

The appropriate recognition and achievement gait is for forensic analysis, arising from the fact that the walking style can be identified at the distance of the subject movement from the safety camera even with low resolution compared to other biometric features in advanced features of biometric performance is very severe.

In addition, the power of recognition and recognition is imperfect as the goal does not require the cooperation of the subject working with the acquisition system. This makes the introduction of a perfect introduction to the situation where the direct relationship with the perpetrator is impossible.

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1.2 Research Motivation

The increasing number of crimes and violence in the world today has become a concern of modern society. This probably due to the growing global flows and these concerns should be enhanced high security requirements. Security cameras require monitoring manpower to monitor the area and the environment and that is why enhanced biometric technology in a surveillance system that became the main factor of security and forensic analysis. The initial recognition of suspicious individuals who may pose various security threats through the use of the biometric system and with the use of this system is that it can prevent the rampant criminal activities in the future. This is an important requirement to solve crimes quickly to avoid errors and provide justice to the victims. The biometric system provides a descriptive measure by nature and human behavior that can distinguish from the other. The power of gait recognition that non-invasiveness with the identification process no longer requires the subject to cooperate with the acquisition system. With this, it makes gait as the perfect introduction to a situation where the direct contact with the perpetrator is not possible. Therefore, the gait recognition is a biometric modality of human behavior that identifies people based on their unique pattern of behavior. Compared with the previous biometric modality of fingerprint recognition, iris recognition, footprints have an unobtrusive advantage as it does not require a subject relationship. This gait recognition is based on the notion that everyone has a unique and distinctive walking style and is easily viewed from a biomechanical point of view.

1.3 Research Objectives

The main objectives of the research are:

i. To design a framework of gait recognition detection for leave bag behind.
ii. To implement the chosen technique by using gait
iii. To test and compare the performance gait biometric in term of step length and speed.

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1.4 Limitation and Scope

This research is conducted in order to focus on gait recognition for leave bag behind using model-based and appearance based. The gait recognition will be analyzed using two types of algorithms which are Support Vector Machine (SVM) algorithm and K – Nearest Neighbour (KNN) algorithm. Thus, the features of gait recognition from two different datasets were used for analysis and algorithm development purposed.

1.5 Significance of the study

In this research, biometrics offers a naturally dependable solution to specific aspects of identity management by using fully automated or semi-automatic methods or schemes to recognize individuals based on their biological characteristics. The effectiveness of validation is based on its relevance to certain applications as well as its steadfastness towards various types of malicious attacks. Lifestyle biometrics has shown potential promises as an alternative or complementary identifier for use in human recognition systems. However, there is no single step that includes a complete set of complex dynamics that reflect the view as a human lifestyle. The suspicion of suspicious individuals that may pose a security threat and the ongoing recognition will be able to reduce future crime. This is because most of the facial features are irreversible and other biometric limitations experience the face, fingerprints and iris recognition that can be blurred in most situations where serious crimes are involved. Tracking gait may be considered less intrusive than other biometrics and it may also be found as invasive privacy due to the facility that can be used for it to track individuals without them knowing that they are actually being monitored. By using model-based and appearance based method, the gait recognition transfer strengths are non-invasive, and therefore do not require the subject to work with the acquisition system. This makes the introduction of walking styles ideal for situations where the direct relationship with the perpetrator is impossible.

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1.6 Thesis organization

In this chapter, a brief background of the study, research motivation, research objectives and scope have been explained. Chapter 2 discussed the literature review that the information required in the production of literature described the research, technology approach, technique, and algorithm used to analyze the research analysis. Chapter 3 discussed the methodology for the research method. Then, chapter 4 discussed the result and discussion that describe the method approach used in the research analysis. Chapter 5 discussed the conclusions and future work using gait biometric which has been completely analyzing with their views responsibly on the achievement of the objectives of the overall improvements, the advantages, and disadvantages of the research as well as suggestions for improving the research in the future.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A literature review of measures to collect the information needed to develop the system. The literature review helps system builders to solve problems in the system. Among the information required in the production of literature is the description of the system, technological approaches, techniques and algorithms used to build the system. The literature review is also to analyze the methods available in the system to determine the best method that can be used in the system.

This chapter describes in detail the appearance of gait analysis methods and model based on classifying and track objects as a security measure to prevent the omission bag in public places such as airports in committing the crime. Gait analysis includes scaling and recognition bodies to improve the stability and reliability of recognition gait analysis.

2.2 Biometric

Biometrics is the science and technology that can detect, evaluate and analyze biological data. This technology is the biometric system can be used to detect DNA, fingerprints, retina, voice, facial features and body parts of others. As we all know, every human being has a DNA, retina, fingerprints, voices, and faces are different, no two individuals are the same [1].

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Another biometric based on the physiological or behavioural a characteristic of people. It is a pattern recognition system at establishes a person's identity by the comparison of data. It is authentication is "automatic", "real-time", "non-forensic" subset of the broader field of human identification. Gait is defined as the manner of locomotion, which is the way of walking [2].

Gait biometric appears prudent to investigate the translation of these techniques for forensic use. For gait analysis, the rapid growth in the number of security cameras and of the need for sufficient manpower to supervise them, the deployment of noninvasively biometric technologies become important for the development of automated visual surveillance systems and forensic investigation. The use of gait for people identification in surveillance applications has attracted by many organizations [2].

The suitability of gait recognition within surveillance a system emerges from the fact that gait can be perceived from a distance and no contact is made with the subject. Currently, as most biometric systems are still in their infancy, biometrics is deployed for identity verification and authentication. Identification systems undoubtedly play a key role in aiding law enforcement officers in their forensic investigations. More important, by the early recognition of suspicious individuals who may pose security threats, the system reduces future crime [2].

Gait recognition has the potential to overcome most of the limitations that other biometrics suffer from such as a face, fingerprints, and iris recognition, which can be obscured in most situations where serious crimes are involved. Face recognition has in many cases been proven to be unreliable for visual surveillance systems. This is attributable to the fact that people can disguise or hide their faces as well as that the video data might be captured in a too low resolution [3].

Furthermore, another major drawback of face identification in security applications is the low recognition capability in poor illumination. This is because most of the facial features cannot be recovered at large distances even using night vision capability [2].

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Although fingerprint and iris recognition has proved to be robust for applications where authentication or verification is required, such biometrics are inapplicable for situations where the subject's consent and cooperation are impossible to obtain [2].
Detect objects such as bags carried by pedestrians illustrated in short video sequences. This began with the averaging method line foreground area pedestrian walk to the representation of motion and generates temporal form templates that have some immunity to noise in the foreground segmentation phase of the cycle and run [4]. The main novelty of the object is brought to the public by comparing the temporal template to model specific view generated offline for pedestrians unencumbered. Methods that can be used for the detection of irregularities in appearance to other categories of objects moving in a way that regular [4].

2.2.1 Functions of using biometric in life

a) Registration

In the biometric registration system, the system will generate information and store the user's registration of the individual biometric template [5].

b) Validation

Validation in biometric is a system function that verifies the identity of a user. The confirmation is to match each other. This verification process is a benchmark that can be made by comparing some current biometric samples stored from individuals or users in the database [5]. This individual biometric sample will be compared directly with the stored data and subsequently the validation is made by comparing the samples of users scanned by biometrics in addition to making comparisons in the database [5].

c) Identification

Identification is a process for identifying system identities from a system database or user list as a sample stored in the database. Match recognition is one-to-many. This identification process will be matched by comparing the biometric samples on

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individuals by comparing the existing samples in the system to identify the individual or not [5].

2.3 Biometric Components

i) Capture data

The capture of the system used is to capture and collect individual movement from the input of the sample image and process the biometric sample [5].

ii) Sample processing

The sample processing system is to identify the specific characteristics of the sample biometric and implement the biometric characteristics. If the biometric nature does not meet the quality control, the signal is sent to the system [5].

iii) Data Storage

The biometric samples taken will be stored in the database. This allows the sample to be accessed by the system when required. Each sample obtained and stored must have detailed data to identify biometric samples and bind the individual safety measures, and the database is accessible only to certain individuals [5].

iv) Matching

The corresponding matching of the system is that the characteristics of the biometric samples obtained by the acquired individual must match the existing sample in the database. A sample matching score with an individual is measured by showing similarities between the characteristics of the sample in the system. As a biometric confirmation destination, the characteristics of this sample will be compared to the advance of all the data contained in the database and the biometric benchmark score to be made for each sample comparison made. Next, when the corresponding score can then be sent to the system to make the individual's confirmation [5].

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v) Decision

The system will decide using the corresponding scores for the purpose of determining the results by confirmation and biometric identification. For verification purposes, the characteristics of the sample are assumed to be the same as the biometric template in the database, if the comparison score exceeds the specified score level and is listed as a subject corresponding to the biometric sample characteristics taken for the purposes of the biometric recognition [5].

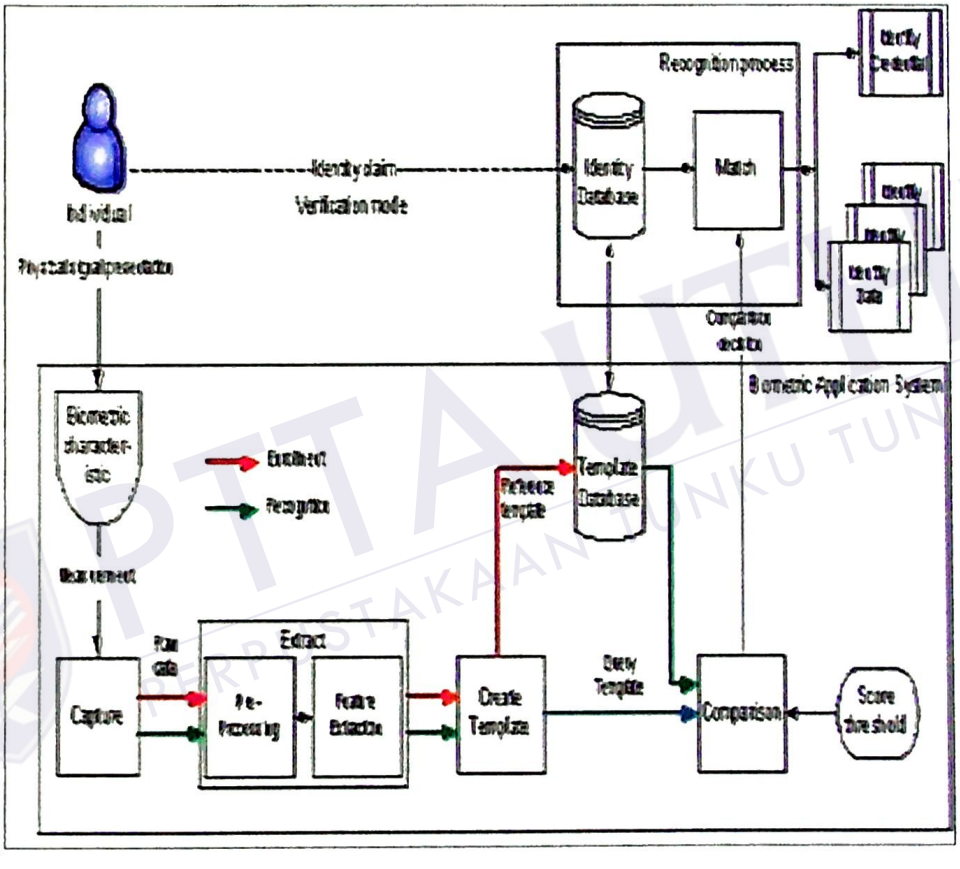

Figure 2.1: Components in gait biometric process

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2.4 Gait Biometrics

The gait recognition is a biometric modality of human behavior that identifies people based on their unique pattern of behavior. Compared with the previous biometric modality of fingerprint recognition, iris recognition, footprints have an unobtrusive advantage as it does not require a subject relationship.

The recognition of this gait is based on the notion that everyone has a unique walking style and is invisible and easily visible from a biomechanical point of view. Human movements consist of hundreds of muscular and joint movements, although the pattern of basic movements is the same, the walking force of each person is different from one person to another in terms of time and magnitude.

Subsequently, a small variation in the introduction of gait style can be used as a biometric introduction to identify individuals. Since human walking is a form of human movement, gait recognition is closely related to the sighting, tracking, and analyzing human behaviour in the analysis of human movements. The gait recognition technology is still in its early stages but the detection of this technique shows the right decision in identifying humans.

Gait is interpreted by a method of locomotion that is characterized by periods of loading and unloading members. Inside this gait includes walking, walking and jumping. However, the gait is most often used in describing the pattern of a person walking [6]. Inside the gait can also be identified with the method of human street rhythmic patterns performed in a recurring manner and in nature consisting of successive cycles.

The walking cycle or gait has been defined by the time interval between consecutive instances starting from the foot to the initial floor to the same foot, and the human walking pattern is indicated by the movement. Each moving leg will be determined so that each leg has two different phases. When the legs are in contact with the floor, the gait is identified as the leg at the stage of establishment. When the foot time is off the floor and to the next step then this gait is defined as the *swing* phase. This is because each phase marked with beginning and end with the phase of stance begins with a one-footed strike when the *foot strikes* to the ground [7].

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The locomotion process involves the interaction of many body systems working together to yield the most efficient walking pattern [6]. This locomotion system consists of four main subtasks and fulfilled at the same time to produce the walking pattern [7].

Typically, the gait biometric system consists of two main components, which is a hardware platform dedicated for data acquisition. This can be a single CCTV camera or a distributed network of cameras. The software platform for data processing and recognition [3]. The gait biometric system is composed broadly based of three main components which is to detect and track of the subject, features extraction and classification stage. Tracking of subjects and tracking measured by subject running was initially detected in the sequence of the framework by using simple background rejection techniques or other methods performed to set the same person correspondence in successive frames [3].

Based on the Figure 2.2, the important measurement for tracking and tracking is by extrapolating the features that will be assigned to the marker system whether there is less automatic marking for the identification of running, classification of activity or other imaging applications. This is because the data is important that is needed for a classification phase found at this stage [3].

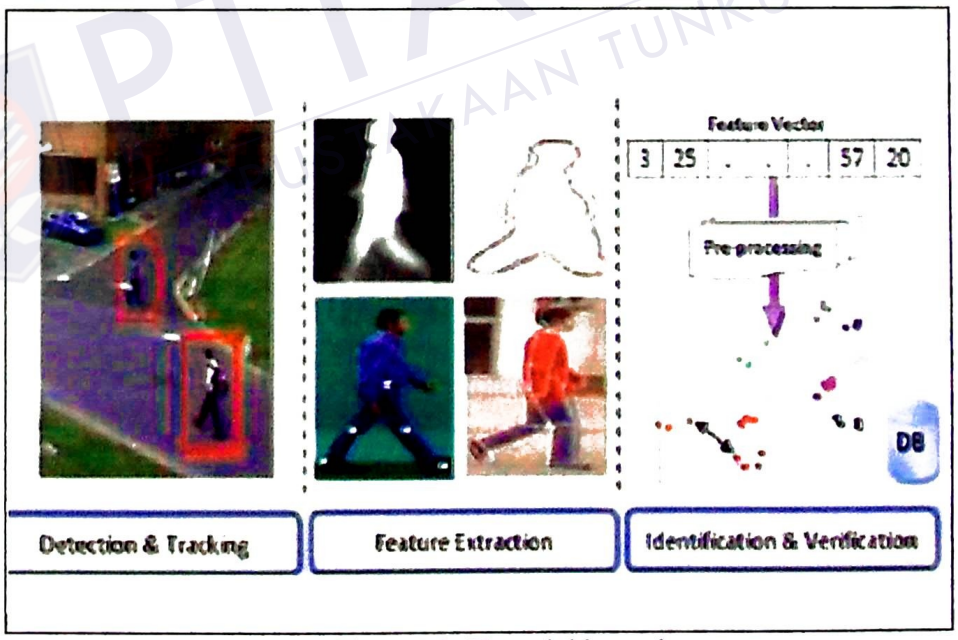

Figure 2.2: The gait biometric system

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The extraction of this biometric feature is a process that estimates a set of measurements whether it relates to the configuration of the entire body movement or the configuration of different body parts in a given motion by tracking them in sequence of frames. These characteristics should bear every level of particular personality subject [6].

The high level extraction feature estimated at this stage is to recognize that the gait can be categorized into two types for example the static gait and another dynamic gait. Examples of static features include the height of the subject and other anthropometric measurements while the dynamic or kinematic feature is the angle of the joint and the trunk of the body.

For the phase of identification or verification, it is primarily a classification process that involves matching test sequences with unknown labels to a labelled reference group considered to be a gallery data set [6]. At this stage, a high-level description is derived from the extracted features of the previous phase to conclude or validate the subject identity.

Classification processes are usually preceded by pre-processing stages such as data normalization, feature selection and dimension dimensions of feature space through the use of statistical methods. Various pattern recognition methods are used in vision-based systems for gait recognition, including Neural Networks, Support Vector Machines (SVMs) and K-nearby Neighbour Classers (KNNs).

2.5 Gait Biometric Versus Other Biometric Security Techniques

Biometrics has offered a naturally dependable solution to a specific aspect of management identity by using automated or semi-automatic schemes or identification methods to identify those individuals based on their biological features. The level of effectiveness of this biometric validation is based on the relevance of certain applications and their robustness to various types of threats.

Gait recognition has attracted general attention because there are some weaknesses identified in other biometrics. Security techniques that exist in other biometrics such as examples, irrelevant biometrics and face scanning and recognizing faces by requiring high-quality images from the CCTV footage itself as well as require

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