REDUCED SET KERNEL PRINCIPAL COMPONENT ANALYSIS (RSKPCA) ALGORITHM FOR PALM PRINT BASED MOBILE BIOMETRIC SYSTEM

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by

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LIST OF ABBREVIATIONS

APK	Android Application Package
BMP	Bitmap file format
CCD	Charge-Coupled Device
EER	Equal Error Rate
et al.	(et alia): and others
FAR	False Acceptance Rate
FIR	Finite Impulse Response
FRR	False Reject Rate
GAR	Genuine Acceptance Rate
PCA	Principal Component Analysis
KPCA	Kernel Principal Component Analysis
LDA	Linear Discriminant Analysis
ID	Identity Document
RSKPCA	Reduced Set Kernel Principal Component Analysis
RGB	Red-Green-Blue
ROC	Receiver Operation Characteristic
ROI	Region of Interest
ATM	Auto Teller Machine
BPNN	Back-Propagation Neural Network
DNA	Deoxyribo Nucleic Acid
DPI	Dots Per Inch
e.g	(exempligratia): for example
GUI	Graphical User Interface

HTTP	Hyper Text Transfer Protocol
KDE	Kernel Density Estimate
OS	Operating System
PHP	Hypertext Preprocessor
RSDE	Reduced Set Density Estimate
SDK	Software Development Kit
SVM	Support Vector Machine
WAP	Wireless Application Protocol
WIFI	Wireless Fidelity
XML	Extensible Markup Language

ALGORITMA ANALISIS KOMPONEN UTAMA KERNEL SET DIKURANGI (RSKPCA) UNTUK SISTEM BIOMETRIK MUDAH ALIH BERASASKAN TAPAK TANGAN

ABSTRAK

Kemunculan baru dimensi internet dan teknologi tanpa wayar telah membawa era baru dalam teknologi biometrik. Selain sistem biometrik dengan peranti statik, sistem biometrik mudah alih boleh dilaksanakan dan pendekatan ini membawa kepada pelaksanaan yang lebih cekap dan efisien. Dalam kajian ini, sistem biometrik mudah alih berasaskan tapak tangan telah dibangunkan. Walau bagaimanapun, untuk melaksanakan sistem biometrik mudah alih, masa pemprosesan dan penyimpanan yang cekap adalah faktor penting yang perlu dipertimbangkan.Dalam kajian ini, beberapa algoritma yang melibatkan pemprosesan ciri tapak tangan dinilai berdasarkan penggunaan masa dan memori yang optimum. Beberapa kaedah pemprosesan ciri termasuk Ruang Dikehendaki (ROI), Analisa Komponen Utama (PCA) dan Analisa Komponen Utama Kernel (KPCA) disiasat. Pendekatan baru dalam pengekstrakan ciri yang digelar Analisa Komponen Utama Kernel Set Dikurangi (RSKPCA) dicadangkan untuk mempercepatkan pemprosesan pengekstrakan ciri. RSKPCA yang dicadangkan menggunakan anggaran Kepadatan set Dikurangkan (RSDE) untuk menentukan matriks gram yang wajar. Hasilnya, RSKPCA hanya mengekstrak maklumat yang paling relevan dan penting dari set data. 2400 imej tapak tangan yang telah dikumpul daripada tiga jenis peranti Android mudah alih. Penilaian eksperimen menunjukkan bahawa RSKPCA yang dicadangkan mempunyai prestasi lebih baik berbanding ROI, PCA dan KPCA dengan Kadar Penerimaan Tulen (GAR) adalah lebih daripada 98% dan masa pemadanan kurang daripada 0.5s. Projek ini telah membuktikan bahawa pengektsrakan ciri menggunakan RSKPCA yang dicadangkan memberikan keputusan yang terbaik untuk sistem biometrik mudah alih berasaskan imej tapak tangan.

REDUCED SET KERNEL PRINCIPAL COMPONENT ANALYSIS (RSKPCA) ALGORITHM FOR PALM PRINT BASED MOBILE BIOMETRIC SYSTEM

ABSTRACT

The emerging of internet and wireless dimension has brought a new era in biometrics technology. Instead of operating the biometric system with static biometric device, mobile biometric system can be implemented and this approach leads to more efficient and reliable implementation. In this study mobile biometric system based on palm print modality is developed. However, in order to execute mobile biometric system, efficient processing time and storage are some of the important factors that need to be considered. In this research, algorithms involving palm print feature processing are evaluated so as to obtain optimum time and memory consumption. Several feature processing methods including Region of Interest (ROI), Principal Component Analysis (PCA), and Kernel Principal Component Analysis (KPCA) are investigated. A new approach in feature extraction called Reduced-Set Kernel Principal Component Analysis (RSKPCA) is proposed to speed up the processing in feature extraction. The proposed RSKPCA employs a Reduced Set Density Estimate (RSDE) to define a weighted gram matrix. As a result, the RSKPCA only extracts the most relevant and important information from a dataset. 2400 palm print images which were collected from three types of android mobile are employed. Experimental evaluation shows that the proposed RSKPCA has better performance compared to the ROI, PCA and KPCA with the Genuine Acceptance Rates (GAR) is more than 98% and the matching time is less than 0.5s. In this project, it has been proven that the proposed RSKPCA as feature extraction gives the best result for mobile biometric system based on palm print. .

CHAPTER 1

INTRODUCTION

1.1 Overview of Biometric System

Biometrics is the science of authenticating and identifying individuals based on people's physical or behavioral characteristics (Jain et al., 2004; Mir et al., 2011). Traditionally, key, smart card and password have been used for the purpose of verification and identification. However, this approach is not reliable due to it can be lost, stolen, forgotten and duplicated (Connie et al., 2003, Bhattacharyya et al., 2009). Due to the advancement of information technology field and the use of internet as medium to carry out social interchanges, monetary transactions and storehouse of personal information, hence a reliable authentication and identification system is very crucial so as to guarantee the security, privacy and confidentiality. Besides, the increase of security breach and transaction fraud cases from year to year has demanded for a highly secure personal identification and authentication technology. Apart from that, with the increasing numbers of population, the conventional ways of maintaining security by manual record keeping such as signature verification and identity card verification are no longer practicable. Likewise, password and pin number also cannot assure the security and privacy of individual's valuable information as there are many software available in the market for the purpose of password cracking (Jain and Prabhakar, 2004). As a consequence, biometric approach has become a good alternative for the identity authentication and identification due to its uniqueness to each individual and cannot be lost, recreated or forgotten.

In recent times, automatic biometric authentication has emerged as backbone of the new-age solution to our society's demand for the improved security requirements. There are many types of modalities that have been used in biometric system which can be categorized into two categories i.e. physiological and behavioural (Mir et al., 2011). Physiological characteristic are related to the shape or structure of the body for examples fingerprint, face, DNA, iris, retina, hand geometry and palm print. Whereas, the behavioural characteristics are typing rhythm, gait and voice (Yih et al., 2008). So far, variety of biometric systems have been implemented and used successfully over the years for instances fingerprint, palm print, iris, facial images, hand geometry, speaker recognition and signature systems. A palm-print verification or identification system is one of the biometric systems that use palm-print trait as features to authenticate or identify individuals.

1.2 Mobile Biometric System

The emerging of internet and wireless dimension has brought a new era in biometric technology. Instead of operating the biometric system with fixed or static device for example auto teller machine (ATM), mobile biometric system can be implemented and this approach leads to more efficient and reliable implementation. Mobile biometric system is a biometric system that extends the functionality and capabilities of a static biometrics by allowing user to capture any biometric data out in the field. Mobile devices such as smart phone, tablet, laptop and handheld gadget can be used for this purpose. Mobile biometric device is designed for intuitive operation by integrating a reader, scanner or camera for data capturing.

Subsequently, by converting the biometric data to the digital format, the authentication or identification process is done either locally where the database and processing software are stored on the handheld device itself or remotely by sending the captured biometric data to the centralized biometric server (Caldwell, 2010; White, 2008). For the local implementation, the biometric device consumes more memory for storing the database and processing software inside its space and this requires a high-end device to achieve good performance. On the other hand, for remote verification, the mobile biometric device communicates through common wireless technologies such as cellular, Wi-Fi or Bluetooth with the server in which the verification and identification process is run. Summary of biometric implementation is given as in Figure 1.1.

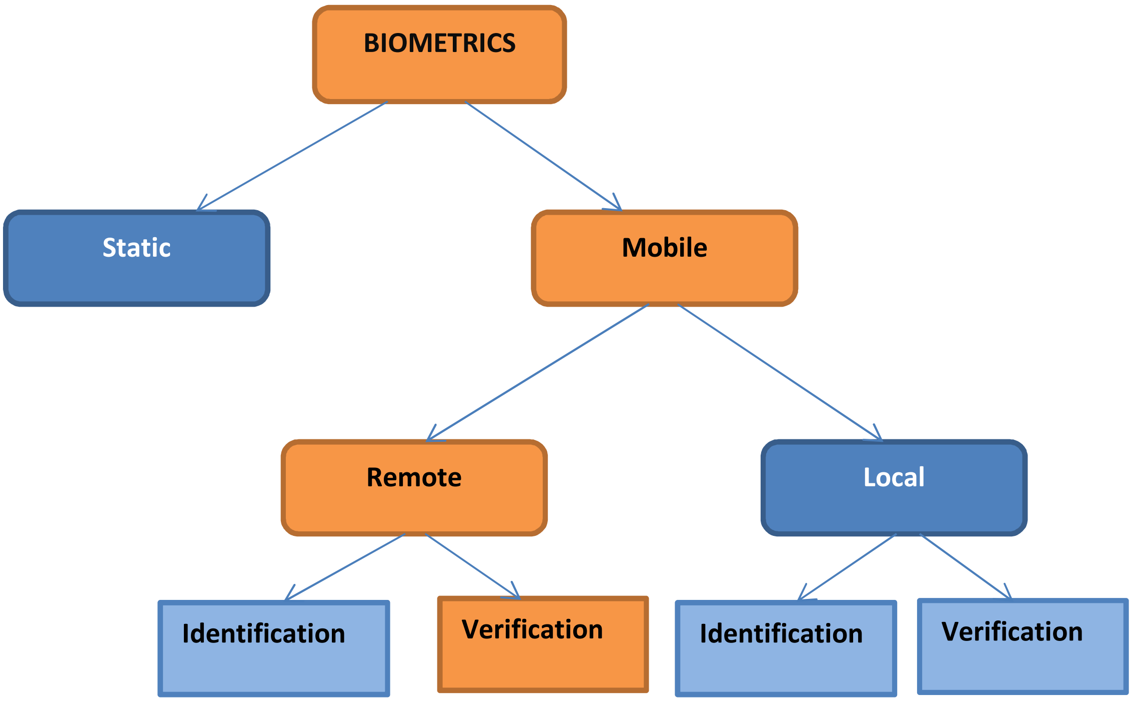

Figure 1.1: Summary of biometric implementation.

In this research, a mobile biometric system for authentication purpose is developed based on palm print and smart phone is used as the mobile biometric device. Palm print is chosen as a modality in this research due to its advantages as it requires only low-resolution imaging and low cost capturing device for data collection. Moreover, it has stable line features and low intrusiveness. As the use of smart phone become common nowadays in our society and has been equipped with built in digital camera, Bluetooth and WIFI, so this can be a good medium for the implementation of mobile biometric system prototype. Besides, the advantage of touch less screen of the smart phone for data capturing is also beneficial due to the user nowadays are very concern with privacy and hygiene issues.

1.3 Problem Statement

So far, several researchers have developed palm print biometric verification system using scanner to capture high resolution palm print image (Shu et al, 1998, Lu et al., 2003). These devices can extract many detailed features including minutiae and singular points. Although these platform scanner can meet the requirements of online system, but it takes a few seconds to scan a palm. To achieve online palm print verification in real time, a special device and method are required for fast palm print sampling with good performance result. Apart from that, feature extraction process also plays important role to makes the palm print biometric system fast and accurate. Some of the feature extraction approach takes longer time to extract and require high resolution image for example like line structure based approach (Funada, 1998; Zhang et al.,1999). Other than that, transform based feature extraction also require high resolution image plus the captured environment lighting and the image quality also need to be considered (Zhang et al, 2003). This research is studied on subspace based feature extraction which focus to dimensional reduction approach and the feature extraction only need low resolution image to extract. This also can give good performance in terms of time and accuracy.

As some of the mobile devices for example smart phone have a limited memory, storage and computation power to perform the authentication process as well as to store the database, so running the processing algorithm inside the device itself is not very practical. So, the use of remote processing is more preferable for low cost mobile biometric system. By delegating this massive processing to server, the system can be responsive and more prevailing and sophisticated processing algorithm can be deployed. However, one of the important factors that need to be considered for remote implementation is the time consumption in order to complete the whole cycle of the authentication process. As this type of implementation involved three times interval i.e. client (smart phone) to server communication for sending the acquired biometric data to server, verification processing in server and server to smart phone communication for sending the authentication result to client, hence processing algorithm in the server is the most important part that can improve the whole authentication process. So, in this study several algorithms involving palm print feature processing are evaluated so as to employ less complicated processing algorithm yet maintaining good performance. Hence, less time processing can be achieved. Here, a reduced set kernel principal component analysis (RSKPCA) which is the extended version of PCA and KPCA algorithms is proposed.

1.4 Objectives

1. To develop an android application for palm print data collection and to collect data using the application.
2. To develop hand image identification and region of interest (ROI) extraction algorithms and to implement several subspace based feature processing algorithms for fast and accurate verification performances.
3. To develop a mobile palm print biometric system by setting up the client to server and server to client communication. The system performances based on the developed algorithms in objective 2 are then evaluated.

1.5 Scope of Research

The overall research can be divided into three parts which are the client or smart phone side, internet side and the server side which are illustrated as in Figure 1.2.

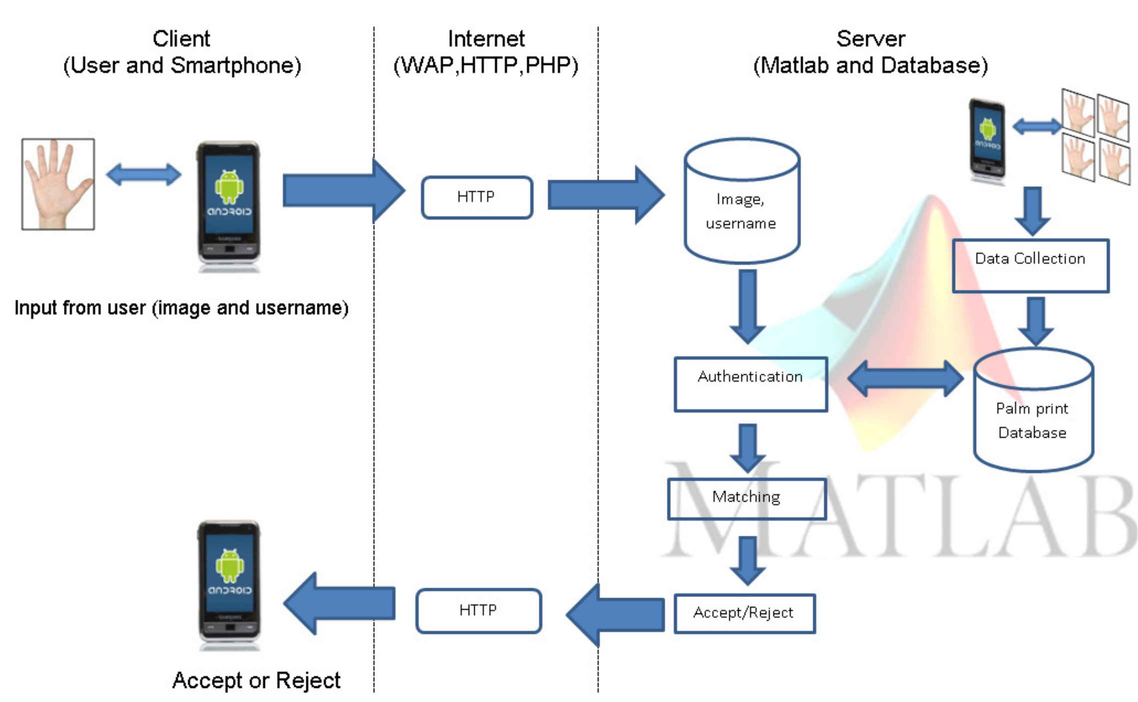

Figure 1.2: Overall research architecture

For the client side, the Android Application for capturing biometric data is developed and it programs by using the latest few version of Android OS, range from version 1.6 to version 4.1.2. Its programs support the mobile phone camera with the resolution up to 3.2 megapixels, hence only a few smart phone and tablet can be used for testing. In this research three types of smart phone are used i.e. Samsung Galaxy S3, Samsung Galaxy Tab 2.0 10.1 inches and HTC One X. Due to the existing camera application varies for almost all smart phones and tablets, thus a customized camera application with the integration of enrolment and verification functions are developed for this research. The internet site is to connect the communication between smart phone and server and the connection is done via WIFI and the PHP script is created to invoke the MATLAB program in the server.

The last part is server side where all the MATLAB programming including hand image identification, ROI extraction, palm print feature extraction and pattern matching algorithms are written. The server software used in the project is free software where a personal computer serves as a server and has limited access from the client. Several palm print feature extraction algorithms which are based on subspace method are developed and evaluated for the fast and efficient mobile biometric system.

1.6 Thesis Contribution

This section will highlight the contribution of this research. There a three main contribution from this research:

1. Palm print database was developed. There are 3 devices and 40 subjects involved during data collection where each subject contributes 60 palm print

sample images for each device. Hence, each subject contributes in total of 180 images hence the total number of collected images are 7200 images that contained in the palm print database.

2. Another contribution in this thesis was automatic ROI selection process. The hand image is acquired but only the Region of Interest (ROI) which is the palm area.
3. This research proposed an approach in feature extraction called Reduced-Set Kernel Principal Component Analysis (RSKPCA) to speed up the processing in feature extraction.

1.7 Thesis Outline

This chapter presents an overview of biometric system and mobile biometric system, problem statement, objectives and scope of research. Subsequently, chapter 2 discusses the literature reviews on palm print modality, palm print biometrics research, feature extraction and classification. The methodology including data collection process, hand image identification, ROI extraction, palm print feature processing algorithm, verification using Support Vector Machine (SVM) classifier and performance evaluation techniques are then explained in chapter 3. Experimental results and discussion on system performances are then given in chapter 4. Finally, chapter 5 discusses the conclusion and future work.