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Advances in Biometrics, International Conference

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This Special Issue of Biometric Bits is devoted the abstracts of papers that are being presented at the foregoing conference. The General Table of Contents provides links to the major subject headings within the Item Table Of Contents. Clicking on a title within the Item Table of Contents will bring you to the abstract for that title. You can simply scroll through the Item Table of Contents or go to the Abstract section and scroll through the Abstracts. This issue is also available in PDF format, for ease of searching and printing.

This collection of abstracts provides an ideal means to familiarize yourself with the cutting edge of development and theory in biometrics science and technology.

The organizers and presenters have done an outstanding job in assembling these technical presentations. While there are some passing mentions of privacy, none of the presentations appears to focus on privacy, standards, interoperability, policy or ethics relating to identity management..

Henry J. Boitel, Editor
Biometric Bits - The Key to Identity Management Information

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01. David Zhang, Anil K. Jain (Eds.): Advances in Biometrics, International Conference, ICB 2006, Hong Kong, China, January 5-7, 2006, Proceedings. Lecture Notes in Computer Science 3832 Springer 2006, ISBN 3-540-31111-4 BibTeX

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Performance Characterisation of Face Recognition Algorithms and Their Sensitivity to Severe Illumination Changes. 1-11
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Performance Characterisation of Face Recognition Algorithms and Their Sensitivity to Severe

Illumination Changes

Kieron Messer1, Josef Kittler1, James Short1, G. Heusch2, Fabien Cardinaux2, Sebastien Marcel2, Yann Rodriguez2, Shiguang Shan3, Y. Su3, Wen Gao3 and X. Chen3
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Abstract
This paper details the results of a face verification competition [2] held in conjunction with the Second International Conference on Biometric Authentication. The contest was held on the publically available XM2VTS database [4] according to a defined protocol [15]. The aim of the competition was to assess the advances made in face recognition since 2003 and to measure the sensitivity of the tested algorithms to severe changes in illumination conditions. In total, more than 10 algorithms submitted by three groups were compared 1. The results show that the relative performance of some algorithms is dependent on training conditions (data, protocol) as well as environmental changes.
1 This project was supported by EU Network of Excellence Biosecure.
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03. Mohamed Abdel-Mottaleb, Mohammad H. Mahoor:
Assessment of Blurring and Facial Expression Effects on Facial Image Recognition. 12-18
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Assessment of Blurring and Facial Expression Effects on Facial Image Recognition

Mohamed Abdel-Mottaleb1 Contact Information and Mohammad H. Mahoor1 Contact Information
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Abstract
In this paper we present methods for assessing the quality of facial images, degraded by blurring and facial expressions, for recognition. To assess the blurring effect, we measure the level of blurriness in the facial images by statistical analysis in the Fourier domain. Based on this analysis, a function is proposed to predict the performance of face recognition on blurred images. To assess facial images with expressions, we use Gaussian Mixture Models (GMMs) to represent images that can be recognized with the Eigenface method, we refer to these images as “Good Quality”, and images that cannot be recognized, we refer to these images as “Poor Quality”. During testing, we classify a given image into one of the two classes. We use the FERET and Cohn-Kanade facial image databases to evaluate our algorithms for image quality assessment. The experimental results demonstrate that the prediction function for assessing the quality of blurred facial images is successful. In addition, our experiments show that our approach for assessing facial images with expressions is successful in predicting whether an image has a good quality or poor quality for recognition. Although the experiments in this paper are

based on the Eigenface technique, the assessment methods can be extended to other face recognition algorithms.
Keywords: Face recognition, Image Quality Assessment, Facial expressions, Blurring Effect, Gaussian Mixture Model.
This work is supported in part through an award from the NSF Center for Identification Technology Research (CITeR).

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04. Xuan Zou, Josef Kittler, Kieron Messer:
Ambient Illumination Variation Removal by Active Near-IR Imaging. 19-25
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Ambient Illumination Variation Removal by Active Near-IR Imaging

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Abstract
We investigate an active illumination method to overcome the effect of illumination variation in face recognition. Active Near-Infrared (Near-IR) illumination projected by a Light Emitting Diode (LED) light source is used to provide a constant illumination. The difference between two face images captured when the LED light is on and off respectively, is the image of a face under just the LED illumination, and is independent of ambient illumination. In preliminary experiments across different illuminations, across time, and their combinations, significantly better results are achieved in both automatic and semi-automatic face recognition experiments on LED illuminated faces than on face images under ambient illuminations.

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05. Byoungwoo Kim, Sunjin Yu, Sangyoun Lee, Jaihie Kim:
Rapid 3D Face Data Acquisition Using a Color-Coded Pattern and a Stereo Camera System. 26-32
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Rapid 3D Face Data Acquisition Using a Color-Coded Pattern and a Stereo Camera System

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Abstract
This paper presents a rapid 3D face data acquisition method that uses a color-coded pattern and a stereo camera system. The technique works by projecting a color coded pattern on an object and capturing two images with two cameras. The proposed color encoding strategy not only increased the speed of feature matching but also increased the accuracy of the process. We then solved the correspondence problem between the two images by using epipolar constraint, disparity compensation based searching range reduction, and hue correlation. The proposed method was applied to 3D data acquisition and time efficiency was compared with previous methods. The time efficiency of the suggested method was improved by about 40% and reasonable accuracy was achieved.

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06. Marijana Kosmerlj, Tom Fladsrud, Erik Hjelmås, Einar Snekkenes:
Face Recognition Issues in a Border Control Environment. 33-39
Electronic Edition (link) BibTeX
Face Recognition Issues in a Border Control Environment

Marijana Kosmerlj1 Contact Information, Tom Fladsrud1 Contact Information, Erik Hjelmås1 Contact Information and Einar Snekkenes1 Contact Information
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Abstract
Face recognition has greatly matured since the earliest forms, but still improvements must be made before it can be applied in high security or large scale applications. We conducted an experiment in order to estimate percentage of Norwegian people having one or more look-alikes in Norwegian population. The results indicate that the face recognition technology may not be adequate for identity verification in large scale applications. To survey the additional value of a human supervisor, we conducted an experiment where we investigated whether a human guard would detect false acceptances made by a computerized system, and the role of hair in human recognition of faces. The study showed that the human guard was able to detect almost 80% of the errors made by the computerized system.

More over, the study showed that the ability of human guard to recognize a human face is a function of hair: false acceptance rate was significantly higher for the images where the hair was removed compared to where it was present.

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07. ShengCai Liao, Zhen Lei, XiangXin Zhu, Zhenan Sun, Stan Z. Li, Tieniu Tan:
Face Recognition Using Ordinal Features. 40-46
Electronic Edition (link) BibTeX
Face Recognition Using Ordinal Features

ShengCai Liao1 Contact Information, Zhen Lei1 Contact Information, XiangXin Zhu1 Contact Information, Zhenan Sun1 Contact Information, Stan Z. Li1 Contact Information and Tieniu Tan1 Contact Information
(1) Center for Biometrics and Security Research & National Laboratory of Pattern Recognition, Institute of Automation, Chinese Academy of Sciences, 95 Zhongguancun Donglu Beijing 100080, China
Abstract
In this paper, we present an ordinal feature based method for face recognition. Ordinal features are used to represent faces. Hamming distance of many local sub-windows is computed to evaluate differences of two ordinal faces. AdaBoost learning is finally applied to select most effective hamming distance based weak classifiers and build a powerful classifier. Experiments demonstrate good results for face recognition on the FERET database, and the power of learning ordinal features for face recognition.
This work was supported by Chinese National 863 Projects 2004AA1Z2290 & 2004AA119050.

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08. Walid Hizem, Emine Krichen, Yang Ni, Bernadette Dorizzi, Sonia Garcia-Salicetti:
Specific Sensors for Face Recognition. 47-54
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Specific Sensors for Face Recognition

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Abstract
This paper describes an association of original hardware solutions associated to adequate software software for human face recognition. A differential CMOS imaging system [1] and a Synchronized flash camera [2] have been developed to provide ambient light invariant images and facilitate segmentation of the face from the background. This invariance of face image demonstrated by our prototype camera systems can result in a significant software/hardware simplification in such biometrics applications especially on a mobile platform where the computation power and memory capacity are both limited. In order to evaluate our prototypes we have build a face database of 25 persons with 4 different illumination conditions. These solutions with appropriate cameras give a significant improvement in performance (on the normal CCD cameras) using a simple correlation based algorithm associated with an adequate preprocessing. Finally, we have obtained a promising results using fusion between different sensors.

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09. Xin Chen, Patrick J. Flynn, Kevin W. Bowyer:
Fusion of Infrared and Range Data: Multi-modal Face Images. 55-63
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Fusion of Infrared and Range Data: Multi-modal Face Images

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Abstract
Infrared and range imagery are intriguing sensing modalities for face recognition systems. They may offer better performance than other modalities due to their robustness to environmental effects and deliberate attempts to obscure identity. Furthermore, a combination of these modalities may offer additional discrimination power. Toward this end, we present a semi-automatic system that captures range and infrared data of a human subject's face, registers and integrates multiple 3D views into one model, and applies the infrared measurements as a registered texture map.

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10. Jian Yang, David Zhang, Yong Xu, Jing-Yu Yang:
Recognize Color Face Images Using Complex Eigenfaces. 64-68
Electronic Edition (link) BibTeX
Recognize Color Face Images Using Complex Eigenfaces

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Abstract
A strategy of color image based human face representation is first proposed. Then, based on this representation, complex Eigenfaces technique is developed for facial feature extraction. Finally, we test our idea using the AR face database. The experimental result demonstrates that the proposed color image based complex Eigenfaces method is more robust to illumination variations than the traditional grayscale image based Eigenfaces.

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11. Yunhong Wang, Yiding Wang, Anil K. Jain, Tieniu Tan:
Face Verification Based on Bagging RBF Networks. 69-77
Electronic Edition (link) BibTeX
Face Verification Based on Bagging RBF Networks

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Abstract
Face verification is useful in a variety of applications. A face verification system is vulnerable not only to variations in ambient lighting, facial expression and facial pose, but also to the effect of small sample size during the training phase. In this paper, we propose an approach to face verification based on Radial Basis Function (RBF) networks and bagging. The technique seeks to offset the effect of using a small sample size during the training phase. The RBF networks are trained using all available positive samples of a subject and a few randomly selected negative samples. Bagging is then applied to the outputs of these RBF-based classifiers. Theoretical analysis and experimental results show the validity of the proposed approach.

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12. Wangmeng Zuo, Kuanquan Wang, David Zhang:

Improvement on Null Space LDA for Face Recognition: A Symmetry Consideration. 78-84
Electronic Edition (link) BibTeX

Improvement on Null Space LDA for Face Recognition: A Symmetry Consideration

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(2) Biometrics Research Centre, Department of Computing, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong

Abstract

The approximate bilateral symmetry of human face has been explored to improve the recognition performance of some face recognition algorithms such as Linear Discriminant Analysis (LDA) and Direct-LDA (D-LDA). In this paper we summary the ways to generate virtual sample using facial symmetry, and investigate the three strategies of using facial symmetric information in the Null Space LDA (NLDA) framework. The results of our experiments indicate that, the use of facial symmetric information can further improve the recognition accuracy of conventional NLDA.

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13. Cheng Zhong, Tieniu Tan, Chenghua Xu, Jiangwei Li:

Automatic 3D Face Recognition Using Discriminant Common Vectors. 85-91
Electronic Edition (link) BibTeX

Automatic 3D Face Recognition Using Discriminant Common Vectors

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Abstract

In this paper we propose a fully automatic scheme for 3D face recognition. In our scheme, the original 3D data is automatically converted into the normalized 3D data, then the discriminant common vector

(DCV) is introduced for 3D face recognition. We also compare DCV with two common methods, i.e., principal component analysis (PCA) and linear discriminant analysis (LDA). Our experiments are based on the CASIA 3D Face Database, a challenging database with complex variations. The experimental results show that DCV is superior to the other two methods.

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14. Xiao-Sheng Zhuang, Dao-Qing Dai, Pong Chi Yuen:

Face Recognition by Inverse Fisher Discriminant Features. 92-98

Electronic Edition (link) BibTeX

Face Recognition by Inverse Fisher Discriminant Features

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(2) Department of Computer Science, Hong Kong Baptist University, Hong Kong

Abstract

For face recognition task the PCA plus LDA technique is a famous two-phrase framework to deal with high dimensional space and singular cases. In this paper, we examine the theory of this framework: (1) LDA can still fail even after PCA procedure. (2) Some small principal components that might be essential for classification are thrown away after PCA step. (3) The null space of the within-class scatter matrix Sw contains discriminative information for classification. To eliminate these deficiencies of the PCA plus LDA method we thus develop a new framework by introducing an inverse Fisher criterion and adding a constrain in PCA procedure so that the singularity phenomenon will not occur. Experiment results suggest that this new approach works well.

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15. Hwanjong Song, Ukil Yang, Sangyoun Lee, Kwanghoon Sohn:

3D Face Recognition Based on Facial Shape Indexes with Dynamic Programming. 99-105
Electronic Edition (link) BibTeX
3D Face Recognition Based on Facial Shape Indexes with Dynamic Programming

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Abstract
This paper describes a 3D face recognition method using facial shape indexes. Given an unknown range image, we extract invariant facial features based on the facial geometry. We estimate the 3D head pose using the proposed error compensated SVD method. For face recognition method, we define and extract facial shape indexes based on facial curvature characteristics and perform dynamic programming. Experimental results show that the proposed method is capable of determining the angle of faces accurately over a wide range of poses. In addition, 96.8% face recognition rate has been achieved based on the proposed method with 300 individuals with seven different poses.

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16. King Hong Cheung, Adams Wai-Kin Kong, David Zhang, Mohamed Kamel, Jane Toby You:
Revealing the Secret of FaceHashing. 106-112
Electronic Edition (link) BibTeX
Revealing the Secret of FaceHashing

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Abstract
Biometric authentication has attracted substantial attention over the past few years. It has been reported recently that a new technique called FaceHashing, which is proposed for personal authentication using

face images, has achieved perfect accuracy and zero equal error rates (EER). In this paper, we are going to reveal that the secret of FaceHashing in achieving zero EER is based on a false assumption. This is done through simulating the claimants' experiments. Thus, we would like to alert the use of "safe" token.

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17. Manuele Bicego, Enrico Grosso, Massimo Tistarelli:

Person Authentication from Video of Faces: A Behavioral and Physiological Approach Using Pseudo Hierarchical Hidden Markov Models. 113-120

Electronic Edition (link) BibTeX

Person Authentication from Video of Faces: A Behavioral and Physiological Approach Using Pseudo Hierarchical Hidden Markov Models

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Abstract
In this paper a novel approach to identity verification, based on the analysis of face video streams, is proposed, which makes use of both physiological and behavioral features. While physical features are obtained from the subject's face appearance, behavioral features are obtained by asking the subject to vocalize a given sentence. The recorded video sequence is modelled using a Pseudo-Hierarchical Hidden Markov Model, a new type of HMM in which the emission probability of each state is represented by another HMM. The number of states are automatically determined from the data by unsupervised clustering of expressions of faces in the video. Preliminary results on real image data show the feasibility of the proposed approach.

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18. Zongying Ou, Xusheng Tang, Tieming Su, Pengfei Zhao:

Cascade AdaBoost Classifiers with Stage Optimization for Face Detection. 121-128

Electronic Edition (link) BibTeX

Cascade AdaBoost Classifiers with Stage Optimization for Face Detection

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Abstract

In this paper, we propose a novel feature optimization method to build a cascade Adaboost face detector for real-time applications, such as teleconferencing, user interfaces, and security access control. AdaBoost algorithm selects a set of weak classifiers and combines them into a final strong classifier. However, conventional AdaBoost is a sequential forward search procedure using the greedy selection strategy, the weights of weak classifiers may not be optimized. To address this issue, we proposed a novel Genetic Algorithm post optimization procedure for a given boosted classifier, which yields better generalization performance.

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19. Jooyoung Park, Daesung Kang, James T. Kwok, Sang-Woong Lee, Bon-Woo Hwang, Seong-Whan Lee:

Facial Image Reconstruction by SVDD-Based Pattern De-noising. 129-135
Electronic Edition (link) BibTeX

Facial Image Reconstruction by SVDD-Based Pattern De-noising

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Abstract

The SVDD (support vector data description) is one of the most well-known one-class support vector learning methods, in which one tries the strategy of utilizing balls defined on the feature space in order to distinguish a set of normal data from all other possible abnormal objects. In this paper, we consider the problem of reconstructing facial images from the partially damaged ones, and propose to use the SVDD-based de-noising for the reconstruction. In the proposed method, we deal with the shape and texture information separately. We first solve the SVDD problem for the data belonging to the given prototype facial images, and model the data region for the normal faces as the ball resulting from the SVDD problem. Next, for each damaged input facial image, we project its feature vector onto the decision boundary of the SVDD ball so that it can be tailored enough to belong to the normal region. Finally, we obtain the image of the reconstructed face by obtaining the pre-image of the projection, and then further processing with its shape and texture information. The applicability of the proposed method is illustrated via some experiments dealing with damaged facial images.

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20. Xiujuan Chai, Shiguang Shan, Laiyun Qing, Wen Gao:

Pose Estimation Based on Gaussian Error Models. 136-143

Electronic Edition (link) BibTeX

Pose Estimation Based on Gaussian Error Models

Xiujuan Chai1 Contact Information, Shiguang Shan2 Contact Information, Laiyun Qing2 Contact Information and Wen Gao1, 2 Contact Information

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Abstract

In this paper, a new method is presented to estimate the 3D pose of facial image based on statistical Gaussian error models. The basic idea is that the pose angle can be computed by the orthogonal projection computation if the specific 3D shape vector of the given person is known. In our algorithm, Gaussian probability density function is used to model the distributions of the 3D shape vector as well as the errors between the orthogonal projection computation and the weak perspective projection. By using the prior knowledge of the errors distribution, the most likely 3D shape vector can be referred by the labeled 2D landmarks in the given facial image according to the maximum posterior probability theory. Refining the error term, thus the pose parameters can be estimated by the transformed orthogonal projection formula. Experimental results on real images are presented to give the objective evaluation.

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21. Zhong Jin, Franck Davoine, Zhen Lou, Jingyu Yang:

A Novel PCA-Based Bayes Classifier and Face Analysis. 144-150

Electronic Edition (link) BibTeX

A Novel PCA-Based Bayes Classifier and Face Analysis

Zhong Jin1, 2 Contact Information, Franck Davoine3 Contact Information, Zhen Lou2 and Jingyu Yang2 Contact Information

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Abstract

The classical Bayes classifier plays an important role in the field of pattern recognition. Usually, it is not easy to use a Bayes classifier for pattern recognition problems in high dimensional spaces. This paper proposes a novel PCA-based Bayes classifier for pattern recognition problems in high dimensional spaces. Experiments for face analysis have been performed on CMU facial expression image database. It is shown that the PCA-based Bayes classifier can perform much better than the minimum distance classifier. And, with the PCA-based Bayes classifier, we can obtain a better understanding of data.

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22. Stan Z. Li, Rufeng Chu, Meng Ao, Lun Zhang, Ran He:

Highly Accurate and Fast Face Recognition Using Near Infrared Images. 151-158
Electronic Edition (link) BibTeX

Highly Accurate and Fast Face Recognition Using Near Infrared Images

Stan Z. Li1 Contact Information, RuFeng Chu1 Contact Information, Meng Ao1 Contact Information, Lun Zhang1 Contact Information and Ran He1 Contact Information
(1) Center for Biometrics and Security Research & National Laboratory of Pattern Recognition, Institute of Automation, Chinese Academy of Sciences, 95 Zhongguancun Donglu Beijing 100080, China

Abstract

In this paper, we present a highly accurate, realtime face recognition system for cooperative user applications. The novelties are: (1) a novel design of camera hardware, and (2) a learning based procedure for effective face and eye detection and recognition with the resulting imagery. The hardware minimizes environmental lighting and delivers face images with frontal lighting. This avoids many problems in subsequent face processing to a great extent. The face detection and recognition algorithms are based on a local feature representation. Statistical learning is applied to learn most effective features and classifiers for building face detection and recognition engines. The novel imaging system and the detection and recognition engines are integrated into a powerful face recognition system. Evaluated in real-world user scenario, a condition that is harder than a technology evaluation such as Face Recognition Vendor Tests (FRVT), the system has demonstrated excellent accuracy, speed and usability.
This work was supported by Chinese National 863 Projects 2004AA1Z2290 & 2004AA119050.
See: http://research.microsoft.com/iccv2005/demo/StanLi/IR-Face-Demo.pdf

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23. Jaewon Sung, Daijin Kim:

Background Robust Face Tracking Using Active Contour Technique Combined Active Appearance Model. 159-165

Electronic Edition (link) BibTeX

Background Robust Face Tracking Using Active Contour Technique Combined Active Appearance Model

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Abstract

This paper proposes a two stage AAM fitting algorithm that is robust to the cluttered background and a large motion. The proposed AAM fitting algorithm consists of two alternative procedures: the active contour fitting to find the contour sample that best fits the face image and then the active appearance model fitting over the best selected contour. Experimental results show that the proposed active contour based AAM provides better accuracy and convergence characteristics in terms of RMS error and convergence rate, respectively, than the existing robust AAM.

This work was supported by the Korea Science and Engineering Foundation (KOSEF) through the Biometrics Engineering Research Center (BERC) at Yonsei University.

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24. Hui Kong, Xuchun Li, Jian-Gang Wang, Chandra Kambhamettu:

Ensemble LDA for Face Recognition. 166-172

Electronic Edition (link) BibTeX

Ensemble LDA for Face Recognition

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Abstract

Linear Discriminant Analysis (LDA) is a popular feature extraction technique for face image recognition

and retrieval. However, It often suffers from the small sample size problem when dealing with the high dimensional face data. Two-step LDA (PCA+LDA) [1][2][3] is a class of conventional approaches to address this problem. But in many cases, these LDA classifiers are overfitted to the training set and discard some useful discriminative information. In this paper, by analyzing the overfitting problem for the two-step LDA approach, a framework of Ensemble Linear Discriminant Analysis (EnLDA) is proposed for face recognition with small number of training samples. In EnLDA, a Boosting-LDA (B-LDA) and a Random Sub-feature LDA (RS-LDA) schemes are incorporated together to construct the total weak-LDA classifier ensemble. By combining these weak-LDA classifiers using majority voting method, recognition accuracy can be significantly improved. Extensive experiments on two public face databases verify the superiority of the proposed EnLDA over the state-of-the-art algorithms in recognition accuracy.

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25. Enrique Argones-Rúa, Josef Kittler, José Luis Alba-Castro, Daniel González-Jiménez:
Information Fusion for Local Gabor Features Based Frontal Face Verification. 173-181
Electronic Edition (link) BibTeX
Information Fusion for Local Gabor Features Based Frontal Face Verification

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(2) Centre for Vision, Speech and Signal Processing, University of Surrey, Guildford GU2 7XH, UK
Abstract
We address the problem of fusion in a facial component approach to face verification. In our study the facial components are local image windows defined on a regular grid covering the face image. Gabor jets computed in each window provide face representation. A fusion architecture is proposed to combine the face verification evidence conveyed by each facial component. A novel modification of the linear discriminant analysis method is presented that improves fusion performance as well as providing a basis for feature selection. The potential of the method is demonstrated in experiments on the XM2VTS data base. The references of this article are secured to subscribers.

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26. Sreekar Krishna, John Black, Sethuraman Panchanathan:
Using Genetic Algorithms to Find Person-Specific Gabor Feature Detectors for Face Indexing and Recognition. 182-191
Electronic Edition (link) BibTeX
Using Genetic Algorithms to Find Person-Specific Gabor Feature Detectors for Face Indexing and Recognition

Sreekar Krishna1 Contact Information, John Black1 and Sethuraman Panchanathan1
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Abstract
In this paper, we propose a novel methodology for face recognition, using person-specific Gabor wavelet representations of the human face. For each person in a face database a genetic algorithm selects a set of Gabor features (each feature consisting of a particular Gabor wavelet and a corresponding (x, y) face location) that extract facial features that are unique to that person. This set of Gabor features can then be applied to any normalized face image, to determine the presence or absence of those characteristic facial features. Because a unique set of Gabor features is used for each person in the database, this method effectively employs multiple feature spaces to recognize faces, unlike other face recognition algorithms in which all of the face images are mapped into a single feature space. Face recognition is then accomplished by a sequence of face verification steps, in which the query face image is mapped into the feature space of each person in the database, and compared to the cluster of points in that space that represents that person. The space in which the query face image most closely matches the cluster is used to identify the query face image. To evaluate the performance of this method, it is compared to the most widely used subspace method for face recognition: Principle Component Analysis (PCA). For the set of 30 people used in this experiment, the face recognition rate of the proposed method is shown to be substantially higher than PCA.

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27. Bingpeng Ma, Fei Yang, Wen Gao, Baochang Zhang:
The Application of Extended Geodesic Distance in Head Poses Estimation. 192-198
Electronic Edition (link) BibTeX
The Application of Extended Geodesic Distance in Head Poses Estimation

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(3) Graduate School of the Chinese Academy of Sciences, Beijing 100039, China

Abstract
This paper we proposes an extended geodesic distance for head pose estimation. In ISOMAP, two approaches are applied for neighborhood construction, called k-neighbor and ε-neighbor. For the k-neighbor, the number of the neighbors is a const k. For the other one, all the distances between the neighbors is less than ε. Either the k-neighbor or the ε-neighbor neglects the difference of each point. This paper proposes an new method called the kc-neighbor, in which the neighbors are defined based on c time distance of the k nearest neighbor, which can avoid the neighborhood graph unconnected and improve the accuracy in computing neighbors. In this paper, SVM rather than MDS is applied to classify head poses after the geodesic distances are computed. The experiments show the effectiveness of the proposed method.

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28. Bindang Xue, Wenfang Xue, Zhiguo Jiang:
Improved Parameters Estimating Scheme for E-HMM with Application to Face Recognition. 199-

205
Electronic Edition (link) BibTeX
Improved Parameters Estimating Scheme for E-HMM with Application to Face Recognition

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(2) Institute of Automation, Chinese Academy of Sciences, 100088, Beijing, China
Abstract
This paper presents a new scheme to initialize and re-estimate Embedded Hidden Markov Models(E-HMM) parameters for face recognition. Firstly, the current samples were assumed to be a subset of the whole training samples, after the training process, the E-HMM parameters and the necessary temporary parameters in the parameter re-estimating process were saved for the possible retraining use. When new training samples were added to the training samples, the saved E-HMM parameters were chosen as the initial model parameter. Then the E-HMM was retrained based on the new samples and the new temporary parameters were obtained. Finally, these temporary parameters were combined with saved temporary parameters to form the final E-HMM parameters for representing one person face. Experiments on ORL databases show the improved method is effective.
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29. Cuiping Zhang, Fernand S. Cohen:
Component-Based Active Appearance Models for Face Modelling. 206-212
Electronic Edition (link) BibTeX
Component-Based Active Appearance Models for Face Modelling

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Abstract
The Active Appearance Model (AAM) is a powerful tool for modelling a class of objects such as faces. However, it is common to see a far from optimal local alignment when attempting to model a face that is quite different from training faces. In this paper, we present a novel component-based AAM algorithm. By modelling three components inside the face area, then combining them with a global AAM, face alignment achieves both local as well as global optimality. We also utilize local projection models to locate face contour points. Compared to the original AAM, our experiment shows that this new algorithm is more accurate in shape localization as the decoupling allows more flexibility. Its insensitivity to different face background patterns is also clearly manifested.

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Fingerprint

30. Julian Fiérrez-Aguilar, Yi Chen, Javier Ortega-Garcia, Anil K. Jain:
Incorporating Image Quality in Multi-algorithm Fingerprint Verification. 213-220
Electronic Edition (link) BibTeX
Incorporating Image Quality in Multi-algorithm Fingerprint Verification

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Abstract
The effect of image quality on the performance of fingerprint verification is studied. In particular, we investigate the performance of two fingerprint matchers based on minutiae and ridge information as well as their score-level combination under varying fingerprint image quality. The ridge-based system is found to be more robust to image quality degradation than the minutiae-based system. We exploit this fact by introducing an adaptive score fusion scheme based on automatic quality estimation in the spatial frequency domain. The proposed scheme leads to enhanced performance over a wide range of fingerprint image quality.

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31. A. Antonelli, Raffaele Cappelli, Dario Maio, Davide Maltoni:
A New Approach to Fake Finger Detection Based on Skin Distortion. 221-228
Electronic Edition (link) BibTeX
A New Approach to Fake Finger Detection Based on Skin Distortion ,

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Abstract

This work introduces a new approach for discriminating real fingers from fakes, based on the analysis of human skin elasticity. The user is required to move the finger once it touches the scanner surface, thus deliberately producing skin distortion. A multi-stage feature- extraction technique captures and processes the significant information from a sequence of frames acquired during the finger movement; this information is encoded as a sequence of DistortionCodes and further analyzed to determine the nature of the finger. The experimentation carried out on a database of real and fake fingers shows that the performance of the new approach is very promising.
This work was partially supported by European Commission (BioSec - FP6 IST-2002-001766).
Patent pending(IT #BO2005A000399).

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32. Sanghoon Lee, Chulhan Lee, Jaihie Kim:

Model-Based Quality Estimation of Fingerprint Images. 229-235

Electronic Edition (link) BibTeX

A New Approach to Fake Finger Detection Based on Skin Distortion ,

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Abstract

This work introduces a new approach for discriminating real fingers from fakes, based on the analysis of human skin elasticity. The user is required to move the finger once it touches the scanner surface, thus deliberately producing skin distortion. A multi-stage feature- extraction technique captures and processes the significant information from a sequence of frames acquired during the finger movement; this information is encoded as a sequence of DistortionCodes and further analyzed to determine the nature of the finger. The experimentation carried out on a database of real and fake fingers shows that the performance of the new approach is very promising.
This work was partially supported by European Commission (BioSec - FP6 IST-2002-001766).
Patent pending(IT #BO2005A000399).

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33. J. S. Chen, Y. S. Moon:

A Statistical Evaluation Model for Minutiae-Based Automatic Fingerprint Verification Systems. 236-243

Electronic Edition (link) BibTeX

A Statistical Evaluation Model for Minutiae-Based Automatic Fingerprint Verification Systems

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Abstract

Evaluation of the reliability of an Automatic Fingerprint Verification System (AFVS) is usually performed by applying it to a fingerprint database to get the verification accuracy. However, such an evaluation process might be quite time consuming especially for big fingerprint databases. This may prolong the developing cycles of AFVSs and thus increase the cost. Also, comparison of the reliability of different AFVSs may be unfair if different fingerprint databases are used. In this paper, we propose a solution to solve these problems by creating an AFVS evaluation model which can be used for verification accuracy prediction and fair reliability comparison. Experimental results show that our model can predict the performance of a real AFVS pretty satisfactorily.

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34. Geppy Parziale, Eva Diaz-Santana, Rudolf Hauke:

The Surround Imager^{TM}: A Multi-camera Touchless Device to Acquire 3D Rolled-Equivalent Fingerprints. 244-250

Electronic Edition (link) BibTeX

The Surround ImagerTM: A Multi-camera Touchless Device to Acquire 3D Rolled-Equivalent Fingerprints

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Abstract

The Surround ImagerTM, an innovative multi-camera touchless device able to capture rolled-equivalent fingerprints, is here presented for the first time. Due to the lack of contact between the elastic skin of the finger and any rigid surface, the acquired images present no deformation. The multi-camera system acquires different finger views that are combined together to provide a 3D representation of the fingerprint. This new representation leads to a new definition of minutiae bringing new challenges in the field of fingerprint recognition.

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35. Xuchu Wang, Jianwei Li, Yanmin Niu, Weimin Chen, Wei Wang:

Extraction of Stable Points from Fingerprint Images Using Zone Could-be-in Theorem. 251-257
Electronic Edition (link) BibTeX

Extraction of Stable Points from Fingerprint Images Using Zone Could-be-in Theorem

Xuchu Wang1 Contact Information, Jianwei Li1 Contact Information, Yanmin Niu2, Weimin Chen1 and Wei Wang1
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(2) College of Physics and Information Techniques, Chongqing Normal University, 400047, Chongqing, P.R.China

Abstract

This paper presents a novel zone Could-be-in theorem, and applies it to interpret and extract singular points (cores and deltas) and estimate directions of cores in a fingerprint image. Where singular points are regarded as stable points (attracting points and rejecting points just according to their clockwise or anticlockwise rotation), and pattern zones are stable zones. Experimental results validate the theorem. The corresponding algorithm is compared with popular Poincaré index algorithm under two new indices: reliability index (RI) and accuracy cost (AC) in FVC2004 datasets. The proposed algorithm are higher 36.49% in average RI, less 2.47 in average AC, and the advantage is more remarkable with the decrease of block size.

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36. Wonchurl Jang, Deoksoo Park, Dongjae Lee, Sung-jae Kim:
Fingerprint Image Enhancement Based on a Half Gabor Filter. 258-264
Electronic Edition (link) BibTeX
Fingerprint Image Enhancement Based on a Half Gabor Filter

Wonchurl Jang1 Contact Information, Deoksoo Park1 Contact Information, Dongjae Lee1 Contact Information and Sung-jae Kim1 Contact Information
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Abstract
The performance of a fingerprint recognition system relies on the quality of the input fingerprint images. Several researches have been studied on the enhancement of fingerprint images for fingerprint recognition. The representative enhancement is the adaptive filtering method based on Gabor filter (GF). However, this method is computationally expensive due to the large mask size of GF. In this paper, we propose a half Gabor filter (HGF), which is suitable for fast implementation in spatial domain. The HGF is a modified filter which preserves the frequency property of a GF and reduces the mask size of the GF. Compared with the GF, the HGF not only reduces the processing time approximately by 41% but also enhances the fingerprint image which is as reliable as the GF.
Keywords: Gabor Filter, Gabor Enhancement, Fingerprint Image Enhancement, Adaptive Filter.

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37. Denis Baldisserra, Annalisa Franco, Dario Maio, Davide Maltoni:
Fake Fingerprint Detection by Odor Analysis. 265-272
Electronic Edition (link) BibTeX
Fake Fingerprint Detection by Odor Analysis ,

Denis Baldisserra1 Contact Information, Annalisa Franco1 Contact Information, Dario Maio1 Contact Information and Davide Maltoni1 Contact Information
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Abstract
This work proposes a novel approach to secure fingerprint scanners against the presentation of fake fingerprints. An odor sensor (electronic nose) is used to sample the odor signal and an ad-hoc algorithm allows to discriminate the finger skin odor from that of other materials such as latex, silicone or gelatin, usually employed to forge fake fingerprints. The experimental results confirm the effectiveness of the proposed approach.
This work was partially supported by European Commission (BioSec - FP6 IST-2002-001766).
Patent Pending (IT #BO2005A000398).

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38. Xiaohui Xie, Fei Su, Anni Cai:
Ridge-Based Fingerprint Recognition. 273-279
Electronic Edition (link) BibTeX
Ridge-Based Fingerprint Recognition

Xiaohui Xie1, Fei Su1 and Anni Cai1
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Abstract
A new fingerprint matching method is proposed in this paper, with which two fingerprint skeleton images are matched directly. In this method, an associate table is introduced to describe the relation of a ridge with its neighbor ridges, so the whole ridge pattern can be easily handed. In addition, two unique similarity measures, one for ridge curves, another for ridge patterns, are defined with the elastic distortion taken into account. Experiment results on several databases demonstrate the effectiveness and robustness of the proposed method.
Keywords: fingerprint recognition, point-pattern matching, ridge sampling, ridge matching.
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39. Koji Sakata, Takuji Maeda, Masahito Matsushita, Koichi Sasakawa, Hisashi Tamaki:
Fingerprint Authentication Based on Matching Scores with Other Data. 280-286
Electronic Edition (link) BibTeX
Fingerprint Authentication Based on Matching Scores with Other Data

Koji Sakata1, Takuji Maeda1, Masahito Matsushita1, Koichi Sasakawa1 and Hisashi Tamaki2

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Abstract

A method of person authentication based on matching scores with the fingerprint data of others is proposed. Fingerprint data of others is prepared in advance as a set of representative data. Input fingerprint data is verified against the representative data, and the person belonging to the fingerprint is confirmed from the set of matching scores. The set of scores can be thought of as a feature vector, and is compared with the feature vector already enrolled. In this paper, the mechanism of the proposed method, the person authentication system using this method are described, and its advantage. Moreover, the simple criterion and selection method of the representative data are discussed. The basic performance when general techniques are used for the classifier is FNMR-3.6% at FMR-0.1%.

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40. Jun-Ki Min, Jin-Hyuk Hong, Sung-Bae Cho:

Effective Fingerprint Classification by Localized Models of Support Vector Machines. 287-293
Electronic Edition (link) BibTeX

Effective Fingerprint Classification by Localized Models of Support Vector Machines

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(1) Department of Computer Science, Yonsei University, Biometrics Engineering Research Center, 134 Shinchon-dong, Sudaemoon-ku, Seoul 120-749, Korea

Abstract

Fingerprint classification is useful as a preliminary step of the matching process and is performed in order to reduce searching time. Various classifiers like support vector machines (SVMs) have been used to fingerprint classification. Since the SVM which achieves high accuracy in pattern classification is a binary classifier, we propose a classifier-fusion method, multiple decision templates (MuDTs). The proposed method extracts several clusters of different characteristics from each class of fingerprints and constructs localized classification models in order to overcome restrictions to ambiguous fingerprints. Experimental results show the feasibility and validity of the proposed method.

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41. Xiaosi Zhan, Zhaocai Sun, Yilong Yin, Yayun Chu:

Fingerprint Ridge Distance Estimation: Algorithms and the Performance. 294-301
Electronic Edition (link) BibTeX

Fingerprint Ridge Distance Estimation: Algorithms and the Performance

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Abstract
Ridge distance is one important attribute of the fingerprint image and it also is one important parameter in the fingerprint enhancement. It is important for improving the AFIS's performance to estimate the ridge distance correctly. The paper discusses the representative fingerprint ridge distance estimation algorithms and the performance of these algorithms. The most common fingerprint ridge distance estimation algorithm is based on block-level and estimates the ridge distance by calculating the number of cycle pattern in the block fingerprint image. The traditional Fourier transform spectral analysis method has been also applied to estimate the fingerprint ridge distance. The next kind of method is based on the statistical window. Another novel fingerprint ridge distance estimation method is based on the region-level which regards the region with the consistent orientation as the statistical region. One new method obtains the fingerprint ridge distance from the continuous Fourier spectrum. After discussing the dominant algorithm thought, the paper analyzes the performance of each algorithm.
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42. Xinjian Chen, Jie Tian, Yangyang Zhang, Xin Yang:
Enhancement of Low Quality Fingerprints Based on Anisotropic Filtering. 302-308
Electronic Edition (link) BibTeX
Enhancement of Low Quality Fingerprints Based on Anisotropic Filtering

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Abstract

The enhancement of the low quality fingerprint is a difficult and challenge task. This paper proposes an efficient algorithm based on anisotropic filtering to enhance the low quality fingerprint. In our algorithm, an orientation filed estimation with feedback method was proposed to compute the accurate fingerprint orientation. The gradient-based approach was firstly used to compute the coarse orientation. Then the reliability of orientation was computed from the gradient image. If the reliability of the estimated orientation is less than pre-specified threshold, the orientation will be corrected by the mixed orientation model. And an anisotropic filtering was used to enhance the fingerprint, with the advantages of its efficient ridge enhancement and its robustness against noise in the fingerprint image. The proposed algorithm has been evaluated on the databases of Fingerprint verification competition (FVC2004). Experimental results confirm that the proposed algorithm is effective and robust for the enhancement of the low quality fingerprint.

This paper is supported by the Project of National Science Fund for Distinguished Young Scholars of China under Grant No. 60225008, the Key Project of National Natural Science Foundation of China under Grant No. 60332010, the Project for Young Scientists' Fund of National Natural Science Foundation of China under Grant No.60303022, and the Project of Natural Science Foundation of Beijing under Grant No.4052026.

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43. Sharat Chikkerur, Alexander N. Cartwright, Venu Govindaraju:

K-plet and Coupled BFS: A Graph Based Fingerprint Representation and Matching Algorithm.
309-315

Electronic Edition (link) BibTeX

K-plet and Coupled BFS: A Graph Based Fingerprint Representation and Matching Algorithm

Sharat Chikkerur1 Contact Information, Alexander N. Cartwright1 Contact Information and Venu Govindaraju1 Contact Information
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Abstract
In this paper, we present a new fingerprint matching algorithm based on graph matching principles. We define a new representation called K-plet to encode the local neighborhood of each minutiae. We also present CBFS (Coupled BFS), a new dual graph traversal algorithm for consolidating all the local neighborhood matches and analyze its computational complexity. The proposed algorithm is robust to non-linear distortion. Ambiguities in minutiae pairings are solved by employing a dynamic programming based optimization approach. We present an experimental evaluation of the proposed approach and showed that it exceeds the performance of the NIST BOZORTH3 [3] matching algorithm.

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44. Koichi Ito, Ayumi Morita, Takafumi Aoki, Hiroshi Nakajima, Koji Kobayashi, Tatsuo Higuchi:
A Fingerprint Recognition Algorithm Combining Phase-Based Image Matching and Feature-Based Matching. 316-325
Electronic Edition (link) BibTeX

A Fingerprint Recognition Algorithm Combining Phase-Based Image Matching and Feature-Based Matching

Koichi Ito1 Contact Information, Ayumi Morita1, Takafumi Aoki1, Hiroshi Nakajima2, Koji Kobayashi2 and Tatsuo Higuchi3
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(2) Yamatake Corporation, Isehara 259–1195, Japan
(3) Faculty of Engineering, Tohoku Institute of Technology, Sendai 982–8577, Japan

Abstract
This paper proposes an efficient fingerprint recognition algorithm combining phase-based image matching and feature-based matching. The use of Fourier phase information of fingerprint images makes possible to achieve robust recognition for weakly impressed, low-quality fingerprint images. Experimental evaluations using two different types of fingerprint image databases demonstrate efficient recognition performance of the proposed algorithm compared with a typical minutiae-based algorithm and the conventional phase-based algorithm.

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45. Hiroshi Nakajima, Koji Kobayashi, Makoto Morikawa, Atsushi Katsumata, Koichi Ito, Takafumi Aoki, Tatsuo Higuchi:

Fast and Robust Fingerprint Identification Algorithm and Its Application to Residential Access Controller. 326-333
Electronic Edition (link) BibTeX
Fast and Robust Fingerprint Identification Algorithm and Its Application to Residential Access Controller

Hiroshi Nakajima1, Koji Kobayashi2, Makoto Morikawa3, Atsushi Katsumata3, Koichi Ito4, Takafumi Aoki4 and Tatsuo Higuchi5
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Abstract
A novel fingerprint recognition algorithm suitable for poor quality fingerprint is proposed, and implementation considerations to realize fingerprint recognition access controllers for residential applications are discussed. It is shown that optimizing spatial sampling interval of fingerprint image has equivalent effect of optimizing high limit frequency of low-pass filter in the process of phase based correlation. The processing time is 83% shorter for the former than the latter. An ASIC has been designed, and it is shown that fingerprint matching based access controller for residential applications can be successfully realized.
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46. Choonwoo Ryu, Jihyun Moon, Bongku Lee, Hakil Kim:
Design of Algorithm Development Interface for Fingerprint Verification Algorithms. 334-340
Electronic Edition (link) BibTeX
Design of Algorithm Development Interface for Fingerprint Verification Algorithms

Choonwoo Ryu1 Contact Information, Jihyun Moon1 Contact Information, Bongku Lee1 Contact Information and Hakil Kim1 Contact Information
(1) Biometrics Engineering Research Center (BERC), School of Information and Communication Engineering, INHA Unversity, Incheon, Korea
Abstract
This paper proposes a programming interface in order to standardize low-level functional modules that are commonly employed in minutiae-based fingerprint verification algorithms. The interface, called FpADI, defines the protocols, data structures and operational mechanism of the functions. The purpose of designing FpADI is to develop a minutiae-based fingerprint verification algorithm cooperatively and to evaluate the algorithm efficiently. In a preliminary experiment, fingerprint feature extraction algorithms are implemented using FpADI and an application program, called FpAnalyzer, is developed

in order to evaluate the performance of the implemented algorithms by visualizing the information in the FpADI data structures.

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47. Mark B. Edwards, G. E. Torrens, T. A. Bhamra:

The Use of Fingerprint Contact Area for Biometric Identification. 341-347
Electronic Edition (link) BibTeX

The Use of Fingerprint Contact Area for Biometric Identification

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Abstract
This paper details the potential use of finger contact area measurement in combination with existing fingerprint comparison technology for the verification of user identity. Research highlighted includes relationships between finger contact area, pressure applied and other physical characteristics.. With the development of small scale fingerprint readers it is starting to be possible to incorporate these into a wide range of technologies. Analysis of finger pressure and contact area can enhance fingerprint based biometric security systems. The fingertip comprises a range of biological materials which give it complex mechanical properties. These properties govern the way in which a fingertip deforms under load. Anthropometric measurements were taken from 11 males and 5 females along with fingerprint area measurements. Strong correlations were found between fingerprint area and many other measurements, including hand length. Notably there were more strong correlations for the female group than for the male. This pilot study indicates the feasibility of fingerprint area analysis for biometric identification. This work is part of a long term program of human physical characterization.

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48. Chulhan Lee, Sanghoon Lee, Jaihie Kim, Sung-Jae Kim:

Preprocessing of a Fingerprint Image Captured with a Mobile Camera. 348-355
Electronic Edition (link) BibTeX

Preprocessing of a Fingerprint Image Captured with a Mobile Camera

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Abstract
A preprocessing algorithm of a fingerprint image captured with a mobile camera is proposed. Fingerprint images from a mobile camera are different from images from conventional or touch-based sensors such as optical, capacitive, and thermal sensors. For example, images from a mobile camera are colored and the backgrounds or non-finger regions can be very erratic depending on how the image captures time and place. Also, the contrast between the ridges and valleys of images from a mobile camera is lower than that of images from touch-based sensors. Because of these differences between the input images, a new and modified fingerprint preprocessing algorithm is required for fingerprint recognition when using images captured with a mobile camera.

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Iris

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49. Kazuyuki Miyazawa, Koichi Ito, Takafumi Aoki, Koji Kobayashi, Hiroshi Nakajima:
A Phase-Based Iris Recognition Algorithm. 356-365
Electronic Edition (link) BibTeX

A Phase-Based Iris Recognition Algorithm

Kazuyuki Miyazawa1 Contact Information, Koichi Ito1, Takafumi Aoki1, Koji Kobayashi2 and Hiroshi Nakajima2
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(2) Yamatake Corporation, Isehara 259–1195, Japan

Abstract
This paper presents an efficient algorithm for iris recognition using phase-based image matching. The use of phase components in two-dimensional discrete Fourier transforms of iris images makes possible to achieve highly robust iris recognition with a simple matching algorithm. Experimental evaluation using the CASIA iris image database (ver. 1.0 and ver. 2.0) clearly demonstrates an efficient performance of the proposed algorithm.

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50. Zhenan Sun, Tieniu Tan, Xianchao Qiu:
Graph Matching Iris Image Blocks with Local Binary Pattern. 366-372
Electronic Edition (link) BibTeX
Graph Matching Iris Image Blocks with Local Binary Pattern

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Abstract
Iris-based personal identification has attracted much attention in recent years. Almost all the state-of-the-art iris recognition algorithms are based on statistical classifier and local image features, which are noise sensitive and hardly to deliver perfect recognition performance. In this paper, we propose a novel iris recognition method, using the histogram of local binary pattern for global iris texture representation and graph matching for structural classification. The objective of our idea is to complement the state-of-the-art methods with orthogonal features and classifier. In the texture-rich iris image database UPOL, our method achieves higher discriminability than state-of-the-art approaches. But our algorithm does not perform well in the CASIA database whose images are less textured. Then the value of our work is demonstrated by providing complementary information to the state-of-the-art iris recognition systems. After simple fusion with our method, the equal error rate of Daugman's algorithm could be halved.

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51. Yi Chen, Sarat C. Dass, Anil K. Jain:
Localized Iris Image Quality Using 2-D Wavelets. 373-381
Electronic Edition (link) BibTeX
Localized Iris Image Quality Using 2-D Wavelets

Yi Chen1 Contact Information, Sarat C. Dass1 Contact Information and Anil K. Jain1 Contact Information
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Abstract
The performance of an iris recognition system can be undermined by poor quality images and result in high false reject rates (FRR) and failure to enroll (FTE) rates. In this paper, a wavelet-based quality measure for iris images is proposed. The merit of the this approach lies in its ability to deliver good spatial adaptivity and determine local quality measures for different regions of an iris image. Our

experiments demonstrate that the proposed quality index can reliably predict the matching performance of an iris recognition system. By incorporating local quality measures in the matching algorithm, we also observe a relative matching performance improvement of about 20% and 10% at the equal error rate (EER), respectively, on the CASIA and WVU iris databases.

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52. Siew Chin Chong, Andrew Teoh Beng Jin, David Ngo Chek Ling:
Iris Authentication Using Privatized Advanced Correlation Filter. 382-388
Electronic Edition (link) BibTeX
Iris Authentication Using Privatized Advanced Correlation Filter

Siew Chin Chong1 Contact Information, Andrew Beng Jin Teoh1 Contact Information and David Chek Ling Ngo1 Contact Information
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Abstract
This paper proposes a private biometrics formulation which is based on the concealment of random kernel and the iris images to synthesize a minimum average correlation energy (MACE) filter for iris authentication. Specifically, we multiply training images with the user-specific random kernel in frequency domain before biometric filter is created. The objective of the proposed method is to provide private biometrics realization in iris authentication in which biometric template can be reissued once it was compromised. Meanwhile, the proposed method is able to decrease the computational load, due to the filter size reduction. It also improves the authentication rate significantly compare to the advance correlation based approach [5][6] and comparable to the Daugmant's Iris Code [1].

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53. Chul-Hyun Park, Joon-Jae Lee:

Extracting and Combining Multimodal Directional Iris Features. 389-396
Electronic Edition (link) BibTeX
Extracting and Combining Multimodal Directional Iris Features

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(2) Dept. of Computer and Information Engineering, Dongseo University, Busan, Korea

Abstract

In this paper, we deal with extracting and combining multimodal iris features for person verification. In multibiometric approaches, finding reasonably disjoint features and effective combining methods are crucial. The proposed method considers the directional characteristics of iris patterns as critical features, and first decomposes an iris image into several directional subbands using a directional filter bank (DFB), then generates two kinds of feature vectors from the directional subbands. One is the binarized output features of the directional subbands on multiple scales and the other is the blockwise directional energy features. The former is relatively robust to changes in illumination or image contrast because it uses the directional zero crossing information of the directional subbands, whereas the latter provides another form of rich directional information though it is a bit sensitive to contrast change. Matching is performed separately between the same kind of feature vectors and the final decision is made by combining the matching scores based on the accuracy of each method. Experimental results show that the two kinds of feature vectors used in this paper are reasonably complementary and the combining method is effective.

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54. Eui Chul Lee, Kang Ryoung Park, Jaihie Kim:
Fake Iris Detection by Using Purkinje Image. 397-403
Electronic Edition (link) BibTeX
Fake Iris Detection by Using Purkinje Image

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Abstract

Fake iris detection is to detect and defeat a fake (forgery) iris image input. To solve the problems of previous researches on fake iris detection, we propose the new method of detecting fake iris attack based on the Purkinje image. Especially, we calculated the theoretical positions and distances between the Purkinje images based on the human eye model and the performance of fake detection algorithm could be much enhanced by such information. Experimental results showed that the FAR (False Acceptance Rate for accepting fake iris as live one) was 0.33% and FRR(False Rejection Rate of rejecting live iris as fake one) was 0.33%.

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55. Li Yu, Kuanquan Wang, David Zhang:
A Novel Method for Coarse Iris Classification. 404-410
Electronic Edition (link) BibTeX

A Novel Method for Coarse Iris Classification

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(2) Department of computing, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong

Abstract

This paper proposes a novel method for the automatic coarse classification of iris images using a box-counting method to estimate the fractal dimensions of the iris. First, the iris image is segmented into sixteen blocks, eight belonging to an upper group and eight to a lower group. We then calculate the fractal dimension value of these image blocks and take the mean value of the fractal dimension as the upper and the lower group fractal dimensions. Finally all the iris images are classified into four categories in accordance with the upper and the lower group fractal dimensions. This classification method has been tested and evaluated on 872 iris cases and the accuracy is 94.61%. When we allow for the border effect, the double threshold algorithm is 98.28% accurate.

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56. Xianchao Qiu, Zhenan Sun, Tieniu Tan:

Global Texture Analysis of Iris Images for Ethnic Classification. 411-418

Electronic Edition (link) BibTeX

Global Texture Analysis of Iris Images for Ethnic Classification

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Abstract

Iris pattern is commonly regarded as a kind of phenotypic feature without relation to the genes. In this paper, we propose a novel ethnic classification method based on the global texture information of iris images. So we would argue that iris texture is race related, and its genetic information is illustrated in coarse scale texture features, rather than preserved in the minute local features of state-of-the-art iris recognition algorithms. In our scheme, a bank of multichannel 2D Gabor filters is used to capture the global texture information and AdaBoost is used to learn a discriminant classification principle from the pool of the candidate feature set. Finally iris images are grouped into two race categories, Asian and non-Asian. Based on the proposed method, we get an encouraging correct classification rate (CCR) of 85.95% on a mixed database containing 3982 iris samples in our experiments.

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57. Xin Li:

Modeling Intra-class Variation for Nonideal Iris Recognition. 419-427

Electronic Edition (link) BibTeX

Modeling Intra-class Variation for Nonideal Iris Recognition

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Abstract

Intra-class variation is fundamental to the FNMR performance of iris recognition systems. In this paper,

we perform a systematic study of modeling intra-class variation for nonideal iris images captured under less-controlled environments. We present global geometric calibration techniques for compensating distortion associated with off-angle acquisition and local geometric calibration techniques for compensating distortion due to inaccurate segmentation or pupil dilation. Geometric calibration facilitates both the localization and recognition of iris and more importantly, it offers a new approach of trading FNMR with FMR. We use experimental results to demonstrate the effectiveness of the proposed calibration techniques on both ideal and non-ideal iris databases.
This work was partially supported by NSF Center for Identification Technology Research.
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58. Jinyu Zuo, Natalia A. Schmid:

A Model Based, Anatomy Based Method for Synthesizing Iris Images. 428-435
Electronic Edition (link) BibTeX

A Model Based, Anatomy Based Method for Synthesizing Iris Images

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Abstract

Popularity of iris biometric grew considerably over the past 2-3 years. It resulted in development of a large number of new iris encoding and processing algorithms. Since there are no publicly available large scale and even medium size databases, neither of the algorithms has undergone extensive testing. With the lack of data, two major solutions to the problem of algorithm testing are possible: (i) physically collecting a large number of iris images or (ii) synthetically generating a large scale database of iris images. In this work, we describe a model based/anatomy based method to synthesize iris images and evaluate the performance of synthetic irises by using a traditional Gabor filter based system and by comparing local independent components extracted from synthetic iris images with those from real iris images. The issue of security and privacy is another argument in favor of generation of synthetic data.

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59. Caitang Sun, Chunguang Zhou, Yanchun Liang, Xiangdong Liu:

Study and Improvement of Iris Location Algorithm. 436-442
Electronic Edition (link) BibTeX

Study and Improvement of Iris Location Algorithm

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Abstract

Iris location is a crucial step in iris recognition. Taking into consideration the fact that interior of the

pupil, there would have some lighter spots because of reflection, this paper improves the commonly used coarse location method. It utilizes the gray scale histogram of the iris graphics, first computes the binary threshold, averaging the center of chords to coarsely estimate the center and radius of the pupil, and then finely locates it using the algorithm of circle detection in the binary graphic. This method could reduce the error of locating within the pupil. After that, this paper combines Canny edge detector and Hough voting mechanism to locate the outer boundary. Finally, a statistical method is exploited to exclude eyelash and eyelid areas. Experiments have shown the applicability and efficiency of this algorithm.
Keywords: Iris Location, Circle Detection, Canny Edge Detection, Hough Voting Mechanism.

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60. Junying Gan, Yu Liang:

Applications of Wavelet Packets Decomposition in Iris Recognition. 443-449
Electronic Edition (link) BibTeX

Applications of Wavelet Packets Decomposition in Iris Recognition

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Abstract

The method of Wavelet Packets Decomposition (WPD) originating from wavelet transform is more accurate in signal analysis, with the predominance of analyzing high-frequency information. Combined with the trait of WPD, an algorithm for iris recognition is presented in this paper. Firstly, iris image is divided into several windows, and WPD is done to them. At the same time, some of the subband images from each window are selected, which contain most information of iris image. Secondly, the farther feature extraction and compression are applied to these subband images by way of Singular Value Decomposition (SVD), and iris recognition features are obtained. Finally, Weighted Euclidean Distance (WED) classifier is utilized in recognition. Experimental results on CASIA (Chinese Academy of Sciences, Institute of Automation) iris image database show the method is valid in iris recognition.

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61. Xueyi Ye, Peng Yao, Fei Long, Zhenquan Zhuang:

Iris Image Real-Time Pre-estimation Using Compound BP Neural Network. 450-456
Electronic Edition (link) BibTeX

Iris Image Real-Time Pre-estimation Using Compound BP Neural Network

Xueyi Ye1 Contact Information, Peng Yao1, Fei Long1 and Zhenquan Zhuang1
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Abstract

A practical iris identification application system faces different types of bad iris images resulted from many reasons. Because previous image quality evaluation methods estimate an iris image whether bad or else by the resolution and the definition of the iris part, they just can deal with few types among them. For saving the time occupied by the localization in images real-time estimation, improving friendly interaction of an iris identification system, decreasing the localization failure on account of importing the bad-image, this paper proposes a method of real-time pre-estimation using the compound BP neural network. Multiple independent BP neural networks are used to extract both the overall contour feature and the local of an iris image and to calculate the pre-estimation output by different training weights. The experimental result is shown that the method can detects most types of the bad-image with comparatively low error rate and the pre-estimation network has fairly large throughput. It should satisfy the pre-estimation requirement of a real-time iris identification system.

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62. Dae Sik Jeong, Hyun-Ae Park, Kang Ryoung Park, Jaihie Kim:
Iris Recognition in Mobile Phone Based on Adaptive Gabor Filter. 457-463
Electronic Edition (link) BibTeX
Iris Recognition in Mobile Phone Based on Adaptive Gabor Filter

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Abstract

As the security of personal information is becoming more important in mobile phones, we apply iris recognition technology to mobile device. Different from conventional iris recognition system used for access control, user puts the mobile phone by hands in this case. So, optical and motion blurring happens, frequently. In addition, most users have tendencies to use the mobile phone in outdoor and sunlight (which includes much amount of IR(Infra-Red) light) may have much effect on the input iris image in spite of the visible light cut filter attached in front of iris camera lens. To overcome such problems, we propose a new method of extracting the accurate iris code based on AGF (Adaptive Gabor Filter). The kernel size, frequency and amplitude of Gabor filter are determined by the amount of blurring and sunlight in input image, adaptively. Experimental results show that the EER by our propose method is 0.14 %.

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63. Zhuoshi Wei, Tieniu Tan, Zhenan Sun, Jiali Cui:
Robust and Fast Assessment of Iris Image Quality. 464-471
Electronic Edition (link) BibTeX
Robust and Fast Assessment of Iris Image Quality

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Abstract
Iris recognition is one of the most reliable methods for personal identification. However, not all the iris images obtained from the device are of high quality and suitable for recognition. In this paper, a novel approach for iris image quality assessment is proposed to select clear images in the image sequence. The proposed algorithm uses three distinctive features to distinguish three kinds of poor quality images, i.e. defocus, motion blur and occlusion. Experimental results demonstrate the effectiveness of the algorithm. Clear iris images selected by our method are essential to subsequent iris recognition.

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64. Peeranat Thoonsaengngam, Kittipol Horapong, Somying Thainimit, Vutipong Areekul:
Efficient Iris Recognition Using Adaptive Quotient Thresholding. 472-478
Electronic Edition (link) BibTeX
Efficient Iris Recognition Using Adaptive Quotient Thresholding

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Abstract

This paper presents an intensity-based iris recognition system. The system exploits local intensity changes of the visible iris textures such as crypts and naevi. The textures are extracted using local histogram equalization and the proposed 'quotient thresholding' technique. The quotient thresholding partitions iris images in a database such that a ratio between foreground and background of each image is retained. By fixing this ratio, variations of illumination across iris images are compensated, resulting in informative and distinctive blob-like iris textures. An agreement of the two extracted textures is measured by finding spatial correspondences between the textures. The proposed system yields the 0.22 %EER and 100%CRR. The experimental results indicate encouraging and effective iris recognition system, especially when it is used in identification mode. The system is very robust to changes in decision ratio.

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65. XiaoFu He, Pengfei Shi:

A Novel Iris Segmentation Method for Hand-Held Capture Device. 479-485

Electronic Edition (link) BibTeX

A Novel Iris Segmentation Method for Hand-Held Capture Device

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Abstract

In this paper, a new iris segmentation method for Hand-held capture device is proposed. First, the pupil is binarized using the intensity threshold, then use morphologic method to denoise the eyelashes and eyelids noise. The geometrical method is used to calculate the coordinates of the pupil. Second, the outer (or limbus) boundary is localized using the shrunk image with the Hough transform and modified Canny edge detector in order to reduce computational cost. Third, the eyelids which are constrained to be

within the outer boundary are estimated using the polynomial fitting method. The segmentation method was implemented and tested on iris database set which is captured by hand-held optical sensor device. Experimental results show that the proposed algorithm can separate the iris from the surrounding noises with good speed and accuracy.

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66. Kaushik Roy, Prabir Bhattacharya:

Iris Recognition with Support Vector Machines. 486-492
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Iris Recognition with Support Vector Machines

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Abstract
We propose an iris recognition system for the identification of persons using support vector machines. Canny's edge detection and the Hough transform are used to find the iris/pupil boundary and a simple thresholding method is employed for eyelash detection. The Gabor wavelet technique is deployed in order to extract the deterministic features in the transformed iris of a person in the form of template. The extracted iris features are fed into a support vector machine (SVM) for classification. Our results indicate that the performance of SVM as a classifier is far better than the performance of a classifier based on the artificial neural network.

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Speech and Signature

67. Zhiyong Wu, Lianhong Cai, Helen Meng:

Multi-level Fusion of Audio and Visual Features for Speaker Identification. 493-499
Electronic Edition (link) BibTeX

Multi-level Fusion of Audio and Visual Features for Speaker Identification

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(2) Department of Systems Engineering and Engineering Management, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong SAR, China

Abstract

This paper explores the fusion of audio and visual evidences through a multi-level hybrid fusion architecture based on dynamic Bayesian network (DBN), which combines model level and decision level fusion to achieve higher performance. In model level fusion, a new audio-visual correlative model (AVCM) based on DBN is proposed, which describes both the inter-correlations and loose timing synchronicity between the audio and video streams. The experiments on the CMU database and our own homegrown database both demonstrate that the methods can improve the accuracies of audio-visual bimodal speaker identification at all levels of acoustic signal-to-noise-ratios (SNR) from 0dB to 30dB with varying acoustic conditions.

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68. .Christian Gruber, Thiemo Gruber, Bernhard Sick:

Online Signature Verification with New Time Series Kernels for Support Vector Machines. 500-508

Electronic Edition (link) BibTeX

Online Signature Verification with New Time Series Kernels for Support Vector Machines

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Abstract

In this paper, two new methods for online signature verification are proposed. The methods adopt the idea of the longest common subsequences (LCSS) algorithm to a kernel function for Support Vector Machines (SVM). The two kernels LCSS-global and LCSS-local offer the possibility to classify time series of different lengths with SVM. The similarity of two time series is determined very accurately since outliers are ignored. Consequently, LCSS-global and LCSS-local are more robust than algorithms based on dynamic time alignment such as Dynamic Time Warping (DTW). The new methods are compared to other kernel-based methods (DTW-kernel, Fisher-kernel, Gauss-kernel). Our experiments show that SVM with LCSS-local and LCSS-global authenticate persons very reliably.

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69.Kuan W. Yip, Alwyn Goh, David Ngo Chek Ling, Andrew Teoh Beng Jin:
Generation of Replaceable Cryptographic Keys from Dynamic Handwritten Signatures. 509-515
Electronic Edition (link) BibTeX
Generation of Replaceable Cryptographic Keys from Dynamic Handwritten Signatures

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Abstract
In this paper, we present a method for generating cryptographic keys that can be replaced if the keys are compromised and without requiring a template signature to be stored. The replaceability of keys is accomplished using iterative inner product of Goh-Ngo [1] Biohash method, which has the effect of re-projecting the biometric into another subspace defined by user token. We also utilized a modified Chang et al [2] Multi-state Discretization (MSD) method to translate the inner products into binary bit-strings. Our experiments indicate encouraging result especially for skilled and random forgery whereby the equal error rates are <6.7% and ~0% respectively, indicating that the keys generated are sufficiently distinguishable from impostor keys.

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70. ZhongCheng Wu, Ping Fang, Fei Shen:
Online Signature Verification Based on Global Feature of Writing Forces. 516-522

Electronic Edition (link) BibTeX

Online Signature Verification Based on Global Feature of Writing Forces

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Abstract
Writing forces are important dynamics of online signatures and it is harder to be imitated by forgers than signature shapes. An improved DTW (Dynamic Time Warping) algorithm is put forward to verify online signatures based on writing forces. Compared to the general DTW algorithm, this one deals with the varying consistency of signature point, signing duration and the different weights of writing forces in different direction. The iterative experiment is introduced to decide weights for writing forces in different direction and the classification threshold. A signature database is constructed with F_Tablet and the experiments results are present in the end.
The work was funded by the Natural Science Foundation of China with grant No. 60375027, No. 60475005.

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71.Olaf Henniger, Björn Schneider, Bruno Struif, Ulrich Waldmann:
Improving the Binding of Electronic Signatures to the Signer by Biometric Authentication. 523-530
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Improving the Binding of Electronic Signatures to the Signer by Biometric Authentication

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Abstract
Due to the fact that the biometric characteristics of a person are bound to that person, biometric methods deployed for signer authentication have the potential of improving the binding of electronic signatures to persons. If there is evi dence that a biometric method was used for signer authentication, and if the level of security of this method is suffi ciently high, then the receiver of a signed docu ment can trust that the signature creation was indeed initiated by the legitimate holder of the private signature key. To achieve

this goal, an approach to provide evidence of the use of biometric signer authentication has been developed. The approach has been implemented in a prototype electronic signature creation system with fingerprint verification.

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72.Rong Zheng, Shuwu Zhang, Bo Xu:

A Comparative Study of Feature and Score Normalization for Speaker Verification. 531-538
Electronic Edition (link) BibTeX

A Comparative Study of Feature and Score Normalization for Speaker Verification

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Abstract

In speaker verification, it is necessary to reduce the influence of different environmental conditions. In this paper, two stages of normalization techniques, feature normalization and score normalization, are examined for decreasing the mismatch between training and testing acoustic conditions. At the first stage, cepstral mean and variance normalization (CMVN) is modified to normalize the cepstral coefficients with the similar segmental parameter statistics. Next, due to score variability between verification trials, Test-dependent zero-score normalization (TZnorm) and Zero-dependent test-score normalization (ZTnorm) are comparatively presented to transform the output scores entirely and make the speaker-independent decision threshold more robust under adverse conditions. Experiments on NIST2002 SRE corpus show that the normalizations with CMVN in feature stage and ZTnorm in score stage achieved 20.3% relative reduction of EER and 18.1% relative reduction of the minimal DCF compared to the baseline system using CMN and zero normalization.

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73.Dongdong Li, Yingchun Yang, Zhaohui Wu:
Dynamic Bayesian Networks for Audio-Visual Speaker Recognition. 539-545
Electronic Edition (link) BibTeX
Dynamic Bayesian Networks for Audio-Visual Speaker Recognition

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Abstract
Audio-Visual speaker recognition promises higher performance than any single modal biometric systems. This paper further improves the novel approach based on Dynamic Bayesian Networks (DBNs) to bimodal speaker recognition. In the present paper, we investigate five different topologies of feature-level fusion framework using DBNs. We demonstrate that the performance of multimodal systems can be further improved by modeling the correlation of between the speech features and the face features appropriately. The experiment conducted on a multi-modal database of 54 users indicates promising results, with an absolute improvement of about 7.44% in the best case and 3.13% in the worst case compared with single modal speaker recognition system.

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Biometric Fusion and Performance Evaluation

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74. Kar-Ann Toh, How-Lung Eng, Yuen-Siong Choo, Yoon-Leon Cha, Wei-Yun Yau, Kay-Soon Low:
Identity Verification Through Palm Vein and Crease Texture. 546-553
Electronic Edition (link) BibTeX
Identity Verification Through Palm Vein and Crease Texture

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Abstract
In this paper, an identity verification framework which combines pattern information from the palm-vein and the palm-crease texture is proposed. Main feature of this system is the use of a low cost Near-Infra-Red (NIR) camera instead of the more expensive infra-red thermal camera for palm image capture. Our preliminary experiments show that useful information from palm-vein and palm-crease texture can be effectively extracted for identity verification using a simple setup to contain the camera.
Keywords:Biometrics, Multimodal Biometrics, Palm-vein Recognition, Palm-print Recognition and

Pattern Classification.

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75. Xiaoguang Lu, Hong Chen, Anil K. Jain:
Multimodal Facial Gender and Ethnicity Identification. 554-561
Electronic Edition (link) BibTeX
Multimodal Facial Gender and Ethnicity Identification

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Abstract
Human faces provide demographic information, such as gender and ethnicity. Different modalities of human faces, e.g., range and intensity, provide different cues for gender and ethnicity identifications. In this paper we exploit the range information of human faces for ethnicity identification using a support vector machine. An integration scheme is also proposed for ethnicity and gender identifications by combining the registered range and intensity images. The experiments are conducted on a database containing 1240 facial scans of 376 subjects. It is demonstrated that the range modality provides competitive discriminative power on ethnicity and gender identifications to the intensity modality. For both gender and ethnicity identifications, the proposed integration scheme outperforms each individual modality.

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76. Sheng Zhang, Rajkumar Janakiraman, Terence Sim, Sandeep Kumar:

***Continuous* Verification Using Multimodal Biometrics.** 562-570
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Continuous Verification Using Multimodal Biometrics

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Abstract
In this paper we describe a system that continually verifies the presence/participation of a logged-in user. This is done by integrating multimodal passive biometrics in a Bayesian framework that combines both temporal and modality information holistically, rather than sequentially. This allows our system to output the probability that the user is still present even when there is no observation.
Our implementation of the continuous verification system is distributed and extensible, so it is easy to plug in additional asynchronous modalities, even when they are remotely generated. Based on real data resulting from our implementation, we find the results to be promising.
This work was funded by the National University of Singapore, project no. R-252-146-112.

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77. Ching-Han Chen, Chia Te Chu:
Fusion of Face and Iris Features for Multimodal Biometrics. 571-580
Electronic Edition (link) BibTeX
Biometric Fusion and Performance Evaluation
Fusion of Face and Iris Features for Multimodal Biometrics

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(1) Institute of Electrical Engineering, I-Shou University, 1, Section 1, Hsueh-Cheng Rd., Ta-Hsu Hsiang, Kaohsiung County, Taiwan 840, R.O.C.
Abstract
The recognition accuracy of a single biometric authentication system is often much reduced due to the environment, user mode and physiological defects. In this paper, we combine face and iris features for developing a multimode biometric approach, which is able to diminish the drawback of single biometric approach as well as to improve the performance of authentication system. We combine a face database

ORL and iris database CASIA to construct a multimodal biometric experimental database with which we validate the proposed approach and evaluate the multimodal biometrics performance. The experimental results reveal the multimodal biometrics verification is much more reliable and precise than single biometric approach.
Keywords: Multimodal biometrics, face, iris, wavelet probabilistic neural network.

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78. Sinjini Mitra, Marios Savvides, Anthony Brockwell:
The Role of Statistical Models in Biometric Authentication. 581-588
Electronic Edition (link) BibTeX
The Role of Statistical Models in Biometric Authentication

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(2) Electrical and Computer Engineering Department, Carnegie Mellon University, Pittsburgh, PA 15213,

Abstract
The current paper demonstrates the role of statistical models in authentication tasks – both in system development and in performance evaluation. We first introduce a model-based face authentication system based on the Fourier domain phase using Gaussian Mixture Models (GMM) which yields verification error rates as low as 0.3% on a face database of 65 individuals with extreme illumination variations. We then present a statistical framework for predicting authentication error rates for future populations in a rigorous way. This is in contrast to most evaluation protocols used today that are based on observational studies and valid only for the databases at hand. Applications establish that our model-based approach has better predictive performance than an existing state-of-the-art authentication technique.

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79. Congcong Li, Guangda Su, Kai Meng, Jun Zhou:

Technology Evaluations on the TH-FACE Recognition System. 589-597
Electronic Edition (link) BibTeX

Technology Evaluations on the TH-FACE Recognition System

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Abstract
For biometric person authentication, evaluations on a biometric system are very essential parts of the entire process. This paper presents the technology evaluations on the TH-FACE recognition system. The main objectives of the evaluations are to 1) test the performance of the TH-FACE recognition system objectively; 2) provide a method to design and organize a database for evaluations; 3) identify the advantage and weakness for the TH-FACE recognition system. Particular description of the test database used in the evaluations is given in this paper. The database contains different subsets which are sorted by different poses, illuminations, ages, accessory, etc. Results and analysis on the entire performances of the TH-FACE recognition system would be also presented.

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Gait and Keys

80. Kazuhiko Sumi, Chang Liu, Takashi Matsuyama:
Study on Synthetic Face Database for Performance Evaluation. 598-604
Electronic Edition (link) BibTeX
Study on Synthetic Face Database for Performance Evaluation

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Abstract
We have analyzed the vulnerability and threat of the biometric evaluation database and proposed the method to generate a synthetic database from a real database. Our method is characterized by finding nearest neighbor triples or pairs in the feature space of biometric samples, and by crossing over those triples and pairs to generate synthetic samples. The advantages of our method is that we can keep the statistical distribution of the original database, thus, the evaluation result is expected to be the same as original real database. The proposed database, which does not have privacy problem, can be circulated freely among biometric vendors and testers. We have implemented this idea on a face image database using active appearance model. The synthesized image database has the same distance distribution with the original database, which suggests it will deriver the same accuracy with the original one.

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81. Yuan Wang, Shiqi Yu, Yunhong Wang, Tieniu Tan:

Gait Recognition Based on Fusion of Multi-view Gait Sequences. 605-611

Electronic Edition (link) BibTeX

Gait Recognition Based on Fusion of Multi-view Gait Sequences

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(2) School of Computer Science and Engineering, Beihang University,

Abstract

In recent years, many gait recognition algorithms have been developed, but most of them depend on a specific view angle. In this paper,we present a new gait recognition scheme based on multi-view gait sequence fusion. An experimental comparison of the fusion of gait sequences at different views is reported. Our experiments show the fusion of gait sequences at different views can consistently achieve better results. The Dempster-Shafer fusion method is found to give a great improvement. On the other hand, we also find that fusion of gait sequences with an angle difference greater than or equal to 90° can achieve better improvement than fusion of those with an acute angle difference.

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82. Toby H. W. Lam, Raymond S. T. Lee:

A New Representation for Human Gait Recognition: Motion Silhouettes Image (MSI). 612-618

Electronic Edition (link) BibTeX

A New Representation for Human Gait Recognition: Motion Silhouettes Image (MSI)

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Abstract

Recently, gait recognition for human identification has received substantial attention from biometrics researchers. Compared with other biometrics, it is more difficult to disguise. In addition, gait can be captured in a distance by using low-resolution capturing devices. In this paper, we proposed a new representation for human gait recognition which is called Motion Silhouettes Image (MSI). MSI is a grey-level image which embeds the critical spatio-temporal information. Experiments showed that MSI has a high discriminative power for gait recognition. The recognition rate is around 87% in SOTON dataset by using MSI for recognition. The recognition rate is quite promising. In addition, MSI can also reduce the storage size of the dataset. After using MSI, the storage size of SOTON has reduced to 4.2MB.

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83. Hee-Deok Yang, Seong-Whan Lee:

Reconstruction of 3D Human Body Pose for Gait Recognition. 619-625

Electronic Edition (link) BibTeX

Gait and Keystroke

Reconstruction of 3D Human Body Pose for Gait Recognition

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Abstract

In this paper, we propose a novel method to reconstruct 3D human body pose for gait recognition from monocular image sequences based on top-down learning. Human body pose is represented by a linear combination of prototypes of 2D silhouette images and their corresponding 3D body models in terms of the position of a predetermined set of joints. With a 2D silhouette image, we can estimate optimal coefficients for a linear combination of prototypes of the 2D silhouette images by solving least square minimization. The 3D body model of the input silhouette image is obtained by applying the estimated coefficients to the corresponding 3D body model of prototypes. In the learning stage, the proposed method is hierarchically constructed by classifying the training data into several clusters recursively. Also, in the reconstructing stage, the proposed method hierarchically reconstructs 3D human body pose

with a silhouette image. The experimental results show that our method can be efficient and effective to reconstruct 3D human body pose for gait recognition.

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84. Sungzoon Cho, Seongseob Hwang:
Artificial Rhythms and Cues for Keystroke Dynamics Based Authentication. 626-632
Electronic Edition (link) BibTeX
Gait and Keystroke
Artificial Rhythms and Cues for Keystroke Dynamics Based Authentication

Sungzoon Cho1 Contact Information and Seongseob Hwang1 Contact Information
(1) Department of Industrial Engineering, Seoul National University, San 56-1, Shillim-dong, Kwanak-gu, Seoul 151-744, Korea
Abstract
Biometrics based user authentication involves collecting user's patterns and then using them to determine if a new pattern is similar enough. The quality of the user's patterns is as important as the quality of the classifier. But, the issue has been ignored in the literature since the popular biometrics are mostly trait based such as finger prints and iris so that its pattern quality depends on the quality of the input device involved. However, the quality of the user's patterns of behavior based biometric such as keystroke dynamics can be improved artificially by increasing the peculiarity of the typing style. In this paper, we propose several ways to improve the quality. But, first we define the quality of patterns in terms of two factors: uniqueness and consistency. Finally, the results of a preliminary experiment are presented that support the utility of the proposed methods.

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85. Hyoungjoo Lee, Sungzoon Cho:
Retraining a Novelty Detector with Impostor Patterns for Keystroke Dynamics-Based Authentication. 633-639
Electronic Edition (link) BibTeX

Gait and Keystroke
Retraining a Novelty Detector with Impostor Patterns for Keystroke Dynamics-Based Authentication

Hyoung-joo Lee1 Contact Information and Sungzoon Cho1 Contact Information
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Abstract

In keystroke dynamics-based authentication, novelty detection methods have been used since only the valid user's patterns are available when a classifier is built. After a while, however, impostors' keystroke patterns become also available from failed login attempts. We propose to retrain the novelty detector with the impostor patterns to enhance the performance. In this paper the support vector data description (SVDD) and the one-class learning vector quantization (1-LVQ) are retrained with the impostor patterns. Experiments on 21 keystroke pattern datasets show that the performance improves after retraining and that the one-class learning vector quantization outperforms other widely used novelty detectors.

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86. Ricardo N. Rodrigues, Glauco F. G. Yared, Carlos R. do N. Costa, João Baptista T. Yabu-uti, Fábio Violaro, Lee Luan Ling:
Biometric Access Control Through Numerical Keyboards Based on Keystroke Dynamics. 640-646
Electronic Edition (link) BibTeX

Gait and Keystroke
Biometric Access Control Through Numerical Keyboards Based on Keystroke Dynamics

Ricardo N. Rodrigues1 Contact Information, Glauco F.G. Yared1 Contact Information, Carlos R. do N. Costa1 Contact Information, João B.T. Yabu-Uti1 Contact Information, Fábio Violaro1 Contact Information and Lee Luan Ling1 Contact Information
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Abstract

This paper presents a new approach for biometric authentication based on keystroke dynamics through numerical keyboards. The input signal is generated in real time when the user enters with target string. Five features were extracted from this input signal (ASCII key code and four keystroke latencies) and four experiments using samples for genuine and impostor users were performed using two pattern classification technics. The best results were achieved by the HMM (EER=3.6%). This new approach brings security improvements to the process of user authentication, as well as it allows to include

biometric authentication in mobile devices, such as cell phones.

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87. Woojin Chang:
Keystroke Biometric System Using Wavelets. 647-653
Electronic Edition (link) BibTeX
Gait and Keystroke
Keystroke Biometric System Using Wavelets

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Abstract
We developed the keystroke biometric system (KBS) using the statistical features of the discrete wavelet transformed keystroke pattern in the frequency domain in addition to those of the original keystroke pattern in the time domain. Only 20 keystroke patterns of user's password typing, where the length of password is no more than 10, are used for building a KBS. The features in the time domain and those in the frequency domain are separately scored by the rules that we developed, and arbitrary given keystroke patterns are classified on the basis of total scores. The results show that our KBS is competitive in comparison with others due to its cheap computational cost, cheap usability cost, and the practically acceptable classification accuracy.
Keywords: Keystroke Dynamics, Keystroke Biometric System, Key- stroke Authentication, Discrete Wavelet Transform.

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88. Ki-seok Sung, Sungzoon Cho:

GA SVM Wrapper Ensemble for Keystroke Dynamics Authentication. 654-660

Electronic Edition (link) BibTeX

Gait and Keystroke

GA SVM Wrapper Ensemble for Keystroke Dynamics Authentication

Ki-seok Sung1 Contact Information and Sungzoon Cho1 Contact Information

(1) Department of Industrial Engineering, Seoul National University, San 56-1, Shillim-dong, Kwanak-gu, Seoul 151-744, Korea

Abstract

User authentication based on keystroke dynamics is concerned with accepting or rejecting someone based on the way the person types. A timing vector is composed of the keystroke duration times interleaved with the keystroke interval times. Which times or features to use in a classifier is a classic feature selection problem. Genetic algorithm based wrapper approach does not only solve the problem, but also provides a population of “fit” classifiers which can be used in ensemble. In this paper, we propose to add uniqueness term in the fitness function of genetic algorithm. Preliminary experiments show that the proposed approach performed better than two phase ensemble selection approach and prediction based diversity term approach.

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89. Kenneth Revett, Sérgio Tenreiro de Magalhães, Henrique M. D. Santos:

Enhancing Login Security Through the Use of Keystroke Input Dynamics. 661-667

Electronic Edition (link) BibTeX

Gait and Keystroke

Enhancing Login Security Through the Use of Keystroke Input Dynamics

Kenneth Revett1 Contact Information, Sérgio Tenreiro de Magalhães2 Contact Information and Henrique M.D. Santos2 Contact Information

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(2) Universidade do Minho, Department of Information Systems, Campus de Azurem, 4800-058 Guimaraes, Portugal

Abstract

Security is a critical component of most computer systems – especially those used in E-commerce activities over the Internet. Global access to information makes security a critical design issue in these systems. Deployment of sophisticated hardware based authentication systems is prohibitive in all but the most sensitive installations. What is required is a

reliable, hardware independent and efficient security system. In this paper, we propose an extension to a keystroke dynamics based security system. We provide evidence that completely software based systems based on keystroke input dynamics can be as effective as expensive and cumbersome hardware based systems. Our system is behavioral based that captures the typing patterns of a user and uses that information, in addition to standard login/password security to provide a system that is user-friendly and very effective at detecting imposters.

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Others

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90. Adams Wai-Kin Kong, David Zhang, Guangming Lu:
A Study of Identical Twins' Palmprints for Personal Authentication. 668-674
Electronic Edition (link) BibTeX
Others
A Study of Identical Twins' Palmprints for Personal Authentication

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Abstract
Biometric recognition based on human characteristics for personal identification has attracted great attention. The performance of biometric systems highly depends on the distinctive information in the biometrics. However, identical twins having the closest genetics-based relationship are expected to have maximum similarity between their biometrics. Classifying identical twins is a challenging problem for some automatic biometric systems. In this paper, we summarize the exiting experimental results about identical twins' biometrics including face, iris, fingerprint and voice. Then, we systemically examine identical twins' palmprints. The experimental results show that we can employ low-resolution palmprint images to distinguish identical twins.

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91. Fengling Han, Jiankun Hu, Xinhuo Yu, Yong Feng, Jie Zhou:
A Novel Hybrid Crypto-Biometric Authentication Scheme for ATM Based Banking Applications.
675-681
Electronic Edition (link) BibTeX
Others
A Novel Hybrid Crypto-Biometric Authentication Scheme for ATM Based Banking Applications

Fengling Han1 Contact Information, Jiankun Hu1 Contact Information, Xinhuo Yu2 Contact Information, Yong Feng2 Contact Information and Jie Zhou3 Contact Information
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(2) School of Electrical and Computer Engineering, Royal Melbourne Institute of Technology, Melbourne VIC 3001, Australia
(3) Department of Automation, Tsinghua University, Beijing 100084, China
Abstract
This paper studies the smartcard based fingerprint encrytion/auth-entication scheme for ATM banking systems. In this scheme, the system authenticates each user by both his/her possession (smartcard) and biometrics (fingerprint). A smartcard is used for the first layer of authentication. Based on the successful pass of the first layer authentication, a subsequent process of the biometric fingerprint authentication proceeds. The proposed scheme is fast and secure. Computer simulations and statistical analyze are presented.

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92. Xiao-Yuan Jing, Chen Lu, David Zhang:
An Uncorrelated Fisherface Approach for Face and Palmprint Recognition. 682-687
Electronic Edition (link) BibTeX
Others
An Uncorrelated Fisherface Approach for Face and Palmprint Recognition

Xiao-Yuan Jing1 Contact Information, Chen Lu1 Contact Information and David Zhang2 Contact Information
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(2) Dept. of Computing, Hong Kong Polytechnic University, Kowloon, Hong Kong
Abstract
The Fisherface method is a most representative method of the linear discrimination analysis (LDA) technique. However, there persist in the Fisherface method at least two areas of weakness. The first weakness is that it cannot make the achieved discrimination vectors completely satisfy the statistical uncorrelation while costing a minimum of computing time. The second weakness is that not all the discrimination vectors are useful in pattern classification. In this paper, we propose an uncorrelated Fisherface approach (UFA) to improve the Fisherface method in these two areas. Experimental results on different image databases demonstrate that UFA outperforms the Fisherface method and the uncorrelated optimal discrimination vectors (UODV) method.

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93. Xin Li, Ayman Abaza, Diaa Eldin M. Nassar, Hany H. Ammar:
Fast and Accurate Segmentation of Dental X-Ray Records. 688-696
Electronic Edition (link) BibTeX
Others
Fast and Accurate Segmentation of Dental X-Ray Records

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Abstract

Identification of deceased individuals based on dental characteristics is receiving increased attention. Dental radiographic films of an individual are usually composed into a digital image record. In order to achieve high level of automation in postmortem identification, it is necessary to decompose dental image records into their constituent radiographic films, which are in turn segmented to localize dental regions of interest. In this paper we offer an automatic hierarchical treatment to the problem of cropping dental image records into films. Our approach is heavily based on concepts of mathematical morphology and shape analysis. Among the many challenges we face are non-standard assortments of films into records, variability in record digitization as well as randomness of record background both in intensity and texture. We show by experimental evidence that our approach achieves high accuracy and timeliness.

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94. Ton H. M. Akkermans, Tom A. M. Kevenaar, Daniel W. E. Schobben:
Acoustic Ear Recognition. 697-705
Electronic Edition (link) BibTeX
Others
Acoustic Ear Recognition

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Abstract

We investigate how the acoustic properties of the pinna – i.e. the outer flap of the ear- and the ear canal can be used as a biometric. The acoustic properties can be measured relatively easy with an inexpensive sensor and feature vectors can be derived with little effort. Classification results for three platforms are given (headphone, earphone, mobile phone) using noise as an input signal. Furthermore, preliminary results are given for the mobile phone platform where we use music as an input signal. We achieve equal error rates in the order of 1%-5%, depending on the platform that is used to do the measurement.

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95. Myung Hwan Yun, Joo Hwan Lee, Hyoungjoo Lee, Sungzoon Cho:
Classification of Bluffing Behavior and Affective Attitude from Prefrontal Surface Encephalogram During On-Line Game. 706-712
Electronic Edition (link) BibTeX
Others
Classification of Bluffing Behavior and Affective Attitude from Prefrontal Surface Encephalogram During On-Line Game

Myung Hwan Yun1 Contact Information, Joo Hwan Lee1 Contact Information, Hyoung-joo Lee1 Contact Information and Sungzoon Cho1 Contact Information
(1) Department of Industrial Engineering, Seoul National University, Seoul, 151-742, South Korea
Abstract
The purpose of this research was to detect the pattern of player's emotional change during on-line game. By defining data processing technique and analysis method for bio-physiological activity and player's bluffing behavior, the classification of affective attitudes during on-line game was attempted. Bluffing behavior displayed during the game was classified into two dimensions of emotional axis based on prefrontal surface electroencephalographic data. Classified bluffing attitudes were: (1) pleasantness/ unpleasantness; and (2) honesty/bluffing. A multilayer-perception neural network was used to classify the player state into four attitude categories. Resulting classifier showed moderate performance with 67.03% pleasantness/unpleasantness classification, and 77.51% for honesty/bluffing. The classifier model developed in this study was integrated to on-line game as a form of 'emoticon' which displays facial expression of opposing player's emotional state.

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96. Rohit Singh, Sandeep Samal, Tapobrata Lahiri:

A Novel Strategy for Designing Efficient Multiple Classifier. 713-720

Electronic Edition (link) BibTeX

Others

A Novel Strategy for Designing Efficient Multiple Classifier

Rohit Singh1 Contact Information, Sandeep Samal2 Contact Information and Tapobrata Lahiri3 Contact Information

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Abstract

In this paper we have shown that systematic incorporation of decision from various classifiers following a simple decision decomposition rule, gives better decision in comparison to the existing multiple classifier systems. In our method each classifier were graded according to their effectiveness of providing more accurate results. This approach first utilizes the best classifier. If this classifier classifies the test sample into more than one class or fails to classify the test data then the feature next to the best is summoned to finish up the remaining part of the classification. The continuation of this process, along with the judicious selection of classifiers, yields better efficiency in identifying a single class for the test data. The results obtained after the experiments on a set of fingerprint images shows the effectiveness of our proposed classifier.

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97 Marcos Faúndez-Zanuy, Miguel A. Ferrer-Ballester, Carlos Travieso-González, Virginia Espinosa-Duro:

Hand Geometry Based Recognition with a MLP Classifier. 721-727

Electronic Edition (link) BibTeX

Others

Hand Geometry Based Recognition with a MLP Classifier

Marcos Faundez-Zanuy1 Contact Information, Miguel A. Ferrer-Ballester2 Contact Information, Carlos M. Travieso-González2 Contact Information and Virginia Espinosa-Duro1 Contact Information

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Abstract

This paper presents a biometric recognition system based on hand geometry. We describe a database specially collected for research purposes, which consists of 50 people and 10 different acquisitions of the right hand. This database can be freely downloaded. In addition, we describe a feature extraction procedure and we obtain experimental results using different classification strategies based on Multi Layer Perceptrons (MLP). We have evaluated identification rates and Detection Cost Function (DCF) values for verification applications. Experimental results reveal up to 100% identification and 0% DCF.

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Ileana Buhan, Asker M. Bazen, Pieter H. Hartel, Raymond N. J. Veldhuis:

98. A False Rejection Oriented Threat Model for the Design of Biometric Authentication Systems. 728-736

Electronic Edition (link) BibTeX

Others

A False Rejection Oriented Threat Model for the Design of Biometric Authentication Systems

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Abstract

For applications like Terrorist Watch Lists and Smart Guns, a false rejection is more critical than a false acceptance. In this paper a new threat model focusing on false rejections is presented, and the “standard” architecture of a biometric system is extended by adding components like crypto, audit logging, power, and environment to increase the analytic power of the threat model. Our threat model gives new insight into false rejection attacks, emphasizing the role of an external attacker. The threat model is intended to

be used during the design of a system.

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99. Tai-Kia Tan, Cheng-Leong Ng, Kar-Ann Toh, How-Lung Eng, Wei-Yun Yau, Dipti Srinivasan:
A Bimodal Palmprint Verification System. 737-743
Electronic Edition (link) BibTeX
Others
A Bimodal Palmprint Verification System

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Abstract
Hand-based biometrics such as fingerprint and palmprint had been widely accepted because of their convenience and ease in usage without intruding much to one's privacy such as face. The aim of this work is to develop a new point-based algorithm for palmprint feature extraction and perform reliable verification based on the extracted features. This point-based recognition system is next used as part of a bimodal palmprint recognition system combining with a DCT-based (Discrete Cosine Transform) algorithm for identity verification. The performance of the integrated system is evaluated using physical palmprint images.
Keywords: Biometrics, Palmprint Recognition, Multimodal Biometrics, and Identity Verification.

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100. Qiang Li, ZhengDing Qiu, Dongmei Sun:
Feature-Level Fusion of Hand Biometrics for Personal Verification Based on Kernel PCA. 744-750
Electronic Edition (link) BibTeX
Others
Feature-Level Fusion of Hand Biometrics for Personal Verification Based on Kernel PCA

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Abstract

This paper presents a novel method of feature-level fusion (FLF) based on kernel principle component analyze (KPCA). The proposed method is applied to fusion of hand biometrics include palmprint, hand shape and knuckleprint, and we name the new feature as “handmetric”. For different kind of samples, polynomial kernel is employed to generate the kernel matrixes that indicate the relationship among them. While fusing these kernel matrixes by fusion operators and extracting principle components, the handmetric feature space is established and nonlinear feature-level fusion projection could be implemented. The experimental results testify that the method is efficient for feature fusion, and could keep more identity information for verification.

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101. Young-suk Shin, Myung-Su Kim:

Human Identification System Based on PCA Using Geometric Features of Teeth. 751-755
Electronic Edition (link) BibTeX

Others

Human Identification System Based on PCA Using Geometric Features of Teeth

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Abstract

We present a new human identification system based on PCA using geometric features of teeth such as the size and shape of the jaws, size of the teeth and teeth structure. In this paper we try to set forth the foundations of a biometric system for information encrypting of living people using dental features. To create a biometric matching system, a template based on principal component analysis(PCA) is created from dental data collected the plaster figures of teeth which were done at dental hospital, department of oral medicine. Templates of dental images based on PCA representation include the 100 principle components as the features for individual identification. The PCA basis vectors reflects well the features for individual identification in the whole of teeth and the part of teeth. The classification for human identification is generated based on the distance between the whole of teeth and the part of teeth with the nearest neighbor(NN) algorithm. The identification performance in 300 dental image is 97% for the part of teeth missed the right-molar and back teeth, 98.3% for the part of teeth missed the front teeth and 96.6% for the part of teeth missed the left-molar and back-teeth.

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102. Tak Chan, Junping Zhang:

An Improved Super-Resolution with Manifold Learning and Histogram Matching. 756-762
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Others
An Improved Super-Resolution with Manifold Learning and Histogram Matching

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Abstract
Biometric Person Authentication such as face, fingerprint, palmprint and signature depends on the quality of image processing. When it needs to be done under a low-resolution image, the accuracy will be impaired. So how to recover the lost information from downsampled images is important for both authentication and preprocessing. Based on Super-Resolution through Neighbor Embedding algorithm and histogram matching, we propose an improved super-resolution approach to choose more reasonable training images. First, the training image are selected by histogram matching. Second, neighbor embedding algorithm is employed to recover the high-resolution image. Experiments in several images show that our improved super-resolution approach is promising for potential applications such as low-resolution mobile phone or CCTV (Closed Circuit Television) image person authentication.

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103. Jaehyuck Lim, Hyobin Lee, Sangyoun Lee, Jaihie Kim:

Invertible Watermarking Algorithm with Detecting Locations of Malicious Manipulation for Biometric Image Authentication. 763-769
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Others
Invertible Watermarking Algorithm with Detecting Locations of Malicious Manipulation for Biometric Image Authentication

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Abstract

In this paper, we present a new method for authentication of biometric images. Our method uses an invertible watermark that can also detect malicious manipulations simultaneously. While virtually all watermarking schemes introduce a small amount of non-invertible distortion in original biometric images, our new method is invertible in the sense that, if the data is deemed authentic, distortion due to authentication can be removed if it becomes necessary to obtain the original biometric image. This technique provides cryptographic strength when verifying image integrity because the probability of making an undetectable modification to the image can be directly related to a secure cryptographic element, such as a hash function. Also, if the biometric image is manipulated, the positions of intentional manipulation can be clearly identified.

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104. Zhiwen Xu, Xiaoxin Guo, Xiaoying Hu, Xu Chen, Zhengxuan Wang:
The Identification and Recognition Based on Point for Blood Vessel of Ocular Fundus. 770-776
Electronic Edition (link) BibTeX
Others
The Identification and Recognition Based on Point for Blood Vessel of Ocular Fundus

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Abstract

Today, iris recognition, fingerprint recognition, face recognition, voice recognition and other biometric technology are experiencing rapid development. This paper addresses a new biometric technology–the identification and recognition based on point of blood vessel skeleton for ocular fundus. The image for

green gray scale of ocular fundus is utilized. The cross point of skeleton shape of blood vessel for ocular fundus using contrast-limited adaptive histogram equalization is extracted at first. After filtering treatment and extracting shape, shape curve of blood vessels is obtained. The cross point of shape for curve matching is later carried out by means of cross point matching. The recognition based on shape for blood vessel of ocular fundus has been demonstrated in this paper to possess high Identification and recognition rate, low rejection recognition rate as well as good universality, exclusiveness and stability. With more and more progress made in extracting technology, the recognition for blood vessel of optic fundus is to become an effective biometric technology.

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105. Yihong Ding, Xijian Ping, Min Hu, Tao Zhang:

A Method for Footprint Range Image Segmentation and Description. 777-785
Electronic Edition (link) BibTeX
Others
A Method for Footprint Range Image Segmentation and Description

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Abstract
In this paper, we firstly present a novel footprint range image segmentation method using the principal curvatures and the principal directions. Utilizing the principal curvatures information, we detect the peak areas as the seeds, and apply region growing to locate the edges of each patch. We apply the edge detection technology to the region growth rules, so the boundary localization is precise. To obtain more stable edge information, a multi-scale fusion approach is proposed to integrate the segmentation results calculated at different fitting sizes. After the segmentation, according to the shape characteristics of footprint, we use superquadric and saddle models to describe shape features of each patch. The experiments results on footprint range images show that the segmented patches and the descriptions represent footprint biometric information effectively and set a reliable basis for the further recognition.

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106. Mohamed Abdel-Mottaleb, Jindan Zhou:

Human Ear Recognition from Face Profile Images. 786-792
Electronic Edition (link) BibTeX
Others
Human Ear Recognition from Face Profile Images

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Abstract

In this paper, we present a novel system for ear identification from profile images of the face. The system has two steps. In the first step, the ear is automatically detected from the profile image of the face. In the second step, the ear image is transformed to a force field, then feature points are extracted and the best match is found from a database. We propose a method based on differential geometry to extract ear feature points. We use a transformation of the ear image to make it suitable for extracting the feature points using differential geometry. During recognition, the feature points obtained from a query image are aligned and compared with those in the database using Hausdorff distance. The experimental results show that our method is effective

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