EXAMINE IRIS RECOGNITION SYSTEM WITH HYBRID BIOMETRIC PROCESS USING MACHINE LEARNING

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ABSTRACT

Multimodal biometric systems are considered a way to minimize the limitations raised by single traits. Log-Gabor transformation is applied as the feature extraction method on face and iris modalities. In this regard, multimodal biometrics technology has gained interest and became popular due to its ability to overcome a number of significant limitations of unimodal biometric systems. In this paper, a new multimodal biometric human identification system is proposed, which is based on a deep learning algorithm for recognizing humans using biometric modalities of iris, face, and finger vein. The structure of the system is based on convolutional neural networks (CNNs) which extract features and classify images by softmax classifier. To develop the system, three CNN models were combined; one for iris, one for face, and one for finger vein. In order to build the CNN model, the famous pertained model VGG-16 was used, the Adam optimization method was applied and categorical cross-entropy was used as a loss function. Some techniques to avoid overfitting were applied, such as image augmentation and dropout techniques. At each level of fusion, different schemes are proposed to improve the recognition performance and, finally, a combination of schemes at different fusion levels constructs an optimized and robust scheme. In this study, CASIA Iris Distance database is used to examine the robustness of all unimodal and multimodal schemes.

Keywords: *Multimodal biometric systems, iris, dropout techniques, cross-entropy, convolutional neural networks (CNNs), Iris Distance database, loss function.*

INTRODUCTION

The multi-biometric system utilizes fusion to combine multiple biometric sources with improved recognition accuracy while eliminating the limitations of uni-biometric systems relying on a single biometric trait. It is subject to limitations such as noise, poor data quality, non-universality, and large variations between users. As far as multiple sources of biometric information are concerned, five possible scenarios exist. Five scenarios can provide biometric information from multiple sources. Multi-biometric systems can be classified according to their information sources, such as multisensory, multi-algorithm, multi-instance, multisampling, and multimodal. There are four scenarios in which a single biometric trait (like a fingerprint or an iris) can be used to derive several types of information, while a fifth scenario (which is called a multimodal biometric system) involves the use of several biometric traits (such as fingerprints and iris). The above five scenarios can also be combined into a multi-biometric system. Moreover, to further increase the user authentication's complexity and ensure higher security, more than one trait is combined with each other. Therefore, this paper introduces hybrid multi-biometric structures to solve the abovementioned problems. A feature vector is formed by combining two or more feature vectors in the feature space. As a result, the final vector has a higher detection power than the original vectors. The process of combining feature vectors can be performed by mapping them by selecting the reproducing kernel functions to the reproducing kernel Hilbert space (RKHS) with much higher dimensions, and then fusion of the mapped vectors to RKHS via dimensionality reduction algorithms (KPCA, KLDA) and quaternion-based algorithms (KQPCA, KQLDA).

LITERATURE REVIEW

Mohammad Hassan Safavipour (2023) The need for information security and the adoption of the relevant regulations is becoming an overwhelming demand worldwide. As an efficient solution, hybrid multimodal biometric systems utilize fusion to combine multiple biometric traits and sources with improving recognition accuracy, higher security assurance, and to cope with the limitations of the uni-biometric system. In this study, three strategies for dealing with a feature-level deep fusion of five biometric traits (face, both irises, and two fingerprints) derived from three sources of evidence are proposed and compared. In the first two proposed methodologies, each feature vector is mapped from the feature space into the reproducing kernel Hilbert space (RKHS) separately by selecting the appropriate reproducing kernel. In this higher space, where the result is the conversion of nonlinear relations to linear ones, dimensionality reduction algorithms (KPCA, KLDA) and quaternion-based algorithms (KQPCA, KQPCA) are used for the fusion of the feature vectors.

S. Srinivasan (2020) In the recent past, a multi-modal biometric authentication system plays a vital role in individual biometric authentication for private and public sections to assure security. The conventional multimodal biometric system performance is poor in various illumination conditions of biometric images during feature extraction. Fusion-based Multimodal biometric improves the accuracy and efficiency of security level, non-universality, variation of inter and intraclass, etc. In this paper, fusion-based multi-modal based biometric modality verification is proposed through incorporating modalities iris, fingerprint, and face based on Machine Learning (ML) algorithm. The proposed system is based on the individual scores estimated through every biometric modal and then normalized to receive score of fusion. Various statistical features can be estimated through every biometric modality modal based machine learning approach that can be applied for classification using ML.

T. K. Thivakaran (2020) The multimodal biometrics is mainly used for the purpose of person certification and proof. Lot of biometrics is used for human authentication. In which ear and fingerprint are efficient one. There are three vital phases involved in the biometric detection which include the Preprocessing, Feature extraction and the classification. Initially, preprocessing is done with the help of median filter which lends a helping hand to the task of cropping the image for choosing the position. Then, from the preprocessed Finger print and ear image texture and shape features are extracted. In the long run, the extracted features are integrated. The integrated features, in turn, are proficiently classified by means of the optimal neural network (ONN). Here, the

NN weights are optimally, selected with the help of firefly algorithm (FF).

Vijay Bhaskar Semwal (2017) The classification of humanoid locomotion is a troublesome exercise because of non-linearity associate with gait signals. The classification using the different machine learning technique leads for over fitting and under fitting. To select the optimized feature is a difficult task. The high dimension feature vector requires a high computational cost. The hand craft feature selection machine learning techniques performed poor. We have used the incremental feature selection strategy for feature selection. In this paper we first selected the feature and identify the principle feature then we classify gait data using different machine learning technique (KNN, ANN, SVM, DNN and classifier fusion) and shown the performance comparison. Experimental result on real time datasets propose method is better than previous method as far as humanoid locomotion classification is concerned and the generalization accuracy provided by new feature selection method i.e. incremental feature selection (IFS) with analysis of variance (ANOVA).

Joyeeta Singha (2017) Hand gesture recognition provides an alternative way to many devices for human computer interaction. In this work, we have developed a classifier fusion based dynamic free-air hand gesture recognition system to identify the isolated gestures. Different users gesticulate at different speed for the same gesture. Hence, when comparing different samples of the same gesture, variations due to difference in gesturing speed should not contribute to the dissimilarity score. Thus, we have introduced a two-level speed normalization procedure using DTW and Euclidean distance based techniques. Three features such as 'orientation between consecutive points', 'speed' and 'orientation between first and every trajectory points' were used for the speed normalization. Moreover in feature extraction stage, 44 features were selected from the existing literatures. Use of total feature set could lead to over fitting, information redundancy and may increase the computational complexity due to higher dimension.

Face Recognition Technology

A facial recognition technique is an application of computer for automatically identifying or verifying a person from a digital image or a video frame from a video source. It is the most natural means of biometric identification. Facial recognition technologies have recently developed into two areas:

Facial metric and Eigen faces. Facial metric technology relies on the specific facial features such as the positioning of eyes, nose and mouth, and distances between these features. These properties are recorded on an image database. In this method, the face region is normalized (rescaled) to a fixed pre-defined size and the normalized image is called the canonical image. Secondly the facial metrics are computed and stored in a face template. The typical size of such a template is between 3 and 5 KB, but there exist systems with smaller sizes as well.

Retina Geometry Technology

In this method, to obtain a focused image, eyes should be placed close to the camera. Retinal scanners are using low-power infrared laser and cameras to identify information patterns on retinal blood vessel. It is based on the blood vessel pattern in the retina of the eye as the blood vessels at the back of the eye have a unique pattern, from eye to eye and person to person. Retina is not directly visible and so a coherent infrared light source is necessary to illuminate the retina. The infrared energy is absorbed faster by blood vessels in the retina than by the surrounding tissue. The image of the retina blood vessel pattern is then analyzed. Retina scans require that the person removes their glasses and to place their eye close to the scanner, stare at a specific point, and remain still, and focus on a specified location for approximately 10 to 15 seconds while the scan is completed. A retinal scan involves the use of a lowintensity coherent light source, which is projected onto the retina to illuminate the blood vessels which are then photographed and analyzed. A coupler is used to read the blood vessel patterns.

IRIS Technology

This method uses the fact that each person's iris is unique and different with other people in terms of color and texture. Therefore, the complex appearance and structure (pattern) of iris allows extracting comparable features which can be used for recognition purpose. In the method, the colored part of the eye is scanned and analyzed. Imaging of the surface of the iris is not much difficult, but it should be considered carefully. For example, if the ambient light is changed or the rotation angle of the eye is not appropriate as well as the contrast, resolution and image focus is altered; then the possibility of error is considerable. Hence, iris scanning is an appropriate method for individual identification. Recognition methods use the iris of the eye which is colored area that surrounds the pupil. Iris patterns are unique and are obtained through video based image acquisition system. Each iris structure is featuring a complex pattern. This can be a combination of specific characteristics known as corona, crypts, filaments, freckles, pits, furrows, striations and rings.

Applications of Biometric Techniques

Biometric authentication is highly reliable, because physical human characteristics are much more difficult to forge then security codes, passwords, hardware keys and so forth. Biometric- based authentication applications require workstation and network access, single sign-on, application logon, data protection, remote access to resources, transaction security, and Web security. Strong personal authentication procedures could help strong e-commerce and e-government applications. More importantly applications such as secure electronic banking, investing and other financial transactions, retail sales, law enforcement, and health and social services are already benefiting from these technologies. Another promising area is the personal authentication for large- scale enterprises where Biometric technologies are expected to play a key role. Point-of-Sale and protection of all types of digital content such as in Digital Rights Management and Health Care applications are the other possible applications. Biometric technologies with other technologies such as smart cards, encryption keys and digital signatures, biometrics he lp s nearly all aspects of the economy and our daily lives. Examples of other current applications include speaker verification for television home shopping, Internet banking, and users' authentication in a variety of social services.

RESEARCH METHODOLOGY

There exist several algorithms developed by the researchers for face recognition. Among these, appearance-based approaches are the most famous such as PCA, ICA and LDA. In this work, Principal Component Analysis (PCA) based approach is followed for face recognition. PCA method is utilized to extract the discriminating features from face images. Euclidean distance is employed to act as a metric for calculating the matching score of face templates. Iris recognition is one of the most dependable and secure biometric recognition approaches which remains stable all through the entire lifetime of human and has a higher precision rate contrasted with other systems. Alphonse Bertillon, a French ophthalmologist first proposed to utilize iris patterns as a basis for personal identification, however implemented a working automated iris recognition system for the first time, where he implemented integro-differential operator for pupil detection that made his system most popular. Different systems also made great contribution in the iris recognition system. In this work, Daugman's method is followed for iris recognition. First, actual iris and pupil area is localized by performing Hough transformation and canny edge detection. Then, iris normalization is done to transform the iris region to a rectangular form. After that, features in normalized iris are encoded into a binary template using 1D Log-Gabor filters. And finally to calculate the matching score of iris templates hamming distance is utilized to act as a metric.

RESULTS AND DISCUSSION

Performance Parameters Comparison for different Combinations of PID: POD

The EER, maximum TSR, and optimum TSR values are compared with different combinations of PID and POD values are given in Table 1.

Table 1: Performance Parameters Comparison for different combinations of PID and POD

PID	POD	EER (%)	Optimum TSR (%)	Maximum TSR (%)
10	90	10	90	100
20	80	14	86	100
30	70	15	85	100
40	60	16	84	100
50	50	17	83	100
60	40	18	82	100
70	30	19	81	99
80	20	19	81	99

The values of optimum TSR and Maximum TSR decreases as PID increases from 10 to 80. The EER values increase as PID increases to maximum number 80. The success rate of recognition ie., TSR values are high for low PID values. The optimum error ie., EER value is less with low values of PID.

The Proposed method comparison with existing methods

The maximum TSR of proposed iris recognition method using CASIA Version-

1 iris database is compared with existing techniques suchand are tabulated in Table 2.

Table 2: Comparison of Maximum TSR of Proposed method with existing methods

Sl.No.	Authors	Techniques	TSR(%)
1	Yanghuaet al., [147]	Gabor +optimized	96.46
2	JianxuChen etal., [148]	IrisCrypts+EMD	96
3	SushilkumarandNarote [149]	Log-Gabor+FFT+ANN	95.90
4	NishanthRao PR etal.,[150]	Gabor +DCT+DBPSO	95
6	**Proposed Method**	AHE+HE+Gabor	100

The percentage TSR of proposed method is compared with existing methods in table 2 using CASIA V1.0 iris database. The performance evaluation of proposed method is tested with other iris databases such as CASIA V-3, UB-IRIS V-1, CUHK and MMU and is given in Table 3 to show the effect of proposed method on different iris databases in terms of maximum TSR.

The performance parameters are evaluated by considering fifty percent of total number of persons for Persons Inside Database (PID) and remaining fifty percent of total number of persons for Persons Outside Database (POD).

Table 3: The Performance parameters variations with threshold for PID: POD of 50:50

PID:POD 50:50			
THRESHOLD	FRR	FAR	TSR
0.2	100	0	0
0.25	100	0	0
0.3	100	0	0
0.35	100	0	0
0.4	100	0	0
0.45	100	0	0
0.5	92	0	8
0.55	84	0	12
0.6	74	0	18
0.65	60	0	32
0.7	44	0	46
0.75	30	2	54
0.8	16	8	66
0.85	8	60	74
0.9	0	100	78
0.95	0	100	78
1	0	100	78

It is observed that the values of FAR increases from zero to maximum value of 100 and FRR values decreases from a maximum value of 100 to minimum value of zero as threshold increases towards a higher value. The maximum success rate TSR of 78 and Optimum TSR value of 67 are obtained with an EER value of 12 at a threshold value of 0.8.

CONCLUSION

The purpose of this work is to build up a multimodal biometric system which will provide better recognition result over unimodal system. Our method provides a solution to a great issue in fusion technique - how to identify any person - through matching score level fusion and decision level fusion. It also shows that our multimodal biometric system achieves higher accuracy than single biometric system. The straight line fusion technique is used to combine low and high frequency sub-band coefficients of DWT to extract final features. The ED is used to compute performance parameters. Therefore, we have designed a robust multimodal face-iris biometric system by combining the advantages of score level, feature level and decision level fusion. The proposed scheme has applied Log-Gabor transform as the feature extraction method on face and iris modalities and, subsequently, the corresponding features and scores have been employed to construct different fusion schemes. We specifically have applied a threshold-optimized scheme at the decision level fusion step of the proposed scheme that is useful in the presence of outliers. In fact, based on the experimental results provided in this study, we can attract the attention of new perspectives for face-iris multimodal biometric systems that consider the combination of different levels of fusion, in particular decision level fusion, to efficiently represent a robust system.

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