Iris Identification Based on Neural Networks

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ABSTRACT
Iris Identification is one of the biometrics techniques used for biometric authentication based on the physiological characteristic of a human being. This article aims to cover both the historical development and current gradual progress in the iris tracking research on the research work done earlier and recent achievements. This broad study is carried using neural network based methods in terms of most widely used neural networks learning and analysis methods for face detection, iris tracking, occlusion detection, red-eye effect correction and driver fatigue detection, with their success rate and performance analysis.

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INTRODUCTION

Iris biometrics evaluates the distinctive features of the human iris to identify or authenticate the identity of individuals. Iris recognition is a highly accurate computer vision technology, which is considered to be a research hotspot. Iris detection has paramount importance in surveillance, citizen identification, ATM, E-commerce, retail, telephony, criminal identification, PC/network access, time and attendance and so on. Although it has diverse application prospects, still few challenges exist in this research field. The users must be cognitive of the way in which they interact with the system, such as precise head and eyes positioning, retaining correct distance and timing. Also, precise iris identification is limited by the poor illumination conditions or noise, such as obstruction of eyelashes, eye-lids, reflection and blurring. Gradual progress of developing non-invasive iris tracking systems is being currently recorded.

This article presents a state-space model and a tracking algorithm that incorporate these ideas. The designed model is successfully applied with the help of compressive sensing concepts which will reduce the number of pixels and the proposed methods are efficient in feature extraction and dimensionality reduction with high accuracy.

Number of researchers proved acceptable success ratio on precise iris detection using various techniques and devices. The restricted background, changing illuminations and moving head angles limit the scope of its applicability. Eye detection principle is framed on the basis of the following characteristics of the eyes, brightness and contrast between the eye sclera and iris/pupil is high, specific compact elliptical size and placed in the upper half of the face.

Fig. 1: Iris image (http://commons.wikimedia.org/wiki/File:Green_Eye.).
The rest of the paper is organized as follows. In section 2, the work done by other researchers for identifying iris are given. The results analysis of the proposed method is shown in section 3. Section 4 concludes the paper.

1. Iris Identification Based on Neural Networks:
Apart from traditional image processing methods, neural network based image processing application well recognizes the features in the iris images. Noise removal is efficiently carried out in terms of pattern recognition and non-linear functions. Neural network image processing tools provide higher hopes for both present and future enhanced biometric identification and verification systems. Mostly these systems follow the training or learning process where huge number of images are given as input in order to fulfill all the possible image processing operations in future.

Neural network works (as shown in figure 3) on the principle of human biological nervous system. Number of highly interconnected nodes also known as neurons act as processing elements. This structure of elements undergoes some specified learning process. The learning process may be supervised learning or unsupervised learning. The neural net is formed to solve certain problems. The connections among nodes bear numeric parameters called as weights. Neural network consists of set of layers. Each layer has interconnected processing nodes. There are three types of processing units or layers present in a typical neural system. They are: input layer (getting raw input known as patterns given into the network, hidden layer (actual processing based on the input layer activities and the weights assigned on the connection between input and hidden layer, output layer (gaining output based on the hidden layer activities) and the weights assigned on the connection between hidden and output layer. The various method used for identifying iris are discussed in the following sub sections.


Fig. 3: A general framework of Neural Network
1.1. Self-growing Probabilistic Decision based Neural Network

The principle of Self-growing Probabilistic Decision based Neural Network (SPDNN) had both approximation capabilities and learning abilities, was followed by Hsin Chia Fu et al. (Lai, H.F.P.S., et al., 2000). This system was upgraded into Eye Brow IrisSelf-growing Probabilistic Decision based Neural Network (EBI-SPDNN) for finding different oriented faces under unconstrained image environment. Binary image dilation cycles were conducted for facial area segmentation. But only five different angles of faces were tested with 99.8% successful face detection using 755 color images. Eye and face localization performed at 560 ms processing speed.

P. Sankaran et al. (2005) derived pose angle determination by face, eyes and nose localization. Sparse Network of Winnows (SNoW) classification was used for poses and faces determination. Adaptive progressive method of calculating the threshold for locating eyes was followed. Gradient method of thresholding for locating edges of candidate region were used for detecting the nose. Histogram threshold was used for locating the nose exactly. Slope between the line connecting the eye centers and perpendicular line to that line, provided pose angle. Automatic pose recognition was done by eye and nose detection. Yaw and Tilt could be determined well for pose recognition. High quality images might be preserved using multiple classifiers. Eye detection was fully done based on the accuracy of head localization. Only 2 image detections failed on total 5000 images. The mean error recorded was 10 pixels for meta-data. FRGC version 2.0 database consisting of 5000 images were used for eye center localization. FRGC version 1.0 was used for nose tip detection.

1.2. RBF Networks:

Yea-Shaun Huang et al. (2006) implemented a face detection method with high precision based on radial symmetry transform and eye-pair checking. Ada Boosting algorithm was based on cascade face filter that separated the face region from non-face region. Radial–Symmetry Transform helps in easy detection of eye pupil. Eye-pair selection was based on the highest face verification score than specified threshold. Radial Basis Function Networks (RBF) neural net was constructed for face verification. Precise face and eye-pupil detection was carried out in real time images. Exact face region checking was possible by eye-pair validation. Fast detection was performed under different backgrounds, illuminations and face sizes. Error detection was realized due to partially-occluded faces, and light reflection from glasses on faces. Faces much closer to image boundary and objects covering faces was leading to failure detection. 90% correct face detection was possible in BioID database and 98% eye-pupil detection rate was recorded. BioID database consisting of 1521 frontal images of size 384 * 286 was used for tests.

1.3. ALISA:

Teddy Peter Bock Co (2001) worked on the modification of Adaptive Learning Image and Signal Analysis (ALISA) texture model for the face detection and eye localization. Accurate and fast skin area detection and eye location on real time images under different illuminations was recorded. But research was taken for limited set of features and classes such as six classes and four features only. Skins classification algorithm provided 90.67% face detection. 99.5% classification for five-fold cross validation performance analysis for the six dynamic range classes. Real time images from video sequences were obtained for the study with 99.2% for skin class analysis.

1.4. Fuzzy Integral:

Bin Chen et al. (2003) presented an algorithm for localizing the eyes in human face using fuzzy integral. Similar eye pairs were measured by Sugeno Fuzzy Integral. Dilation and erosion localized the eyes. Noise was reduced by Circular Mask Morphological method. Threshold process was used for binarization. Eye detection was performed on different orientations, features and for closed eyes also and it was applied only for single face image where both eyes were present. 91% accurate eye detection was recorded. Experiments were carried out with 41,368 images of 68 people from CMU PIE database.

1.5. Neural Classifier:

T. D’Orazio et al. (2004) developed driver vigilance system based on neural system eye detection. Iris was detected by Hough Transform technique. Eye validation was performed by Neural Classifier. Hierarchical subsampled images were produced by Discrete Wavelet Transform from the original image. This methodology worked well for different eye colors, with or without glasses and for partially occluded eyes. Closed eyes in the image were accurately detected. The main drawback was that this method could detect only on usual day light. Detection in night driving without proper lighting could not be possible. For open eyed images 96% detection was possible, 0% detection for eye closed images, 45% detection for partially opened eyes, 100% validation for true positive and true negative where 0% validation for false positive and false negative conditions. For detecting 1474 images of three sets such as eyes opened, closed and partially opened were used. For validation purpose 330 negative, 281 positive examples of three different people were considered.

1.6. MLP Network:

Eun Yi Kim developed ‘Eye-Mouse’– PC based Human Computer Interface (HCI) system that was
used for eye detection and tracking. Skin-color model based on Gaussian method was used to detect the face. Connected Component Analysis was performed for filtering the region for face. Neural network texture classifier MLP (Multi Layer Perceptron) network classified eye regions and Mean Shift algorithm tracked the eyes. Mouse movements were detected from the tracking of eye movements. Human computer interface was implemented only using not expensive camera. No additional specialized hardware is required. System could be easily controlled by the eye movements. This system was used in live user interactive applications as video games. Better processing time was recorded as 100 frames per 22 ms. Real time live video input of 320*240 size, from PC camera was used for the tests.

1.7. FDA/NDA:
Feng Wang et al. (2005) developed multi-view face and eye detection by learning discriminant features using Fisher Discriminant Analysis (FDA) with AdaBoost to learn features and to train classifiers. Greedy method was used for selecting the finest features from feature pool. Recursive Nonparametric Discriminant Analysis (RNDA) for error free multi-view face, eye classification. Non Parametric Linear Discriminant Analysis (NDA) reduces wrong classification errors producing the accurate multi posed face and eye extraction. It was not based on the traditional geometric features and had limited discrepancies. Searching was done on limited number of optimum features. Reduction of wrong classification errors made the error less classifiers. This approach detected only 3 frames per second. The processing speed was not much satisfactory. 94.5% frontal face and eye tracking was possible. 88% accuracy was obtained from multi view face tracking. 99% false positives were removed successfully. FERET database consisting of 6000 faces, 500 eyes were used for training. CMU and MIT database provided images for frontal face finding. 400 images from FERET were not in training set, 3000 images from FRGC for eye extraction algorithm were used.

SheetalChaudhari et al. (2010) developed a new method for facial feature detection and normalization based on eyeball center and recognition. Geometric Normalization (G Norm) Algorithm and Brightness Normalization (B Norm) Algorithm was implemented for normalizing the face. Principal Component Analysis (PCA), Fisher Linear Discriminant Analysis (FLD), Gabor Wavelet methods were used for comparisons with the proposed combined method. An efficient and fast algorithm was used for face image normalization. Face normalization increased the face recognition rate. Eye ball detection was carried out on faces with or without glasses. Location of mouth center was also detected. 96% face recognition was achieved for PCA with GNorm method. 99.5% face recognition was achieved for FLD with GNorm method. 97.25% face recognition was achieved for Gabor Wavelet with BNorm method. 400 images of 40 people in ORL database were used.

RESULTS AND DISCUSSION
The outcome of this study show that, the modern era needs the widespread adoption of iris based biometric systems in all sectors where security and confidentiality are the key aspects. But the performance of such systems is still far away from 100% accurate state. The following problems can be tackled in this promising field, on taking precise effort and work, proper and careful designing of biometric systems can immune all aspects of spoofing, deploying multi-biometric systems, where pitfall of one can be overcome by others, strictly implementing secure biometric protocols, providing enough confidence and training/ instructions/prompts to the users, liberating the access of biometric databases, more publicly. The industry needs to concentrate on getting ever constant biometric traits as samples and social, cultural issues need to be addressed. Installing biometric systems where security outweigh the privacy concerns, contribution of more vendors in market on developing biometric hardware/processing software, granting more fund for biometric based projects from government and private sectors, innovations of new iris recognition techniques and open source iris based techniques need to be developed. The self-growing network (SPDNN) started its learning process from a single prototype. This can be initialized randomly in the training space. It gradually grows during the learning process. The self-growing process ends at the situation where sufficient numbers of prototypes are built. This neural concept supports almost 99% feature determination under unconstrained environment and also for varying orientation and lighting. SnoW constitutes a multi-class network which follows feature efficient learning method. SnoW adapts to learn the sparse network in the feature space, where the linear functions are represented. This classifier linearly scales in relevant to the number of features in the domain. Large scale visual processing learning (features learning) activities are carried out by SnoW more efficiently. From this survey it is known know that pose and face detection was performed automatically with SnoW with a mean error of 10 pixels per meta data. High quality images in terms of large amount of features can be classified well. RBF follows the supervised linear classify algorithm which facilitates the simple learning in terms of linear algebra. This network produces output which is the linear blend of radial basis function of given inputs at comparatively less computational cost. The basis classification function is placed in the hidden layer. This study points out that real time applications insisting precise eye-pupil
tracking may implement RBF. It is also notable that failure in tracking occurs for faces much closer to the image boundary and objects covering faces.

MLP (Multi Layer Perception) is a feed forward network following supervised learning. These kinds of networks are trained using back propagation technique. MLP consists of nodes that are activated non-linearly and has three or more layers that constitute deep network. It provides machine learning solution for biometric recognition. The survey clearly depicts that MLP can be used for real time eye-region tracking with better processing time. Hough transform for iris tracking is well performed with the neural classifier. Here, the expected output is informed to the classifier then this network adjusts the weight co-efficient in accordance to gain the desired output. 100% true positive and true negative validation achieved for eye validation. Adaptive Learning Image and Signal Analysis (ALISA) is a statistical learning system following a non parametric method for classification. It learns to classify the image structures where the decision rules are extracted from the sample data. From this study it is known that five-fold cross validation scheme attain almost 99% precise detection.

FDA, a pattern recognition/machine learning system divides two or more objects in an image using the linear combination of features. Applying the Discriminant analysis techniques, the dimension of images can be reduced for preprocessing. The survey exhibits that Recursive Nonparametric Discriminant Analysis achieves error free face and eye tracking but the processing time is not satisfactory. The study also analyzes the Sugeno Fuzzy integral compares and integrates the fuzzy sets for valid eye-pairs recognition.

Conclusion:

The study elucidates that the various kinds of neural network based methods achieve better iris recognition among non co-operative users. The pattern recognition is supported under unconstrained environment and for different poses/angles. A broad and depth study of international reputed journals in the research area was carried out. The findings and results were simply provided in the result-table for further reference. The careful study of the limitations and strength of biometric systems shows the urgent need of improving the efficiency rate of biometric systems. Among various unique biometric patterns, the strongest ever changing iris characteristics (trabecular-mesh) can be utilized for efficient tracking. The research can be more pointed towards efficient retrieval of iris patterns in unconstrained conditions, using image processing techniques. The major limitation is in acquiring clear input from acquisition device in unconstrained environment. The biometric data retrieval from low quality image is still an attention getting concern. Research can be directed towards the progress of pattern recognition from such images which have insufficient biometric data. Moreover, research can be enhanced to inbuilt all iris recognition core operations in a mobile device itself. The development of mobile based biometric algorithms needs to be achieved. Last but not least, research students may concentrate on improving the existing security mechanisms in order to avoid spoofing or imposter attacks, more efficiently.

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