Detection of reflection in iris images using back propagation

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Abstract – In our work with the help of back propagation and RST algorithm reflection in iris images are located and removed. From the database the biometric templates from iris images are extracted which are later used for comparison, this phase is called Iris encoding. A pattern recognition system with 2 folds is present in order to recognize the image pattern; extract the set of features from iris using RST [Radial symmetry Transform] algorithm; an inductive classifier to achieve reflection, detection and location by a pixel by pixel analysis. The use of the FFNN method instead of the RSBIN or BIN method can achieve a more robust behaviour of the system with respect to the threshold value. The whole system has been implemented in Mat lab by exploiting the available Neural Network Toolbox and PROTOCOL. The project description consists of five modules. An iris image is extracted, reflection is detected and then the feature extraction, selection and fusion is carried over with classification system and error is estimated. The RST used focus on neural network as classifiers and this RST is best suited for detection and localization of reflection.

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1. Introduction

Biometric systems exploit automated methods capable of recognizing the individuals by analyzing their physiological and or behavioral characteristics. Physiological biometrics is based on data derived from the direct measurement of the body parts (e.g., fingerprints, face, retina, and iris), whereas behavioral biometrics is based on measurements and data extracted from human actions (e.g., gait and signature). Iris biometric systems identify the user by performing the following steps: The first step is acquisition of the iris image (sample) by the sensor module. The second step is the localization of iris in the acquired image. All biometric systems can achieve their maximum accuracy in the identification or verification only if the samples are correctly acquired. For this reason, all the exogenous elements that are superimposed to the real biometric information in the sample must be removed (e.g. reflections, eyelids, eye brushes etc.). This operation can reduce the probability of erroneous matching. In the case of iris sample, the exogenous elements are mainly, Eyelids, Lashes and, Reflections.

In this step, the edges of the pupils and iris must initially be located in the input image, and then the eyelids, lashes, and reflections must be identified and removed from the iris image. The third step aims at extracting biometric template from the iris (iris encoding) [8]. This template will be used by the biometric system to perform comparisons (matching) with the templates are used as reference, generally stored in a database or in an identification document typically using a smartcard-based technology. Most of the systems require about 100 × 100 pixels of resolution for the iris to suitably identify every individual. Nowadays, sensors, such as web cams, have also been considered to perform iris identification Reflections in the iris images can occur in a great variety of applications and acquisition systems. This phenomenon is due to the particular shape and condition of cornea (the spherical and wet transparent surface that protects the iris and the inner eye from the outside). The light coming from windows, screens, and illumination system is often reflected by cornea. Additional reflections may be caused by occlusions such as contact lenses and eye glasses.

Unfortunately, reflections tend to be superimposed on iris pattern, causing difficulties in the iris acquisition. Complex iris based biometric systems use special illumination system (e.g., single point IR illuminators, optical filters,) and requires that users must be correctly positioned in front of the sensor. Consequently, reflections are confined in the pupil area, outside of the iris pattern. However, even in such cases, external reflections are often very frequently present in low-cost systems and in outdoor conditions. A pattern recognition system capable to locate the reflections that are present in the iris image is focused here. In particular, the contribution is in twofold;

i) A highly effective set of features to be extracted from iris images [based on the radial symmetry transform (RST)] and;

ii) An innovative adaptive design methodology for creating an inductive classifier to achieve reflection detection and location by a pixel-by-pixel approach.

The proposed method can work with any close-up image of the eye, and it does not require any information concerning the iris position and other segmentation information. This allows for an implementation of flexible iris-based identification systems that are very robust to environmental and operating conditions.

2. OBJECTIVES

An adaptive design methodology for reflection detection and location in iris biometric images based on inductive classifiers, such as neural networks is presented. In particular, a set of features that can be extracted and measured from the iris image from an every individual can be effectively be used to achieve an accurate identification of the reflection position using a trained classifier and removal of reflections using the neural networks is achieved at an effective rate. The two types of neural network concepts such as inductive classifier and feed forward back propagation are used to evaluate the accuracy rate of those neural network concepts. Thus the final comparison yields the better accuracy rate than the proposed concept.

3. SYSTEM ANALYSIS

The approaches presented in the literature traditionally consider the reflections as any other occlusion in the biometric images. The methods in existing system implicitly estimate the presence of occlusions since their presence tend to degrade the overall sample quality. Reflection removal in iris is typically achieved by localizing reflections by means of segmentation technique based on hard threshold. Threshold is performed by using one or more features extracted from the iris pattern. The existing system consists of certain drawbacks like high computational complexity regarding threshold value; feature extraction varies between samples and no defined methodology for extraction of features and low accuracy. Our designed proposed system doesn't require any information concerning iris position and other segmentation information if the sample is a close up eye image. So the system is tending to be flexible. The system uses RST for detection and location of reflection using two parameters:

1. N- array of candidate radii

*N is symmetry: N = low value- image will be of low contrast; N = high value- image will be of high contrast;

2. α - strictness parameter

* α = low value- bilateral symmetry

α = high value- strict radial symmetry

In the transformed image, only symmetrical objects whose radii are comparable with those in the N array will be enhanced (high contrast). Objects with low radial symmetry tend to be suppressed in the transformed image (low contrast). With small values of the parameter α (i.e., ≤ 1), image features also having bilateral symmetry will be enhanced. With higher values of α, only objects or features in the image with strict radial symmetry will be enhanced.

3.1. RST Algorithm:

- In this algorithm local radial symmetry I(p) is mapped to transformed image s(p), denoted by P (x,y).
- The data set from the sample which are in pixel form are captured and these pixels are classified as pixels with reflection and pixels with no reflection.
- Here the data set consist of 153,876 classified pixels, among these the iris pixel is 6.92% and reflection pixel is 2.34%.
- So any change in reflection will lead to corresponding change in iris pixel there by arising difficulties in pattern recognition. Thus the reflections should be removed.
- Once the RST has been performed, reflections are detected and localized by selecting the pixels in the map that have an RST value of higher than a predefined threshold.

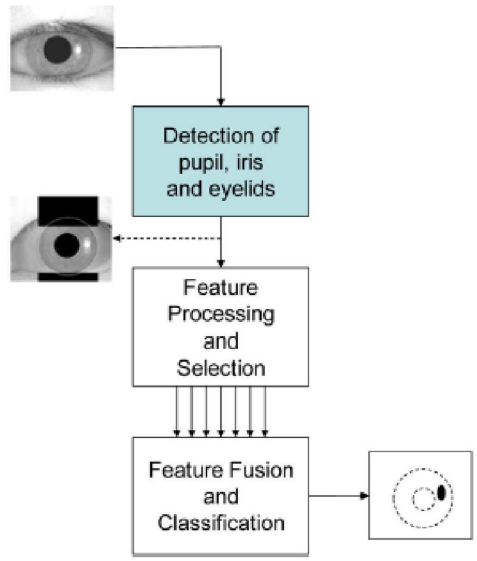

FIGURE: 1 Structure of the Proposed System for Reflection Identification

4. SYSTEM DESCRIPTION:

The reflections in different images are shown in fig .2. Due to the spherical shape of the cornea, the reflection tends to be smaller than pupil. This kind of shape has relative high value in RST. This consist of two parameters "an array of candidate radii (N) and radial strictness parameter α. In the transformed image, only symmetrical objects whose radii are comparable with those in the N array will be enhanced (high contrast). Objects with low radial symmetry are tending to be suppressed. With small values of the parameter α (i.e., ≤ 1), image features also having bilateral symmetry will be enhanced. With higher values of α, only objects or features in the image with strict radial symmetry will be enhanced.

4.1. Module Description:

The modules involved in the development of project are; Image acquisition and Pre-processing; Feature Extraction and Fusion; Inductive Classifier and Error Rate; Feed Forward Back Propagation and Accuracy Rate; Performance Comparison (Inductive Classifier and Feed Forward Back Propagation).

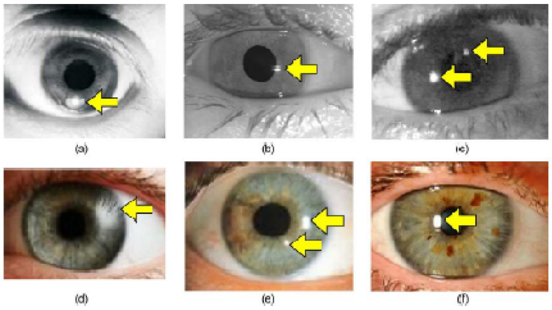

FIG.2: Reflections in Different Images

a. Image Acquisition and Pre-Processing:

This module locate eye image (center of iris) then detect and locate the reflection. This is done by two types of analysis:

1. Global image analysis
2. pixel by pixel analysis

GLOBAL IMAGE ANALYSIS: The single vector of features is extracted from the whole image. This will return a binary answer i.e., reflection present/ reflection not present. In case of absence of reflection the sample images are discarded.

PIXEL by PIXEL ANALYSIS: In this each pixel is analyzed and it returns a transformed image p (x, y) which masks itself. Hence the iris pattern is measured using total amount of pixels classified by classification system. If the measured value is low it will be taken as threshold value and pre-processing is done.

b. Feature Extraction and Fusion:

In this module the relevant and significant features are extracted from input image and if there are no reflections then request for new images are sent and the existing images are discarded. This module consists of two types of classification as:

1. Single pixel classification system -each pixel is analyzed; output will be in binary form (0-no reflection,1 reflection)
2. Multiple classification system considers whole image for analysis and classification so accuracy will be more.

Fusion is described as mapping of input space into potentially reduced subset features. These subset features are used for improving the accuracy of the final classifier. The subset features are obtained using Principle component Analysis (PCA). This PCA transforms variations in input image into minor number of components in order to increase the accuracy.

c. Inductive Classifier and Error Rate:

It will classify each single pixel of image and produce single binary answer concerning the presence of reflection in overall input image. The quality of the eye image depends on feature extracted from iris. The presence of occlusion (blockings) degrades the quality of sample. The neural network concept used in this classification system faces two issues.

1. Disjunct problem: in this number of rules produced by rule induction algorithm is often high;
2. The next problem is that the boundaries of each rule can be optimized in some degree for improved accuracy.

In order to improve the accuracy and to represent as simpler network we use gradient descent optimization of network. The error function is the mean square of error and denoted by Sr, the below Fig: 2 depicts the accuracy obtained in this module. The classification system uses a final acceptance threshold obtained from pixel by pixel analysis. The Final Acceptance Rate (FAR) and Final Rejection Rate (FRR) depend on this threshold value. In this case, the behavior of the overall system is better described by the Receiver Operating Characteristic (ROC), which concisely represents the different FARs and FRRs of the system with respect to the possible threshold values. An ideal system achieves FAR and FRR equal to 0 for all threshold value.

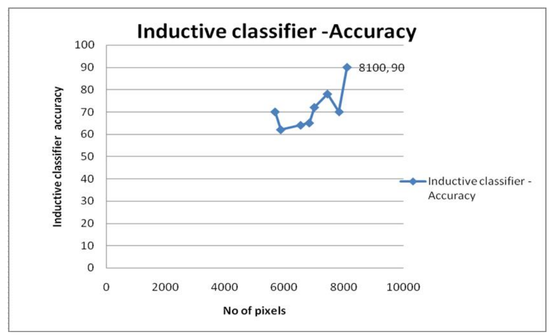

FIG: 3: Inductive Classifier – Accuracy

d. Feed Forward Back Propagation:

This will start with input layer connected to hidden layer and in turn connected to output layer. In any network one hidden and output layer is must and at the same time any number of hidden layers can be.

Input Layer:

It represents the condition for which the neural network is trained. Every input neuron represents the floating point number and in case of non-numeric data we use normalization concept to convert into numeric representation.

Output Layer:

This layer can be directly traced back to input layer. The number of neurons represents the type of work neural network performs. The characters are represented as pixels which in turn represent the number of neurons characters. The characters are represented as 5*7 grids which contain 35 pixels. The number of output neuron depends on how many characters the program has been trained to recognize the patterns. (Maximum 26 characters are trained)

4.2. Back Propagation:

This is used to train multi layered neural network and it represents the network with trained data. In this the error is calculated by difference between actual and expected output. The fig: 4 represent the relation between numbers of pixels and feed forward propagation and existing accuracy.

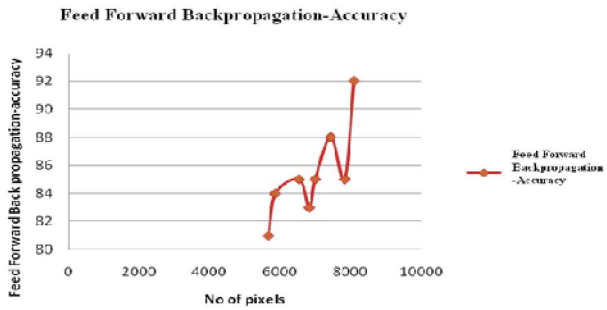

FIG: 4: Feed Forward Back Propagation- Accuracy

Network is presented with samples from trained set and the error is reduced by modifying the weight and threshold. Gradient descent method is used to find the weights that will minimize the error function. This error function is known as back propagation because it propagates the error backward through the network.

4.3 Accuracy Rate:

Existence of reflection is checked from database and carefully identified. Then comparison is made between bits of template and masking bits.

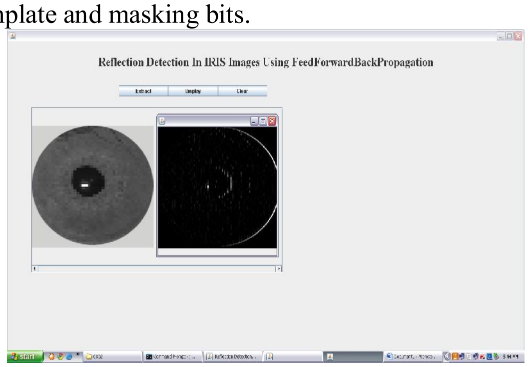

FIG: 5. The Process of Detecting the Edge and Noise Occurred in the IRIS Image.

4.4. Performance Comparison:

S.NO	NO OF PIXELS	INDUCTIVE CLASSIFIER - PIXEL REFLECTION RATE
1	7220	850
2	7440	900
3	7470	910
4	7530	920
5	7635	940
6	7700	950

Table: 1 Inductive Classifier - Pixel Reflection Rate

In this module the data set are divided into two parts. First tune the system parameters and train inductive classifier. Then validation for data set is done. Here tuning depends on technology adapted for feature extraction. Each technique has specific method to set the parameters. The Table: 1 and Fig: 5 depict that when pixel number increases the reflection rate increases.

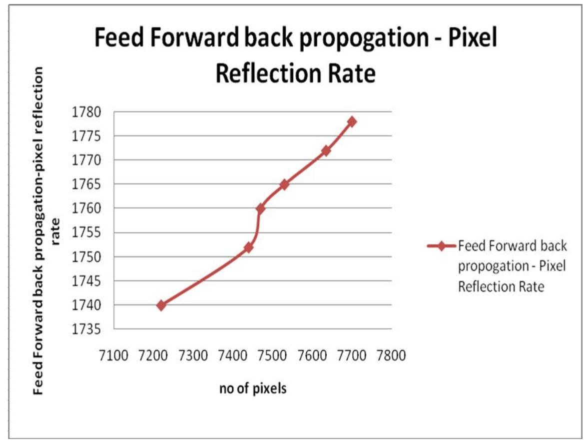

FIG: 5 - Comparison Grap

5. SYSTEM IMPLEMENTATION:

From the acquired image detection and location of reflection is done using RST algorithm. The threshold value (t) is computed as t= α max (RSBIN (p)); α=0.6. ROC is done for RSBIN and BIN; Existing system uses BIN approach and PROPOSED system uses RSBIN approach. In BIN approach left portion of the ROC curve has better behavior at this condition FAR rate is high. This BIN is of no use when minimum total classification error is achieved i.e., when t = 1. So we go with RSBIN. In RSBIN the right side portion of the ROC curve performs well and minimum classification error is achieved when α = 1. The pixels belonging to the reflection has been compensated by processing the mean intensity value of 10- pixel. The data flow diagram (Fig: 6) represents the overall system flow.

5.1. Input Design:

Reflection classification is obtained by using the two inputs; 1. Grey level intensity of pixel 2. Corresponding value of RST.

The input configuration is tested by Feed forward neural network with number of hidden neurons i.e., 1-30. To achieve minimum total error 4 neurons should be present in hidden layer.

5.2. Output Design:

In this K Nearest Neighbor (KNN) classifier is used with K range from 1-15. If K=1 then it shows best result so no threshold and ROC curve is seen but in this case also FAR (1.62%) and FRR (1.66%) exist. So totally 3.28% of total error rate is observed. Thus the computational complexity of KNN model can be estimated with respect to the execution time of two classifiers.

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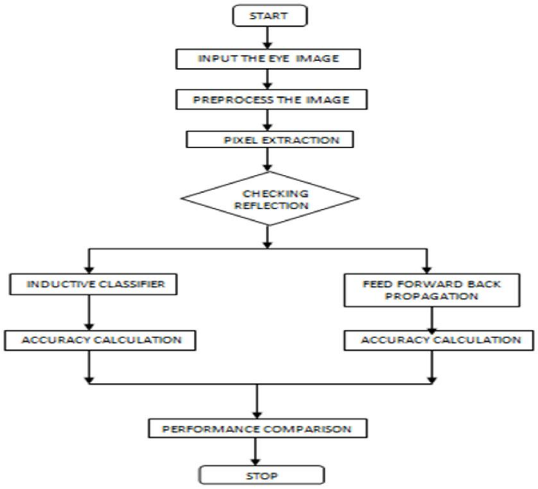

FIG: 6 Data Flow Diagram

6. CONCLUSION:

An adaptive design methodology for reflection detection and localization systems in iris biometric images is presented. The proposed methodology addresses the main steps of system design feature extraction, feature selection, feature fusion, creation of the suited classification system, and its error estimation. The methodology presented here is based on an innovative approach for the detection and localization of reflections. A suited set of features is extracted from the iris pattern, and an inductive classifier is then used to perform the reflection segmentation. In particular, the use of the RST as a new significant feature is introduced, and focused on neural networks as classifiers. Results show that the RST can be considered as a very good feature to detect and localize reflections. This feature can easily be used, with a thresholding approach, to quickly perform detection and localization of the reflections, although not very accurately.

6.1 Future Enhancements:

A more discriminative and significant set of features can be adopted by considering the RSTs and other classical features. This set of features has successfully been used to achieve much higher accuracy by means of neural networks. The proposed methodology allows for creating reflection detection and localization systems that have been proved to be much more accurate than those obtained using traditional threshold methods. The low computational complexity of the proposed systems is very suitable for real-time applications. The future implementation involves the usage of two or more neural network concepts instead of inductive classifiers and feed forward back propagation which could provide an improved efficiency.

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