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Sift Algorithm for Iris Feature Extraction

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Abstract- Iris recognition is proving to be one of the most reliable biometric traits for personal identification. In fact, iris patterns have stable, invariant and distinctive features for personal identification. Reliable authorization and authentication are becoming necessary for many everyday applications. Iris recognition has been paid more attention due to its high reliability in personal identification. But iris feature extraction is easily affected by some practical factors, such as inaccurate localization, occlusion, and nonlinear elastic deformation. The objective of the study and proposed work is to adapt the increasing usage of biometric systems which can reduce the iris preprocessing and describe iris local properties effectively and have encouraging iris recognition performance. This work presents an efficient algorithm of iris feature extraction based on modified scale invariant feature transform algorithm (SIFT) .

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SIFTALGORITHMFORIRISFEATUREEXTRACTION

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Sift Algorithm for Iris Feature Extraction

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Abstract- Iris recognition is proving to be one of the most reliable biometric traits for personal identification. In fact, iris patterns have stable, invariant and distinctive features for personal identification. Reliable authorization and authentication are becoming necessary for many everyday applications. Iris recognition has been paid more attention due to its high reliability in personal identification. But iris feature extraction is easily affected by some practical factors, such as inaccurate localization, occlusion, and nonlinear elastic deformation. The objective of the study and proposed work is to adapt the increasing usage of biometric systems which can reduce the iris preprocessing and describe iris local properties effectively and have encouraging iris recognition performance. This work presents an efficient algorithm of iris feature extraction based on modified scale invariant feature transform algorithm (SIFT) .

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I. Introduction

The recent advances of information technology and the increasing requirement for security have led to a rapid development of intelligent personal identification systems based on biometrics. Biometrics employs physiological or behavioral characteristics to accurately identify an individual. Iris is the best characteristic that can be used for person's identification and authentication in comparison with fingerprints, face, voice, and signature. It combines all the characteristics that a practical biometric should have. Iris pattern is unique to each person even that difference exists between twines. In the same time, the iris pattern is different between the right and left eye of the same person. Moreover, iris is very stable and changeless human characteristic over the time. Also, the sensing device that is used in order to measure the iris characteristic is a camera. This will be convenient for user population. Iris pattern is the safest biometric of all because it cannot be duplicated. The idea of iris identification trace back to the Paris prison in eighteenth century, where police discriminated criminal by inspecting their irises color [3]. The latest threats of security have led to the increased awareness of biometric technologies. Iris recognition is one of the most secure biometric approaches as it is non-invasive and stable throughout life [9][10]. Moreover, it does not require physical contact with the camera. In this way, the hygienic issue is minimized.

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Reliable authorization and authentication are becoming necessary for many everyday applications such as boarding an aircraft, performing financial transaction, logging to a secure system etc. Identity verification becomes a challenging task when it has to be automated with high accuracy and with low probability of break-ins and low rates of false match. Moreover, person verification is not a new problem and society had created three traditional modes of designation. Iris recognition has been paid more attention due to its high reliability in personal identification. But iris feature extraction is easily affected by some practical factors, such as inaccurate localization, occlusion, and nonlinear elastic deformation and so on.

In order to solve the problem, this work presents an efficient algorithm of iris feature extraction based on modified scale invariant feature transform algorithm (SIFT)[8]. It analyze the local feature in iris region to make use of the method of local feature matching, which overcomes the overall feature coding disadvantages to iris recognition. It not only to be an effective approach to simplify the iris image preprocessing, but also to solve the difficulties of iris recognition with iris occlusion and also to improve recognition performance efficiently.

II. Review of Related Work

Although there are many proposed iris recognition systems, all of them approximately share the following main stages: iris Segmentation, iris normalization, feature extraction, and feature comparison, as shown in Figure 1.

Daugman's 1994 patent described an operational iris recognition system in some detail. In 2004 his new paper said that image acquisition should use near-infrared illumination so that the illumination could be controlled. Daugman's approximated the pupil and iris boundaries of the eye as circles. So, he proposed an Integro-Differential operator for detecting the iris boundary by searching the parameter space. Because not all images of an iris are in the same size (e.g. The distance from the camera affects the size of the iris in the image, illumination variations and angle of the image capturing), Daugman proposed the rubber sheet model to normalize the segmented iris. This model represents the iris using a fixed parameter interval in a doubly dimensionless pseudo polar coordinate system. The iris is remapped from raw Cartesian coordinates (x,y) to the dimensionless polar coordinate system, which consists interval [0,1] and θ is an angle in [0,2π]. This makes all irises have the same size and also simplifies subsequent processing. To extract the features from the normalized iris Daugman applied a two dimensional texture filter called Gabor filter to an image of the iris and extracted a representation of the texture, called the iris code. The iris code is a set of bits, each one of which indicates whether a given band pass texture filter (Gabor filter in Daugman algorithm) applied at a given point on the iris image has a negative or nonnegative result. To compare two iris templates Daugman used Hamming distance as the similarity measure for two iris signatures. Wildes described an iris biometrics system uses different techniques from that of Daugman. To accomplish iris segmentation Wildes used a gradient based binary edgemap construction followed by circular Hough transform Wildes applied a Laplacian of Gaussian filter at multiple scales to produce a template and compute the normalized correlation as a similarity measure after normalizing the segmented iris. He used an image registration technique to compensate scaling and rotation then an isotropic band-pass decomposition is proposed, derived from application of Laplacian of Gaussian filters to the image data. In the Comparison stage a procedure based on the normalized correlation between both iris signatures is used. Although Daugman's system is simpler than Wildes' system, Wildes' system has a less intrusive light source designed to eliminate specular reflections. Wildes' approach is expected to be more stable to noise perturbations, it makes less use of available data, due to binary edge abstraction, and therefore might be less sensitive to some details. Also, Wildes' approach encompassed eyelid detection and localization. Li Ma, Tieniu Tan, Yunhong Wang, and Dexin Zhang proposed a new algorithm for iris recognition by characterizing key local variations. The basic idea is that local sharp variation points, denoting the appearing or vanishing of an important image structure, are utilized to represent the characteristics of the iris. First, the background in the iris image is removed by localizing the iris by roughly determine the iris region in the original image, and then use edge image enhancement is applied to handle the low contrast and non-uniform brightness caused by the position of light sources. In feature extraction stage they constructed a set of 1-D intensity signals containing the main intensity variations of the original iris for subsequent feature extraction. Using wavelet analysis, they recorded the position of local sharp variation points in each intensity signal as features. Directly matching a pair of position sequences is also very time-consuming. So, they adopted a fast matching scheme based on the exclusive OR operation to solve this problem intensity signal as features. Directly matching a pair of position sequences is also very time-consuming. So, they adopted a fast matching scheme based on the exclusive OR operation to solve this problem.

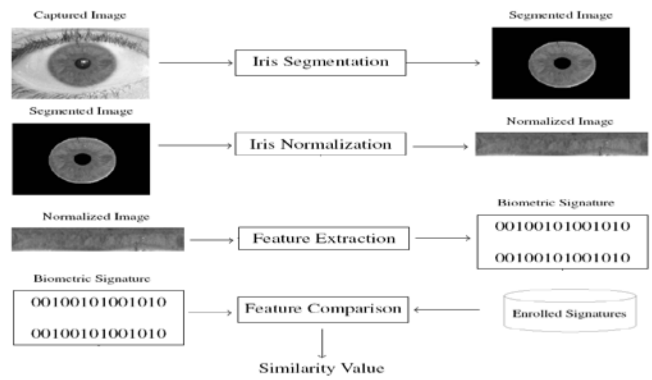

Figure 1 : Main stages of the iris recognition systems

a) Existing Techniques for Iris Recognition

The K-means algorithm is an iterative technique that is used to partition an image into k clusters by assigning each point to the cluster whose center (also called centroid) is nearest. The center is the average of all the points in the cluster that is, its coordinates are the arithmetic mean for each detection and Hough transform to exactly compute the parameters of the two circles in the determined region. Then lighting correction and dimension separately over all the points in the cluster. The basic K-means algorithm we used is:

Compute the intensity distribution (also called the histogram) of the intensities.

The Distance in our algorithm is typically based on pixel intensity. K-means clustering requires to specify the number of clusters to be partitioned and a distance metric to quantify how close two objects are to each other.

The Hough transform is a standard computer vision algorithm that can be used to determine the parameters of simple geometric objects, such as lines and circles, present in an image. It can be described as a transformation of a point in the x, y-plane to the parameter space. The parameter space is defined according to the shape of the object of interest. The circle is actually simple to represent in parameter space, compared to other shapes, since the parameters of the circle can be directly transfer to the parameter space. The circular Hough transform can be employed to deduce the radius and centre coordinates of the pupil and iris regions. It works as follow; at each edge point result from previous edge detection step we draw a circle with center in the point with the desired radius. This circle is drawn in the parameter space Figure 2 shows this process. At the coordinates which belong to the perimeter of the drawn circle we increment the value in our accumulator matrix which essentially has the same size as the parameter space. In this way we sweep over every edge point in the input image drawing circles with the desired radii and incrementing the values in our accumulator. When every edge point and every desired radius is used, we can turn our attention to the accumulator. The accumulator will now contain numbers corresponding to the number of circles passing through the individual coordinates. Thus the highest numbers selected in an intelligent way, in relation to the radius correspond to the center of the circles in the image.

There are many methods for edge detection, but one of the most optimal edge detection methods is Canny edge detection. It receives a grayscale image and outputs a binary map correspondent to the identified edges. It starts by a blur operation followed by the construction of a gradient map for each image pixel. A non-maximal suppression stage sets the value of 0 to all the pixels of the gradient map that have neighbors with higher gradient values. Further, the hysteresis process uses two predefined values to classify some pixels as edge or non-edge. Finally, edges are recursively extended to those pixels that are neighbors of other edges and with gradient amplitude higher than a lower threshold.

III. SYSTEM ARCHITECTURE

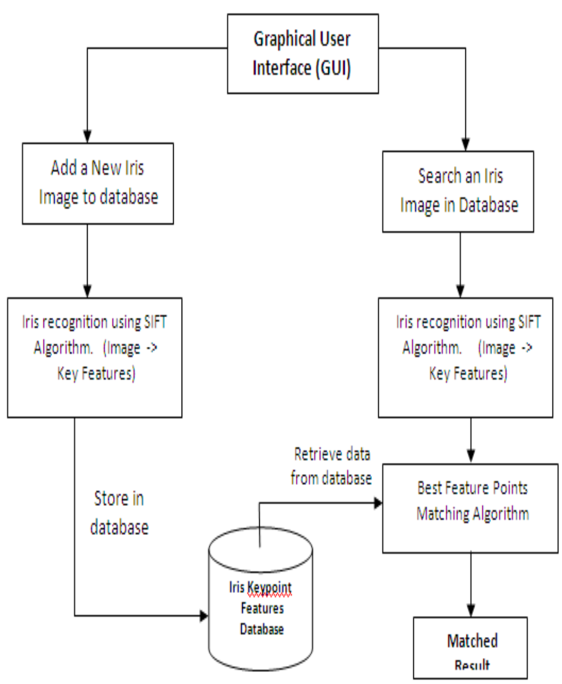

Figure 2 : System Architecture of proposed system

The proposed work implements an efficient method for describing local properties of an image as SIFT as shown in figure-3. The SIFT feature description method is revised appropriately, and is applied to iris recognition. It extracts the feature points which are reliable, stable and diverse. The feature vector is invariant to image translation, scaling, rotation and partially invariant to illumination changes. It can effectively extract the nature feature information of iris veins, so it can solve the traditional problem of low correct identification rate due to occlusion, inaccurate localization and so on. Moreover, it can simplify the iris preprocessing. It also does the satisfactory identification and searching through directly extracting and matching feature from iris images.

a) System Modules

- Iris Acquisition
- Image pre-processing
- Iris Feature Extraction
- Iris Identification

IV. PROBLEM STATEMENT

Reliable authorization and authentication are becoming necessary for many everyday applications such as boarding an aircraft, performing financial transaction, logging to a secure system etc. Identity verification becomes a challenging task when it has to be automated with high accuracy and with low probability of break-ins and low rates of false match. Moreover, person verification is not a new problem and society had created three traditional modes of designation. Iris recognition has been paid more attention due to its high reliability in personal identification. But iris feature extraction is easily affected by some practical factors, such as inaccurate localization, occlusion, and nonlinear elastic deformation and so on. In order to solve the problem, this work presents an efficient algorithm of iris feature extraction based on modified Scale Invariant Feature Transform algorithm (SIFT). It analyze the local feature in iris region to make use of the method of local feature matching, which overcomes the overall feature coding disadvantages to iris recognition. It not only to be an effective approach to simplify the iris image preprocessing, but also to solve the difficulties of iris recognition with iris occlusion and also to improve recognition performance efficiently.

V. ALGORITHM DESIGN

We implement SIFT algorithm for feature extraction and to generate feature vector. SIFT is an efficient method for describing local properties of an image. This implementation tries to extract an image from a collection of keypoints. These are oriented features of the image, so they are invariant to deformation like translation, rotation and scaling. They are partially invariant to change of illumination as well. In SIFT approach, some key points insensitive to illumination, rotation and scale changes are first detected. Then, for each key point, its feature vector is formed using the gradient directions of pixels in a block centered at the point. Hence, each local feature vector is invariant to image translation, scaling, and rotation, and partially invariant to illumination changes. It follows the following methods to generate the features as,

To perform the Iris reorganization and searching based on the feature matching we implemented the

Java Imaging API and SWT kit of eclipse to take advantage to design the interface. We implement the following java classes to achieve the function for evaluation.
The project is implemented in 2 phases as:

a) Phase-1 System Training

To perform the system training we implement the following java classes to generate the feature base for iris recognition. We generate feature database for our proposed SIFT Algorithm and Gabor Filter to evaluate the searching performance. It will be automatically reads all the images provided for training and store the extracted feature into database. We maintain two different database as S Database. iris for SIFT Algorithm and G Database. iris for Gabor filter.

b) Phase-2: Database Searching

To perform the database searching we utilized the features extracted during the training phase. It takes a selected input image for searching and using a selected algorithm approach to extract the image features. The obtained feature will be compared against the database to find the matching.

VI. Mathematical Model

The SIFT keys derived from an image are used in a nearest-neighbour approach to indexing to identify candidate object models. Collections of keys that agree on a potential model pose are first identified through a Hough transform hash table, and then through a least-squares fit to a final estimate of model parameters. When at least 3 keys agree on the model parameters with low residual, there is strong evidence for the presence of the object. Since there may be dozens of SIFT keys in the image of a typical object, it is possible to have substantial levels of occlusion in the image and yet retain high levels of reliability. To achieve rotation invariance and a high level of efficiency, we have chosen to select key locations at maxima and minima of a difference of Gaussian function applied in scale space. This can be computed very efficiently by building an image pyramid with resampling between each level. Furthermore, it locates key points at regions and scales of high variation, making these locations particularly stable for characterizing the image. SIFT is an efficient method for describing local properties of an image. It uses Gaussian kernel scale function which finds the difference of Gaussian image can be computed from the difference of two nearby scales separated by a constant multiplicative factor k in scale space. The Gaussian kernel is used to create scale space as,

$$L(x, y, \sigma) = G(x, y, \sigma) * I(x, y),$$

Where

$$G(x, y, \sigma) = \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/2\sigma^2}.$$

The σ determines the width of the Gaussian kernel, and x, y is the spatial coordinate of image I .Each feature point is assigned a dominant orientation so that the feature vectors describing feature point P(xo, yo), are invariant to rotation.

$$m(x,y)=\sqrt{(L(x+1,y)-L(x-1,y))^2+(L(x,y+1)-L(x,y-1))^2}$$

$$\theta(x,y)=\tan^{-1}((L(x,y+1)-L(x,y-1))/(L(x+1,y)-L(x-1,y)))$$

where L(x, y) is produced from the convolution of a variable scale Gaussian, G(x, y, k σ), with an input image I(x, y).Peaks in the orientation histogram correspond to dominant directions of local gradients. The highest peak in the histogram is detected, and then any other local peak that is within 80% of the highest peak is used to also create a feature point with that orientation.

$$w(x,y)=m(x,y)\exp(-((x-x_0)^2+(y-y_0)^2)/2\sigma^2)$$

Finally, the feature vectors are generated. F(x, y) = (F1, F2... FN) is feature vector of feature point P(xo,yo); N is the number of 4x4 sub-region in feature point region.

VII. Result Discussions

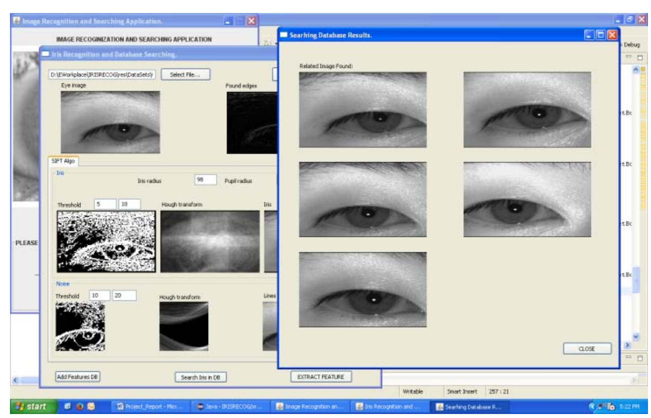

Figure 3 : Search Result of Input Iris with > 80% similarity using SIFT

Figure 4 shows the output search result match of an input image. The obtain result is based on percentage of feature matching. The obtain result is above 80% feature similarity compares to input images. We evaluated the search by varying the feature similarity percentage to > 90% and 100%. The obtained search result is shown below in figure 4 and 5. iris search using

Gabor filter. The obtain result shows a difference in feature matching and result retrieval in compare to SIFT Algorithm. To evaluate further we run this with various different samples and finally we measures the precision and recall ratio.

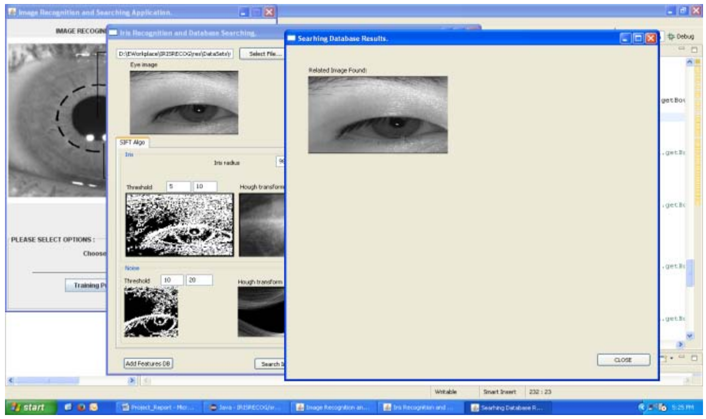

Figure 6 : Search Result of Input Iris with 100% similarity using SIFT

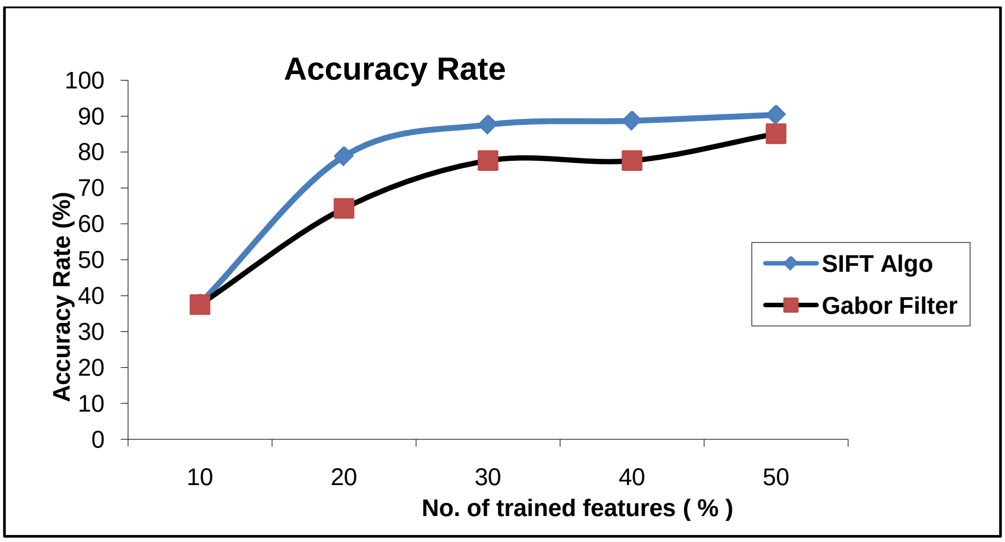

Figure 7 : Rate of accuracy comparison at different trained features

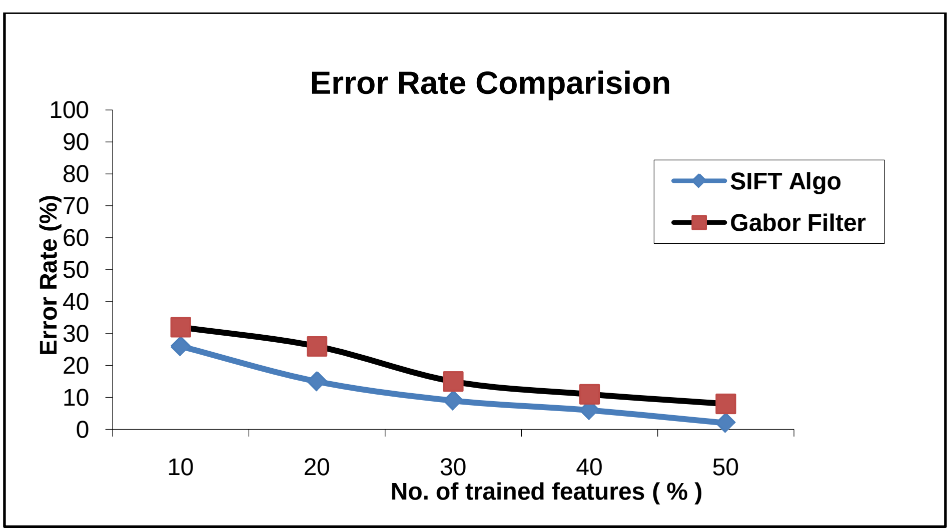

Figure 8 : Error Rate comparison at different trained features

VIII. Conclusion

The requirements of biometric operation in identification mode by exhaustively searching a large database are vastly more demanding than operating merely in one-to one verification mode A major approach for iris recognition today is to generate feature vectors from individual iris images and to perform iris matching based on some distance metrics and most of the commercial iris recognition systems implement a famous algorithm using iris codes proposed by Daugman. We proposed a work is to adapt the increasing usage of biometric systems which can reduce the iris preprocessing and describe iris local properties effectively and have encouraging iris recognition performance using SIFT Algorithm The experiment observation shows that SIFT feature description method is revised and appropriately can be applied to iris recognition. Moreover, it simplifies the iris preprocessing and also does the satisfactory identification and searching through directly extracting and matching feature from iris images. Although the developed system has recorded good results with the data sets presented, there are still some factors to consider if the software was to be used with a hardware camera in future enhancement of this work for a real-time evaluation.

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