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A Study on Retina: A Unique Identification Using Stereoscopic Retinal Image

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Abstract: ***This paper focuses on vessel extraction algorithm for personal identification of retinal blood vessel of both eyes. Blood vessel extraction is an important task for biometric application. Using morphological approaches the vessel extraction is done. Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels). The operation of partitioning an image into component parts, or into separate objects is our main purpose. This is done by Segmentation process where it subdivides an image into its constituent regions or objects. The level to which the subdivision is carried depends on the problem being solved. The goal of segmentation is to simplify or change the representation of an image into something that is more meaningful and easier to analyze. The objective of Segmentation is to partition an image into regions. This paper proposes biometric application for retinal images. Each individual has unique retinal blood vessels. Thus retinal blood vessels can be used for personal identification. input image is first preprocessed. The pre processed image contains enhanced blood vessels. After pre processing it is taken for vessel extraction followed by feature extraction. Finally it is given to the classifier. There are ways of encoding the iris scan biometric data in a way that it can be carried around securely in a "barcode" format. As far as anyone knows, the pattern of the blood vessels at the back of the eye is completely unique and stays the same for one's lifetime. Retina scan remains a standard in military and government installations. Its authentication is unquestionable e.g Adhaar Card giving unique identity to each and every individual.***

Keywords: Retina, Biometric, Image Segmentation, Personal Identification, Morphological Approaches

1. Introduction

Human beings have various traits, some of which can be uniquely identified and gives special recognition. Today's technical world may create various identification related issues. A solution to the problem is "The Retinal Scan". In Retina, iris is scanned which provides unique biometric data that is very difficult to duplicate. There are ways of Encoding the iris scan biometric data in a way that it can be carried around securely in a "barcode" format. As far as anyone knows, the pattern of the blood vessels at the back of the eye is completely unique and stays the same for one's lifetime. Retina scan remains a standard in military and government installations. Its authentication is unquestionable e.g Adhaar Card giving unique identity to each and every individual.

2. Anatomy of Retina

The retina covers the inner side at the back of the eye and it is about 0.5 mm thick [8]. Optical nerve or OD with about 2 × 1.5 mm across is laid inside the central part of the retina. Figure 1 shows a side view of the eye. Blood vessels form a connected pattern like a tree with OD as root over the surface of retina. The average thickness of these vessels is about 250 μm .

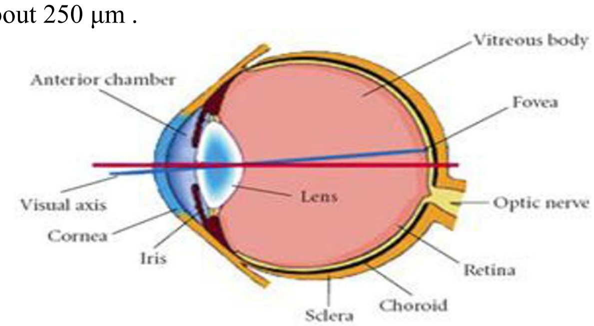

Figure 1: Side view of the eye

3. Objective

The main aim of this project is to provide unique identification on the basis of retinal scanning. It is computationally efficient, once the scanner device captures a retinal image, specialized software complies the unique features of the network of retinal blood vessels into a template. Retinal scan algorithms require a high - quality image and will not let a user enroll or verify until the system is able to capture an image of sufficient quality. Once user is acclimated to the process, an enrolled person can be identified with a retinal scan process in seconds. Henceforth, this methodology would be inherently more accurate for either verification or identification.

4. Image Processing

It is the process of transforming the grey values of the pixels. The aims of processing of an image normally falls into one of the three broad enhancement, restoration and segmentation.

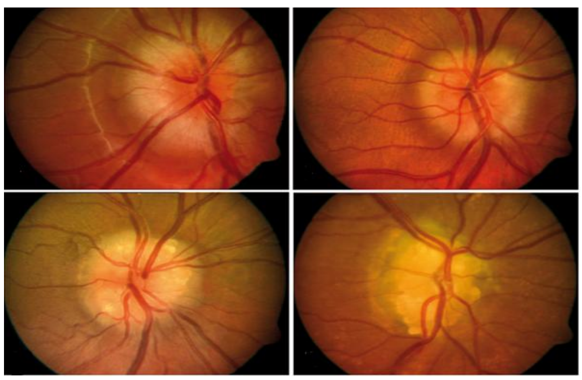

Figure 3: Sample of fundus image for two persons of both eye

5. Image Segmentation

It is the process of dividing images into subsections which basically involves specific information. It appropriately analyses the image like, finding circles, lines or other shapes of interest. It is the a process of alignment of two or more images and then comparing one of the image with the other. The main aim is to bring the input image into alignment with the base image.

6. Image Registration

Image registration is a process of aligning two or more images of the same scene. One image (the base image) is compared to the other input images. The aim of registration is to apply spatial transformations to the input image to bring the input image into alignment with the base image. Commonly, the input images may be misaligned due to different camera angles or different imaging modalities

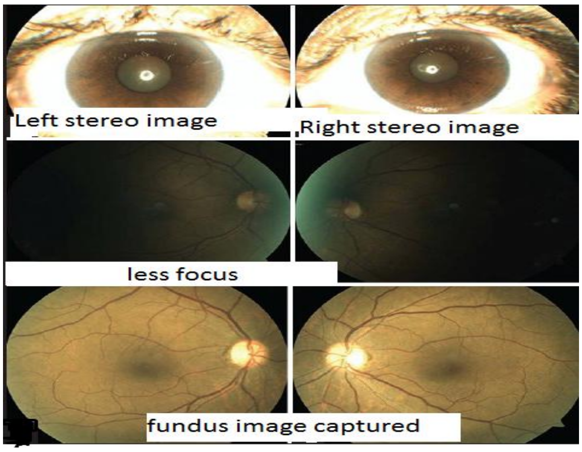

Figure 4: Steps of image capture by camera & fundus camera for identification

Methodology for Identification

The various modules of the project has been divided into various stages as follows:
1) Collection of sample images
2) Image processing
3) Features extraction
4) Development of algorithm
5) Classifier selection
6) Comparative study of classifier
7) Verification and accuracy check

Morphological changes in optical cup, optical disc and macula helps to identify a person. Here the proposed method for the authentication will be based on Discrete Wavelet Transformation and Spread Spectrum Techniques.

7. Methodology of recognition for Retina image

Here we are going to explain a new identification method based on retinal image. This method is computationally inexpensive and very efficient to use. We examine simulation results in the next section. These results are obtained using drive standard database, as we could see later the proposed system has about 99.75% accuracy In the proposed algorithm, a suitable resistance to the rotation has been formed using 1d Fourier transform.

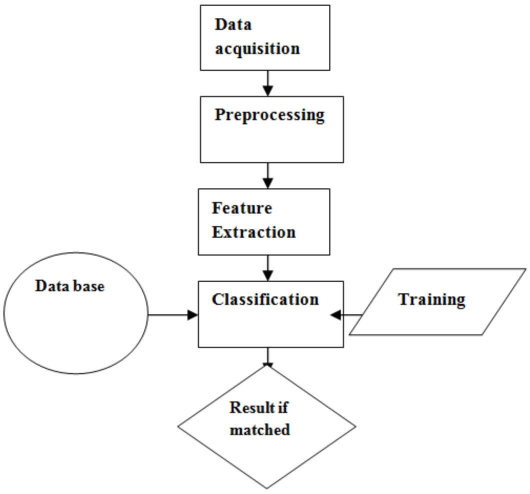

Figure 3: Generalized Flow Chart for Recognition

8. Feature Extraction

It is done using two methods

1) Angular Portioning

Angular sections defined as Ø degree pieces on the Ω image [19]. Number of pieces is k and the Ø = 2π/K equation is true (see Figure 3).According to Figure 3, if any rotation has been made on the image then pixels in section Si will be moved to section Sj so that Equation 1 will be true.

$$j = (i + \lambda) \bmod K, \text{ for } i, \lambda = 0, 1, 2, \ldots, K - 1$$

Feature of that slice. The scale and translation invariant Image feature is then {f(i)} where

$$f(i) = \sum_{\theta = \frac{i2\pi}{K}}^{\frac{(i+1)2\pi}{K}} \sum_{\rho=0}^{R} \Omega(\rho, \theta) \quad \text{for } i = 0, 1, 2, \ldots, K - 1$$

where R is the radius of the surrounding circle of the Image. When the considered image rotates to τ = l2π/K radians (l = 0, 1, 2, ...) then its corresponding feature vector shifts circularly. To demonstrate this subject, let Ωτ as counter counterclockwise rotated image of Ω to τ radians

$$\Omega_\tau(\rho, \theta) = \Omega(\rho, \theta - \tau)$$

So, the feature element of a considered section will be obtained from Equation 4.

$$f_\tau(i) = \sum_{\theta = \frac{i2\pi}{K}}^{\frac{(i+1)2\pi}{K}} \sum_{\rho=0}^{R} \Omega_\tau(\rho, \theta)$$

Also I can express fτ as:

$$f_\tau(i) = \sum_{\theta=\frac{i2\pi}{K}}^{\frac{(i+1)2\pi}{K}} \sum_{\rho=0}^{R} \Omega(\rho, \theta-\tau)$$
$$= \sum_{\theta=\frac{(i-l)2\pi}{K}}^{\frac{(i-l+1)2\pi}{K}} \sum_{\rho=0}^{R} \Omega(\rho, \theta)$$
$$= f(i-l)$$

Since fτ(i) = f(i - l) is true, I could conclude that the feature vector has been circularly shifted. If I apply 1D Fourier transform to the images, Equation 6 will be obtained.

$$F(u) = \frac{1}{K} \sum_{i=0}^{K-1} f(i)\, e^{-j2\pi ui/K}$$
$$F_\tau(u) = \frac{1}{K} \sum_{i=0}^{K-1} f_\tau(i)\, e^{-j2\pi ui/K}$$
$$= \frac{1}{K} \sum_{i=0}^{K-1} f(i-l)\, e^{-j2\pi ui/K}$$
$$= \frac{1}{K} \sum_{i=-l}^{K-1-l} f(i)\, e^{-j2\pi u(i+l)/K}$$
$$= e^{-j2\pi ul/K} F(u)$$

2) Radial Partitioning

In radial partitioning, the image I is divided into several concentric circles. The number of circles may be changed to get to best results. In radial partitioning, features are determined like angular partitioning; it means that I let the number of the edges pixels in each circle as a feature element. According to structure of this type of partitioning and because the centers of circles are one point, local information and feature values are not changed if a rotation happened.

3) Flow Chart

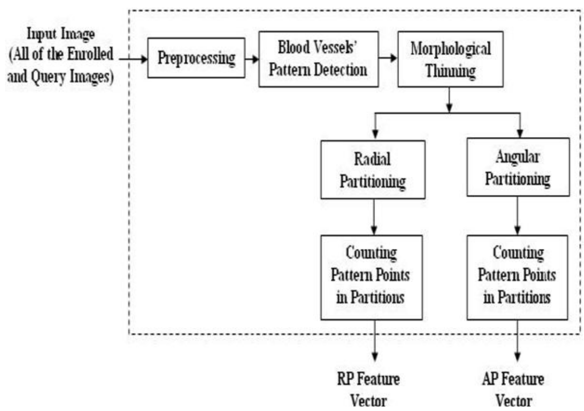

Figure 4: Flow Chart for feature extraction

9. Overview of Methods

Classification Complex valued neural network

The complex value model is divided into two parts. Summation and activation part. It begins by summing up the complex valued inputs in order to obtain the threshold value which is used to obtain the internal state of a given input pattern. From this study the sigmoid function i s :-

$$Z = \frac{1}{1+exp^{-zR}} + j\frac{1}{1+exp^{-zI}}$$

zR and zI are real and imaginary threshold of activation function. From the model neuron the net output /input relationship is given by:-

$$Net_z = \sum_{1=1}^{j} X_j W_j 1 + b_i$$

where Wj1 is the complex synaptic Iight connecting complex valued neuron j in input n layer to hidden layer , Xi is the complex input signal, j is neuron number , and b is a bias value of neuron i.

But,

$$y(n) = \sum_{m=1}^{q} Net_z V_{q1} + b_n$$

where Vql is complex output Iight.Therefore in complex form the eqn is –

$$e(n) = [d_R(n) + id_I(n)] - [y_R(n) + iy_I(n)]$$

9.1 Distortion Free classifier

The prime aim of the distortion free classifier is to group together in number of groups so that CVNN of all the regions will have the same characteristics. The output may be positive or negative.

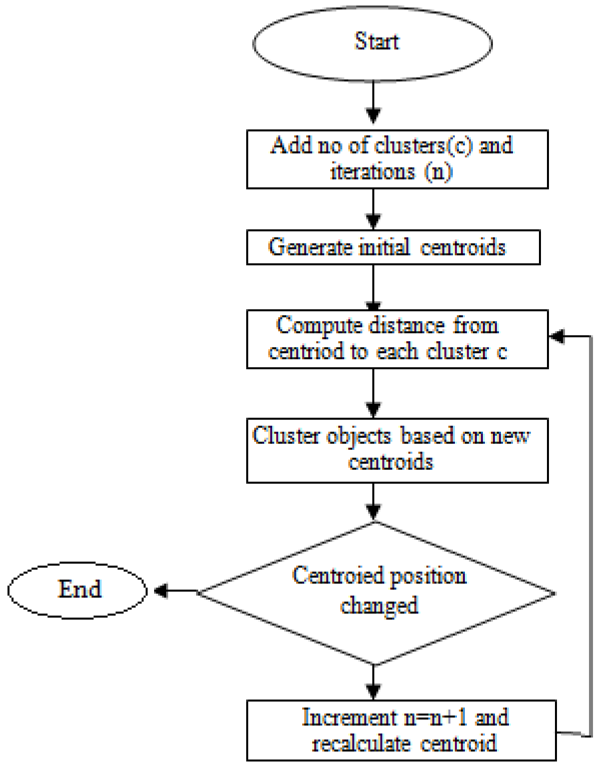

Figure 5: Distortion free Classifier

9.2 Watermark Embedding Model

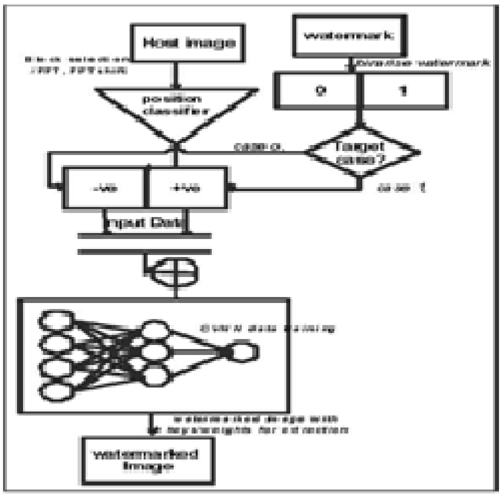

Figure 6: Embedding Process

The main step in embedding is sufficient generation of lights (hidden and output) by the CVNN and carefully mapping of the target contents (watermark bits) to the input data (host image.

9.3 Watermark Extraction Model

In this model, extraction is done on the various blocks for the recovery of hidden bits. During the training phase of the CVNN hidden nodes and output lights are generated for each and every block. Extractor must be positioned correctly because it serves as a pointer in order to retrieve proper lights from network since only proper light can give the correct hidden bits. Lights are saved for extraction. The examiner examines extractor. The extracted bits are then compared with values induced from frequency component. The flow chart is depicted in Fig7.

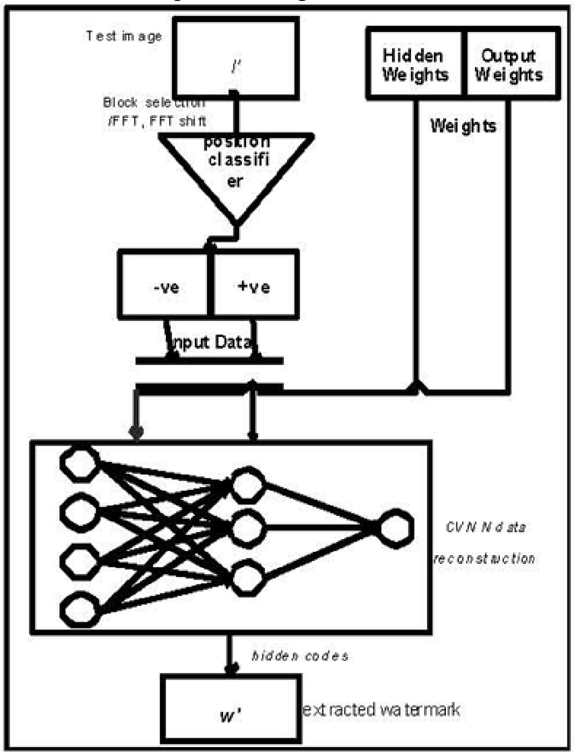

Figure 7: Extraction Process

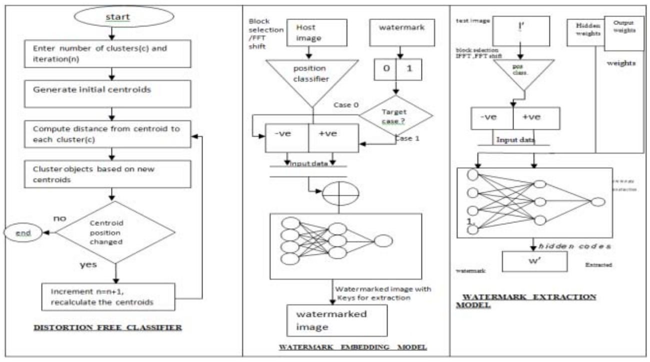

Figure 8: Comparison

10. Comparison of Algorithm

Here our main concern is to make comparisons at series of various steps and depending upon the outcomes at each steps further decisions are taken . The given architecture provides us the actual flow of correct decision making.

10.1 Result Analysis

Pattern matching is a key point in all pattern-recognition algorithms. Searching and finding similar images to a requested image in database is one of the most important tasks in image-based identification systems. Feature vectors of the query image and images in the database are compared to each other and nearest image to the query image returned as a result. In suggested algorithms for pattern matching, various distance criterions have been used as similarity measure. Manhattan distance and Euclidian distance are two of the most important similarity measures used until now.

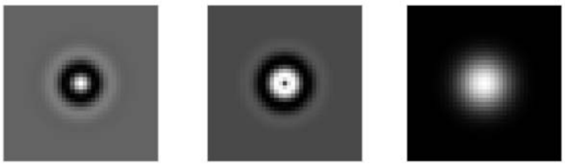

Figure 9: Optical disc Localization

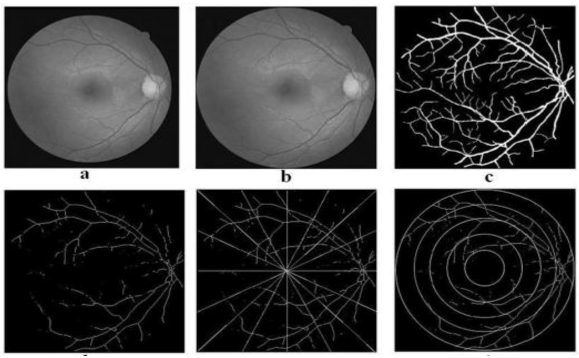

Figure 10: Segmented Blood Vessel for single retina.

Table 1: comparison between watermarked & recovered watermarked Image

Embedded watermark	Low	Mid	High	Recovered watermark, Thresholded	IFM
010	0.0553	0.9107	0.0443	010	0.9844
010	0.0049	0.9350	0.0465	010	0.9927
010	0.0005	0.9296	0.0608	010	0.9900
010	0.0491	0.8457	0.0875	010	0.9533
010	0.0096	0.9763	0.0266	010	0.9986
010	0.0378	0.9457	0.0424	010	0.9931
010	0.0201	0.9706	0.0238	010	0.9981
010	0.0205	0.9475	0.0582	010	0.9927
010	0.0289	0.9530	0.0304	010	0.9956
010	0.0027	0.9640	0.0436	010	0.9966
010	0.0366	0.9313	0.0560	010	0.9894
010	0.0002	0.9987	0.0104	010	0.9999
010	0.0000	0.9820	0.0327	010	0.9986
010	0.0001	0.9985	0.0162	010	0.9997
010	0.0030	0.9986	0.0374	010	0.9986
010	0.0312	0.9446	0.0084	010	0.9954
010	0.0706	0.8576	0.0502	010	0.9625
010	0.0284	0.9420	0.0223	010	0.9947
010	0.0460	0.9182	0.0207	010	0.9891
010	0.0484	0.8819	0.1029	010	0.9660

11. Conclusion and Future Works

We have approached towards an identification system based on retina image in this period. The suggested system uses angular and radial partitioning for feature extraction. After feature extraction step, Manhattan distances between the query image and database images are computed and final decision is made based on the proposed fuzzy system. Simulation results show high accuracy of our system in comparison with similar systems. More over rotation invariance and low computational overhead are other advantages of system that make it suitable. Hence forth this single person image identification is to be now implemented on several human beings which is stored in a database collected by field work. The database of the images will be treated as a training sample and then only for test images proper being can be encrypted by stego image which will contain the whole data of that specific person without increasing data ambiguity & complexity identification. Also the information about the human.

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