Retina Identification Based on Combined Angular and Radial Partitioning using Fuzzy Logic

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***Abstract*—This paper presents a novel biometric human identification system. The features of the proposed system are obtained from human retinal images. The two main components of the system are feature extraction and decision making component. Here first blood vessels are extracted and then features are extracted by combined angular and radial partitioning and decision making component is based on rules of the fuzzy system.**

Keywords—retinal images, blood vessel extraction pattern, combined angular and radial partitioning

I. INTRODUCTION

Inorder to improve the security issues in different organizations the biometric identification systems have became a real demand. Biometrics is the science of recognizing the identity of a person based on physical or behavioral characteristics of the person. Biometric is a Greek word – Bios meaning life and metron meaning measure. Finger prints, palm vein, face, iris, retina, voice, DNA and so on are some examples of these characteristics. Traditional authentication systems requires the person to remember and protect the keywords and passwords but biometric authentication releases the person from all these. These characteristics are never been lost, robbed, or forgotten, they are available anytime and anywhere and coping them or forging them are so difficult.

The characteristics which could be used in biometrics should satisfy the following properties.

1. Universality: Indicates every person should have the characteristic.
2. Uniqueness: Means that any two persons should be different enough to distinguish each other based on this characteristic.
3. Permance: The characteristics should be stable enough and not change significantly with environment or time.
4. Collectability: The characteristics can be measured qualitatively.
5. Performance: Refers to the achievable identification accuracy.
6. Circumvention: Refers how easy it's to fool the system by fraudulent technology.

Biometric features are divided into physical, behavioral, and chemical categories. The physical characteristic based identification method is the oldest biometric identification method. The main advantage of physical based identification method is that they are highly unique and stable. Fingerprint, face, iris, and retina are examples of the physical biometrics.

Behavioral techniques evaluate doing of some task by the user. Signature modes, walking style, or expression style of some statement are examples of these features. Moreover, typing or writing style or voice could be classified as behavioral characteristics too. The main disadvantage of this method is people's habits and behaviors are being changed over time and as a result these characteristics will also be changing resulting in lack of stability. For resolving this problem, database of human features must be updated frequently.

Chemical techniques measure chemical properties of the user's body like body smell or blood glucose, these features are not stable in all conditions and situations therefore they are not dependable so much [1].

Among all the biometrics in use today, eye biometrics (iris and retina) offers the highest level of uniqueness, universality, permanence, and accuracy. The blood vessel pattern of human's retina is unique among people and moreover human's retina is present at the innermost layer of the eye therefore no modification can be performed on it. The pattern of blood vessel is unique even for identical twins. Owing to all this property retina images could be one of the best choices for biometric systems.

II. OVERVIEW OF RETINAL TECHNOLOGY

Humans retina rarely changes during one's lifetime and it's not possible to modify it as it's present as the innermost layer of the eyes and as a result there is low possibility of fraud therefore retina is one of the most dependable biometric feature. The blood vessel pattern of human's retina is unique and stable as a result the retina based identification system has uniqueness and stability property.

In recent decades the retina based identification was not much used because of technological limitations and

expensive corresponding devices. These restrictions have now been eliminated because of technological advances and cheapen retinal scanners. Retinal Scanning is done by passing low-energy infrared rays to the person's eyes. The retinal blood vessels are more absorbent of this light than the rest of the eye.

A. Retinal Scanning

Retinal Scanning is done by passing low-energy infrared rays to the person's eyes. The retinal blood vessels are more absorbent of this light than the rest of the eye. The first major vendor for the research/development and production of retinal scanning devices was a company called EyeDentify, Inc. This company was created in 1976. The first types of devices used to obtain images of the retina were called "fundus cameras." These were instruments created for ophthalmologists but were adapted to obtain images of the retina. However, there were a number of problems using this type of device. First, the equipment was considered to be very expensive and difficult to operate. Second, the light used to illuminate the retina was considered to be far too bright and discomforting to the user. As a result, further research and development were conducted, which subsequently yielded the first true prototype of a retinal scanning device in 1981.

B. Anatomy of Retina

The retina is the innermost layer of the eye and it's present at the inner side at the back of the eye and is about 0.5 mm thick [2]. At the center of the eye is the Optical Disc (OD) and it's about 2 x 1.5 mm. OD is the region where blood vessels enters and leaves the retina. The blood vessels form a connected pattern and thickness of these blood vessels is about 250 μm.

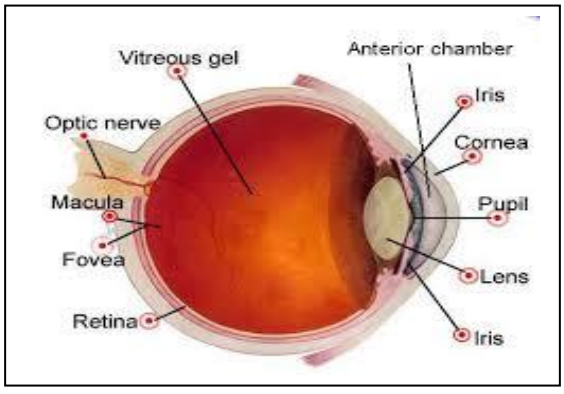

Fig 1: Anatomy of Human Eye

The blood vessel pattern of human's retina is unique among people which could be used for identification. The retinal blood vessel images of four different people are shown below.

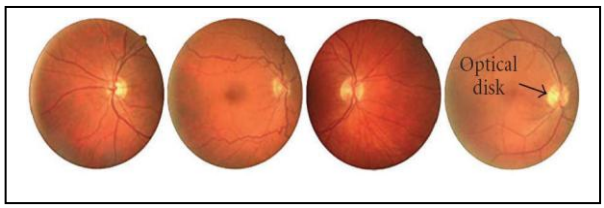

Fig 2: Retina images from four different subjects.

III. PROPOSED SYSTEM

In this proposed system an identification method based on retinal image is proposed. The proposed methods consist of feature extraction and decision making component. In feature extraction phase, feature vector is extracted by combined angular and radial partitioning. In decision making phase, first Manhattan distance is obtained for images and then individual is identified by utilizing the fuzzy system.

A. Feature Extraction Component

The feature extraction has the following steps.
1. Preprocessing.
2. Blood Vessel Pattern Detection.
3. Combined Angular and Radial Partitioning.

The overview of feature extraction component is shown below.

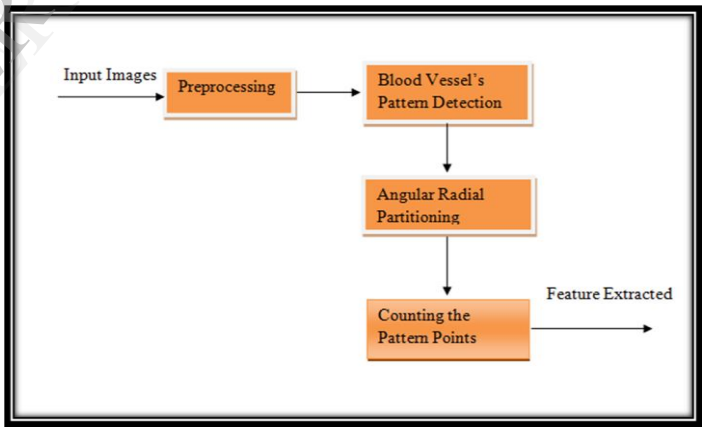

Fig 3: Overview of Feature Extraction Component.

In preprocessing first the image is converted into gray image and the image is saved in a J x J array. Then blood vessels are extracted as in [5]. Then combined angular and radial partitioning is done.

B. Combined Angular and Radial Partitioning

Angular sections are defined as θ degree pieces on the I image. K is the number of angular partitions on the image. Therefore, $\theta = 2\pi/K$. After that radial partitioning is done on the same image, the image I is divided into several concentric circles. The number of the edges pixels in each partition is considered as a feature element.

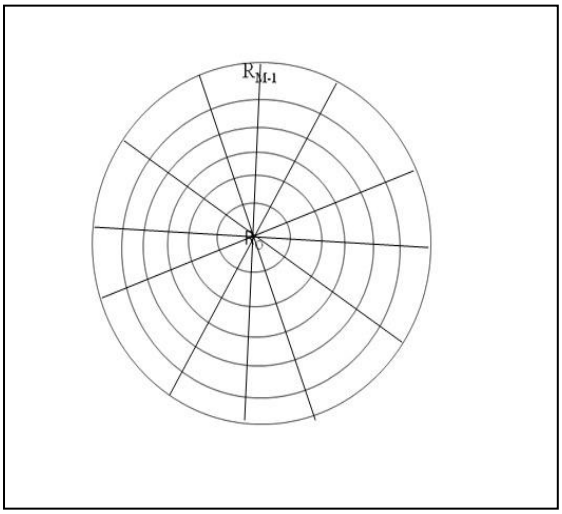

Fig 4: Combined Angular and Radial Partitioning.

C. *Decision Making Component*

For in image-based identification systems the most important task is to search and find similar images to requested image in database. First the feature vector of query image and all images in the database are computed and the image which is nearer to the query image will be returned as a result. Various distance criterions can be used as similarity measure. Manhattan distance and Euclidian distance are two of the most important similarity measures used until now. Also some systems have used weighted Manhattan and Euclidian distances as their similarity measures .

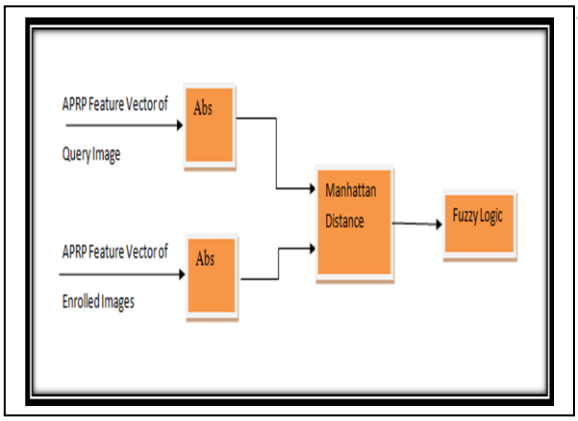

Fig 5: Overview of decision making component.

Here first the Manhattan Distance of the feature vector (APRP) of query image and all the enrolled images is computed and the final decision is based on fuzzy rules. The fuzzy rules which are used in the proposed system are

1. If (APRP is Low) then (Similarity is High).
2. If (APRP is Medium) then (Similarity is Medium).
3. If (APRP is High) then (Similarity is Low).

It is noted that we have mapped Manhattan distances to the range of [0 1000]. The value of the output is in the range [0 1], when the value is close to 1 it means that two images are very similar. Finally, we consider closest image to the query image as result. The membership function of input and output variable are shown below.

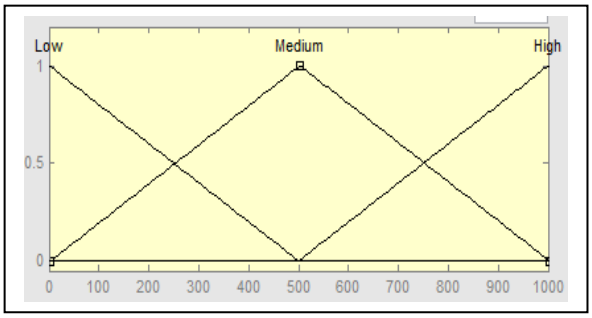

Fig 6 : Membership Function of Input Variable

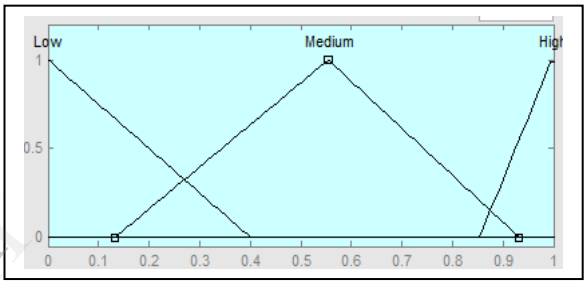

Fig 7: Membership Function of Output Variable

IV. RESULTS AND DISCUSSION

The proposed system is implemented on MATLAB platform and has been tested on DRIVE standard database. The DRIVE database contains retina images of 40 people. Here the feature vectors are obtained based on combined angular and radial partitioning. Here each image is divided based on angular and radial partitioning and in total there are 80 feature elements for each image.

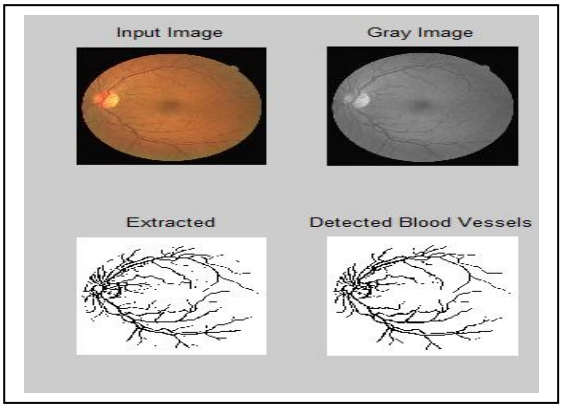

Fig 8: Result

We have proposed an identification system based on retina image in this article. The suggested system uses combined 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. As for future work neural network can be used.

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