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Iris Recognition for Security & Safety of Automobiles

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Abstract
The objective of this paper is towards implementing the Iris Recognition System (IRS) for ensuring security as well as safety of owner of the automobile. Iris Recognition is a method of biometric authentication that employs pattern recognition techniques based on iris images of an individual's eyes. It is regarded as the most stable, reliable and accurate biometric identification system available. From studies, it is found that algorithms developed by Daugman produce perfect recognition rates. The Iris Recognition System consists of the following steps; Image Acquisition, Image Pre-Processing which involves image segmentation and normalization, then Feature Extraction and finally matching the processed image with database. The first two steps for Iris Recognition were performed successfully in MATLAB®. The edges of iris and pupil were detected using Canny Edge Detection technique and results were plotted. The state of drowsiness can also be detected by observing the closing of eyes which can ensure in safety of driver. Therefore, Iris Recognition is considered to be reliable and accurate biometric technique for authentication of driver in automobile.

Keywords: *Iris Recognition System, Security, Biometrics, Image Processing, MATLAB*

1. Introduction

1.1 Biometric Technology

A biometric system provides automatic identification of an individual based on a unique feature or characteristic possessed by the individual. Biometric systems have been developed based on fingerprints, facial features, voice, hand geometry, handwriting, the retina and the iris [9].

Historically, identity or authentication procedures were based on things one possessed (a key or a passport), or something one knew (a password, the answer to a question, or a PIN.) This possession was generally all that was required to confirm identity. However, these conventions could be compromised as the requisite knowledge by the wrong individual could lead to security breaches.
To bind identity more closely to an individual and appropriate authorization, a new identity convention became more prevalent which is based on physical characteristics or personal behavior traits they exhibit. Biometrics includes measurements of behavioral or physical attributes or how an individual smells, walks, their voice, fingers, facial structure, vein patterns or patterns in the iris [9].

1.2 Iris Recognition as Biometric Authentication in Automobiles

Among the aforementioned physical attributes, the iris recognition technique is considered as the most stable and reliable authentication technique. Thus for identifying the owner of the vehicle and preventing theft actions, Iris Recognition can be implemented into the automobile's integrated systems.

Iris Recognition System is as an automated method of biometric identification that uses mathematical pattern-recognition techniques on images of one or both of the irises of an individual's eyes, whose random patterns are unique, stable, and can be seen from some distance [8].

A good Iris recognition biometrics is characterized by use of a feature that is; highly unique – so that the chance of any two people having the same characteristic will be minimal, stable – so that the feature does not change over time, and be easily captured – in order to provide convenience to the user, and prevent misrepresentation of the feature [4].

2. Literature Review

Sreekala P. [1] suggests that biometrics deals with identification of individuals based on their biological or behavioral characteristics. Iris recognition is a method of biometric authentication that uses pattern recognition techniques based on high-resolution images of the irises of an individual's eyes. These unique structures converted into digital templates, provide mathematical

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representations of the iris that yield unambiguous positive identification of an individual. It designed for use in a one-to many search environment, a key advantage of iris recognition is its stability security system especially car .Iris recognition method gives better performance than all other image processing system.

Rajat Garg [2] introduces three distinct but closely related concepts viz. an Iris Recognition system, a Drowsy Driver Detection system and a Distress Signaling system using non-intrusive machine vision based concepts. Biometric security through Iris recognition will help in authentication and an improved sleep detection and driver alert system by monitoring both the driver's eyes as well as sensing the heat variation of the body via infrared thermal sensor. This paper combines computer vision, pattern recognition and optics.

Izem Hamouchenea, [5], has proposed a new iris recognition system using a novel feature extraction method called as Neighborhood-based Binary Pattern which compares each neighbor of the central pixel with the next neighbor to encode it by 1 if it is greater or 0 if it is lower than the central pixel. The obtained binary code is converted into a decimal number to construct the NBP image. This image is subdivided into several blocks and the mean of each block is calculated. After, the variations of the means are encoded by a binary code.

3. Emergence of Iris Recognition

In 1936, ophthalmologist Frank Burch proposed the concept of using iris patterns as a method to recognize an individual. In 1985, Drs. Leonard Flom and Aran Safir, ophthalmologists proposed the concept that no two irises are alike. Dr. John Daugman developed an algorithm to automate identification of the human iris [1].

Although John Daugman developed, patented the first actual algorithms to perform iris recognition and gave the first live demonstrations, the concept behind this invention has a much longer history. The core theoretical idea in Daugman's algorithms is that the failure of a test of statistical independence can be a very strong basis for pattern recognition, if there is sufficiently high entropy (enough degrees-of-freedom of random variation) among samples from different classes. In 1994 he patented this basis for iris recognition and its underlying Computer Vision algorithms for image processing, feature extraction, and matching. These algorithms became widely licensed through a series of companies [8]. In 1995, the first commercial products became available.

With various improvements over the years, these algorithms remain today the basis of all significant public deployments of iris recognition. In 2005, opportunities for other companies to develop their own algorithms for iris recognition were implemented [1].

4. Human Eye Structure

The anatomy of human eye is shown in Figure 1.The very front of the eye is made up of two parts: the sclera, or "white" of the eye, and cornea. A small section directly in front and centered is known as the cornea [1].

The cornea consists of fibers arranged in a regular fashion. Conveniently, this makes the cornea transparent, allowing light to filter in. Behind the cornea is the anterior chamber. It is filled with a fluid known as the aqueous humor. This fluid is primarily responsible for carrying oxygen and nutrients to the organs submerged in it [1].

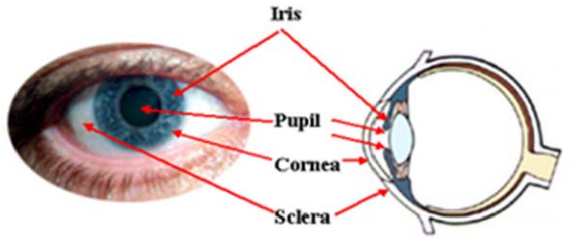

Fig. 1 Basic Human Eye Diagram Showing All Components

4.1 Function of Human Iris

A spongy tissue, the ciliary bodies, arranged around the edge of the cornea, constantly produces the aqueous humor. In the aqueous humor, a ring of muscles are immersed which is commonly referred to as the iris [1].

The function of the iris is to control the amount of light entering through the pupil. The average diameter of the iris is 12 mm, and the pupil size can vary from 10% to 80% of the iris diameter [4].

4.2 Characteristics of Human Iris

Irises not only differ between identical twins, but also between the left and right eye of an individual. It has being examined that no two irises are same. Iris pattern is formed during the first year of life and pigmentation of the stromal takes place for the first few years. Formation of the unique patterns of the iris is random and not related to any genetic factors [4].

The only characteristic that is dependent on genetics is the

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pigmentation of the iris, which determines its color. Epigenetic nature of iris patterns results in completely independent iris patterns. Even identical twins possess uncorrelated iris patterns [8].

4. Iris Recognition System

The proposed Iris Recognition System for authentication of driver in automobiles is based on image processing technique to ensure the uniqueness of driver.

Image processing techniques can be employed to extract the unique iris pattern from a digitized image of the eye, and encode it into a biometric template, which can be stored in a database.

When the driver is identified by iris recognition system, their eye is first photographed, and then a template is created for their iris region. This template is then compared with the other templates stored in a database until either a matching template is found and the driver is identified, or no match is found.

4.1 General Process of Iris Recognition

The general procedure for Iris Recognition System to operate effectively is shown in Figure 2.

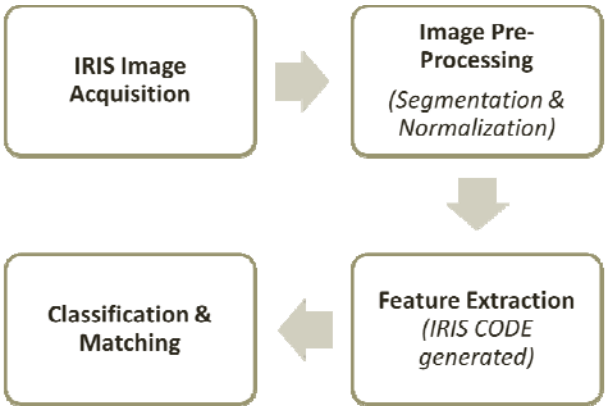

Fig. 2 Block Diagram of Iris Recognition

1) *Image Acquisition:* The image of the iris is captured using a camera. The automatic procedure uses a camera that locate the face and iris automatically thus making this process much more user friendly.

2) *Image Pre-Processing:* This step involves edge detection, contrast adjustment and multiplier. The image is segmented to locate the appropriate position of iris outer and inner boundaries. For normalization, the circular image is transformed from polar to Cartesian coordinates.

3) Feature Extraction: This includes noise removal from iris image and generating iris code.

4) Classification & Matching: This involves comparing and matching of iris code with the codes already saved in database.

4.2 Daughman's Algothrim

The Daugman's Algorithm for Iris Recognition is considered as the most accurate and reliable.The iris recognition system consists of an automatic segmentation system that is based on the Hough transforms which involves following steps, (see Figure 3):

- Image Acquisition is performed by capturing the iris image from a person and is able to localize the circular iris and pupil region, occluding eyelids and eyelashes, and reflections.
- The extracted iris region was then normalized into a rectangular block with constant dimensions to account for imaging inconsistencies.
- Finally, the phase data from 1D Log-Gabor filters was extracted and quantized to four levels to encode the unique pattern of the iris into a bit-wise biometric template.
- The Hamming distance was employed for classification of iris templates. Distance measure between generated iris code and stored iris code is calculated. If the distance measure is below a threshold (around 0.34), iris is considered as authentic [4], [10].

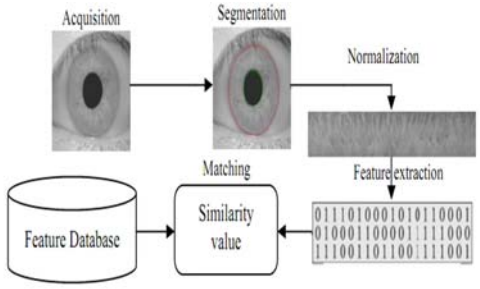

Fig. 3 Block Diagram showing algorithm for Iris Recognition

4.3 Simulation Software: MATLAB

MATLAB is a high-level language and interactive environment for numerical computation, visualization, and programming. Using MATLAB, we can analyze data, develop algorithms, and create models and applications [10].

Iris Recognition can be successfully implemented using MATLAB Software. The Image Processing Toolbox

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available in MATLAB provides the iris image to be detected, normalized and matched with database.

Image Processing Toolbox provides a comprehensive set of reference standard algorithms and graphical tools for image processing, analysis, visualization, and algorithm development.

The key features of Image Processing Toolbox are as follows:

- Image enhancement, filtering, and deblurring.
- Image analysis, including segmentation, morphology, feature extraction, and measurement.
- Spatial transformations and intensity-based image registration methods.
- Image transforms.
- Interactive tools, including Region Of Interest (ROI) selections, histograms, and distance measurements

The basic data structure in MATLAB is the array. The representation of images is a real-valued ordered sets of color or intensity data. MATLAB stores most images as two-dimensional arrays (i.e., matrices), in which each element of the matrix corresponds to a single pixel in the displayed image. (Pixel is derived from picture element and usually denotes a single dot on a computer display). This convention makes working with images in MATLAB similar to working with any other type of matrix data, and makes the full power of MATLAB available for image processing applications.

4.4 Connection to Ignition Control Unit of Vehicle

The image is acquired using a standard camera which can be placed onto the steering wheel of automobile. Once the camera captures the face of the person, the iris recognition algorithm segments the face image to acquire only the iris region separated from the pupil region. Once the iris edges are detected using Canny Edge Detection method, the iris image can be transformed to digital form and then matched with the database values.

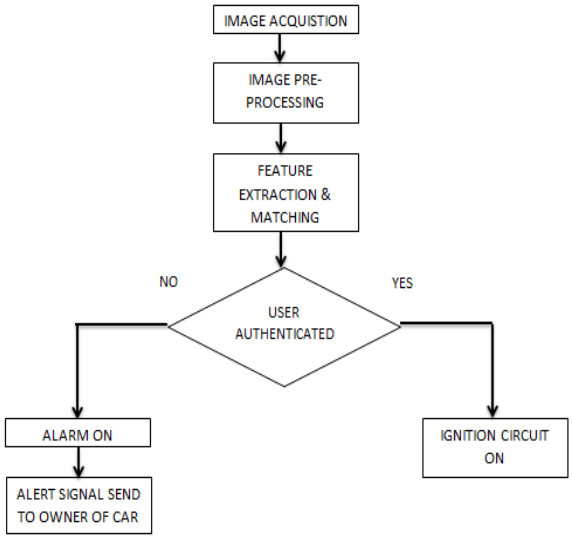

Fig. 4 Flowchart showing Iris Recognition System connected with Ignition Control Unit of vehicle

If the iris image is matched with the database, i.e. the user is authenticated, a signal is sent to the ignition control unit of the vehicle so as to start the engine. If not, an alert signal is send to the owner of the vehicle via as text message or to the nearby police station informing the global positioning coordinates of the vehicle. This step will be beneficial if the owner of the vehicle is not present in the parking vicinity.

5. Simulation Results & Discussions

5.1 Canny Edge Detection Method

The Canny edge detection method finds edges by looking for local maxima of the gradient of I, where I is the intensity of image. The gradient is calculated using the derivative of a Gaussian filter [10].

The method uses two thresholds, to detect strong and weak edges, and includes the weak edges in the output only if they are connected to strong edges. This method is therefore less likely than the others to be "fooled" by noise, and more likely to detect true weak edges. The syntax for detecting edges by Canny Method is:

BW = edge (I, 'canny')
BW = edge (I, 'canny', THRESH)

Where, THRESH is a two-element vector in which the first element is the low threshold, and the second element is the high threshold.

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5.2 Simulation Results

Using the Canny Edge Detection technique available in MATLAB, the edges of iris and pupil regions are detected which is the very first step for Iris Recognition.

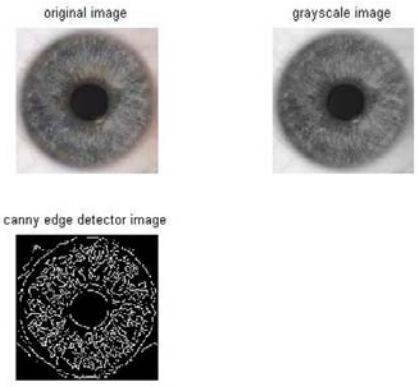

Fig. 5 Edge Detection Output for Iris Image

The simulated result for a given Iris image is shown in Figure 5.

- The original iris image is first acquired from an individual.
- Then the image is converted to gray scale image for image pre-processing.
- Then the Canny Edge detection function is applied and the output with edges of iris and pupil is plotted (See Figure 5).

6. Conclusion and Future Work

Face Recognition method is very prominent these days and have more number of disadvantages such as facial changes leading to inaccurate results. Thus among all the existing biometric techniques, Iris Recognition is considered to be most reliable and stable.

The results obtained from the simulation validate the edge detection for iris boundaries by capturing the iris image. The pattern recognition of iris image is performed using the MATLAB software. The Image Processing Toolbox facilitated the edge detection of iris image which can then be normalized and matched with the other iris images in the database.

Following are the point's which makes iris recognition the authentication system of choice:

- *Stable* - the unique pattern in the human iris is formed by 10 months of age, and remains unchanged throughout one's lifetime.
- *Unique* - the probability of two rises producing the same code is nearly impossible.
- *Flexible* - iris recognition technology easily integrates into existing security systems or operates as a standalone.
- *Reliable* - a distinctive iris pattern is not susceptible to theft, loss or compromise.
- *Non-Invasive* - unlike retinal screening, iris recognition is non-contact and quick, offering unmatched accuracy when compared to any other security alternative.
- *Versatile* – Designed to work for one to many and 1-1 matching, or verification, making the technology ideal for use in multifactor authentication environments where PINs are used.
- As it is designed to work in 1-n or exhaustive search mode, it is ideal for handling large databases without degradation in authentication accuracy

There are very few limitations such as small target (1 cm) to acquire from a distance (1 m) and moving target.

The output of proposed Iris Recognition System can be integrated into the Electronic Control Unit (ECU) of the automobile to ensure the security of vehicle in case of theft action. The future work can be detection of state of drowsiness using the same algorithm for by capturing complete closeness of both eyes. This can ensure the safety of driver in fatigue cases along with security while driving.

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Sintu Punnoose has completed Bachelors of Engineering (B.E.) in Instrumentation and Control Engineering, University of Delhi, 2009-2013, and is currently pursuing Masters of Technology (M.Tech.) in Electronics and Control Engineering, SRM University, 2013-2015. Current research work is progressing on the novel MEMS based alcohol sensor for ensuring safety of driver during drunk and driving cases. By combing the iris recognition system produced in this paper and the MEMS based alcohol sensor, to the electronic control unit of the automobile, one can ensure both safety and security of the driver.

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