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Security Based on Sclera Recognition

Sohail Patel[1], Abhishek Bhurke[2], Krish Thakkar[3], Sulochana Madachane[4]
[1, 2, 3, 4]Computer Engineering, K.C. College of Engineering & Management Studies & Research, Mumbai, India

Abstract: In this research we have portrayed one of the biometric method that is Sclera recognition. As the sclera patterns are uncommon for every human, it can be replaced or combined with fingerprint, face and voice recognition. Different filters are applied to differentiate the sclera patterns and identify them. The blood vessel of sclera is different for each human being so we can use it for human identification. In image processing, a Gabor filter is a linear filter used for texture analysis, which essentially means that it analyzes whether there is any specific frequency content in the image in specific directions in a localized region around the point or region of analysis. Gabor filters are bandpass filters which are used in image processing for feature extraction. In this project we will convert image to grayscale image and than all the filters will be applied for identification.
(Keywords: sclera recognition, grayscale images, Gabor filter)

I. INTRODUCTION

Biometric is the analysis of some unique physical or behavioral characteristics for human identification. There are many different methods for human identification like face recognition, iris recognition, fingerprint recognition and voice recognition but every recognition has some downside which will hinder the human identification. Sclera recognition will have more precise and efficient than other identification methods as it uses blood veins which are unique and do not change for human being. Sclera is the white part of an eye and the vessels do not change by any factors. Sclera recognition can also be combined with different biometric human identifications to get more precise results which can further help to achieve more efficient human-identifications.

II. REVIEW OF LITERATURE

Many methodologies have been proposed to analyze human eye features for frontal looking eye such as iris or sclera vein in an automated fashion. A large percentage of such works utilize pattern recognition techniques to model and extract the features of human eye from gray scale images of human eye, however additionally, color images of human eye have also been taken into consideration to improve recognition process.

A. R. Derakhshani, A. Ross, and S. Crihalmeanu - A new Biometric Modality based on Conjunctival Vasculature

In an early study the research on conjunctival vasculature feature has been done. The authors showed that the conjunctival vessels can be observed on the visible part of the sclera that is exposed to the outside world. These vessels demonstrate rich and specific patterns in visible light, and can be easily photographed using a regular digital camera. In this paper the methods for conjunctival imaging, preprocessing, and feature extraction in order to derive a suitable conjunctival vascular template for biometric authentication have been used. The authors introduced and discussed a new modality for personal identification using the patterns of ocular surface vessels residing in the episclera and conjunctiva. Experimental results suggest the potential of using conjunctival vasculature as a biometric measure.

B. R. Derakhshani and A. Ross - A Texture-Based Neural NetworkClassifier for Biometric Identification Using Ocular Surface Vasculature

The authors have introduced a texture-based classification scheme for conjunctival vasculature biometrics. Using the established Wavelet-derived features and neural network classifiers for a new application domain, they have shown the potential of conjunctival biometrics as a standalone authentication system using ordinary
photographic setup. This new biometric modality also has the potential of adding precision and security to existing iris biometric systems. The experimental results, based on the evidence of 50 subjects, indicate the potential of the proposed scheme to characterize the individualityof the ocularsurface vascular patterns and further confirm the assertion that these patterns are indeed unique across individuals.

C. Mohammad Hossein Khosravi and Reza Safabakhsh - Human eye sclera detection and tracking using a modified time-adaptive self-organizing map

This paper proposed a new method for human eye sclera detection and tracking its movements in a sequence of images based on a modified time-adaptive self-organizing map (TASOM)-based active contour models (ACMs). The method starts with skin color segmentation followed by eye strip localization via a novel morphological method. Next, localization of the eye components such as iris, eyelids, and eye corners is carried out. Eye features such as the iris center or eye corners are detected through the iris edge information. TASOM-based ACM is used to extract the inner boundary of the eye. Finally, by tracking the changes in the neighborhood characteristics of the eye-boundary estimating neurons, the eyes are tracked effectively. This paper introduced a new method for finding the winning neuron, a new definition for unused neurons, and a new method of feature selection and application to the network. Experimental results show a very good performance for the proposed method in general.

D. J. R. Parker and A. Q. Duong - Gaze Tracking: A Sclera Recognition Approach

This paper introduces new techniques devised to create a gaze tracking system that relies solely on image processing and pattern analysis. This study starts with the method for locating the eye region. This includes three steps- Finding eye region boundary, finding eye major axis, compute eye region point. Then the gaze calculation has been done. Now, sclera detection lies at the root of successful gaze tracking because it is used to find both the iris center and the eye-region point. The experiments showed that this system was able to calculate a gaze coordinate with an accuracy of 1.5 centimeter radius

E. Z. Luo and T. Lin - Detection of non-iris region in the iris recognition

In this paper a detection approach of non-iris region in the iris segment has been proposed. Based on mathematical morphology knowledge, it firstly introduced an exclusion method of eyelid and eyelash, then the proposed method has shown the process of combining edge detection with least squares method to locate eyelid, using double threshold to detect eyelash. The reflection spot can also be detected with threshold method. The experimental results show that this method may detect non iris region accurately and effectively, and can exclude it from the iris region.

F. N. L. Thomas, Y. Du, and Z. Zhou - A new Approach for Sclera Vein Recognition

The authors proposed a new method for sclera recognition. First, a color-based sclera region estimation scheme for sclera segmentation has been developed. Thus the sclera portion of the human eye has been extracted. Second, a Gabor wavelet-based sclera pattern enhancement method, and an adaptive thresholding method to emphasize and binarize the sclera vein patterns has been implemented. This increased the possibility to extract sclera vein pattern in a better way. Third, they proposed a line descriptor based feature extraction, registration, and matching method i.e. illumination-, scale-, orientation-, and deformation-invariant, and can mitigate the multi-layered deformation effects exhibited in the sclera and tolerate segmentation error. The algorithm had been verified using the UBIRIS database that the proposed method can perform accurate sclera recognition.

G. Zhi Zhou, Eliza Yingzi Du, N. Luke Thomas, and Edward J. Delp - Multi angle Sclera Recognition System

The authors modelled a multi-angle sclera recognition method. In first step the frontal sclera segmentation has been done. For the frontal-looking images, quality measure will be applied to assess the quality of the images. Then the sclera feature has been extracted and matched. This process was also applied to the angular looking eye images. In the process of segmentation the estimation of glare area was done first. Then the iris boundary detection and sclera area detection was done. After refining the eyelids and iris the segmented sclera has been achieved. The IUPUI green wavelength database has been used for the experiment. The experimental results showed that these proposed multi-angle sclera recognition fusion methods can improve the performance of sclera recognition systems in general.

H. Tatiana Tambouratzis and Michael Masouris - GA-Based Iris/Sclera Boundary Detection for Biometric Iris Identification.

In this paper a novel approach to iris boundary detection has been presented, featuring a genetic algorithm (GA) for outer iris boundary detection. First the inner iris boundary has been detected using Integro-differential operators (IDO), the Hough transform (HT), Canny edge detection (CED) and intensity thresholding (IT) .Thus the IBC(inner boundary circle) has been calculated. Then the IDO, CED, and HT have been combined for OBC (outer boundary circle) calculation. This novel genetic algorithm-based approach to outer iris boundary and inner iris boundary extraction has been found accurate when it has been applied on the CASIA v1.0 and CASIA v2.0 databases.

I. Fernando Alonso-Fernandez and Josef Bigun - Iris Boundaries Segmentation Using the Generalized Structure Tensor. A Study on the Effects of Image Degradation.

In this the authors have presented a iris segmentation algorithm based on the Generalized Structure Tensor (GST), which also includes an eyelid detection procedure. Apart from a correlation of edge magnitudes, the GST takes into account the direction of the edges. The segmentation has been done by removing specular reflections and coarse pupil detection. After segmentation, we obtain the centre/radius of the two circles that approximates the iris boundaries, and the coordinates of the four cross points (if exist) between the eyelids and the sclera boundary. We also compute the straight line that crosses the upper/lower pair of cross points, so regions above/below are discarded. First the pupil has been detected using the circular filter of variable radius. The sclera portion also has been detected using the same technique. Then the iris occlusion detection has been done. After applying on CASIA-Iris V3-Interval database the GST algorithm has always got top performance for all levels of degradation, with similar performance than the others in pupil detection, and clearly better performance for sclera detection. Eyelids and eyelashes occluding the iris region are noise factors that degrade the performance of iris recognition. If they are incorrectly classified as the iris region, the false iris pattern information will increase, decreasing the recognition rate. So, there was a need of proper eyelid and eyelash detection algorithm.

J. M. Abdullah-Al-Wadud and Oksam Chae - Skin Segmentation Using Color Distance Map and Water-flow Property.

In this authors have presented an adaptive skin segmentation algorithm. The method has basically run using an explicit threshold based skin cluster classifier and has provided enhanced performance in varying imaging conditions. They have used a color distance map (CDM) that can be generated without prior knowledge about current image. The CDM itself is a grayscale image, which has made the algorithm very simple. However, it is still capable of providing color information based on which some skin and non-skin seed regions can be determined reliably. Furthermore, this algorithm has applied a water-flow based algorithm to generate solid and perfect skin regions without generating much noisy segments. Experimental results have showed that the proposed approach was better than applying the traditional skin cluster classifier itself.

K. M. Abdullah-Al-Wadud and Oksam Chae - Region-of-Interest Selection for Skin Detection Based Applications.

In this authors have proposed a simple and reliable approach for skin region segmentation to generate region-of-interest (ROI) for various human computer interaction based applications. An adaptive skin segmentation algorithm has been presented, which is very much reliable and flexible to generate ROI for human-related image processing applications. The method has basically run using an explicit skin cluster classifiers to enhance its performance in varying imaging conditions. The authors has made use of a standard skin color (SSC), based on which a distance map has been generated. The distance map itself is a grayscale image making the procedure

III. METHODOLOGY

A. Input image:- How to capture the image and load it on our system?

Any image capturing device can be used to capture the image of the eye. The device can be anything like digital cameras, mobile phones, high definition cameras, DSLR etc. better and advance the camera, better is the quality of the image. Now the image captured by the device should be 1st saved in our system, now this image must be taken as an input for the further processing. To take the image as input, we need to browse the computer and open the image from the location at which the image is been saved. That location path can either be copied or applied as an input or open the image directly. Once we click on open, the image of the eye will appear on the simulation box of MATLAB software.

B. How to browse image?

Click on input image in MATLAB simulation software, a dialog box will open. Now search for the location or folder where the image to be taken as input is saved. After finding that location choose the image file, the file should be in ―.tif or .jpg‖ format. Select the file which you wish to load and click on open.Thus image will open and this image will be our input image on which we will start our processing.

C. Color To Grayscale And Green Plane Conversion

In photography and computing, a grayscale or greyscale digital image is an image in which the value of each pixel is a single sample, that is, it carries only intensity information. Images of this sort, also known as black-and-white, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest.

Grayscale images are distinct from one-bit bi-tonal black-and-white images, which in the context of computer imaging are images with only the two colors, black, and white (also called bilevel or binary images). Grayscale images have many shades of gray in between. Grayscale images are often the result of measuring the intensity of light at each pixel in a single band of the electromagnetic spectrum (e.g. infrared, visible light, ultraviolet, etc.), and in such cases they are monochromatic proper when only a given frequency is captured. But also they can be synthesized from a full color image; see the section about converting to grayscale. Now we have the input image, it is in a coloured image but for our segmentation process and other processes that we use in our program we have to convert this image to grayscale. We convert the image in grayscale to get it in binary form i.e. 1‘s and 0‘s. We do this conversion since all systems process on binary codes. The binary format will provide us with proper segregation of black and white colours. So accordingly we can add or remove data from image. We can also invert the image with the help of these 0‘s and 1‘s just by complimenting them. Thus in order convert the images into binary and grayscale we use this operation which is predefined in MATLAB software. The image we get from the input block is been converted into grayscale. Now, we apply color division plane to get more accurate vein pattern. Thus we divide our image in red, green, blue plane. Red plane:- here the features like vein patterns are not visible because the color of our veins is also red thus it cannot differentiate between the vein and other parts of our eye.Blue plane:- here the image quality is good and the vein patterns which we require also visible, but the man drawback here is; the devise will not be able to differentiate between the sclera and iris of people with blue iris. As if we go in European countries most of the people have blue iris. Thus blue plane is not recommended. Green plane:- here all the features are distinguished than blue plane. The vein pattern is visible thoroughly which makes it best plane for segmentation. The glare area, iris area, and other unwanted parts are visible properly thus makes us easy to remove this unwanted parts.

D. Sclera Segmentation

Segmentation is a process where all the unwanted area of our eye are removed. These areas act as a noise towards system. This leads the device to provide wrong output. It is essential for us to remove this noise otherwise the system would not work efficiently. Segmentation consist of following steps

1) Glare estimation
2) Boundary estimation and detection
3) Eyelid and iris detection
4) Sclera area detection
5) Edge detection and removal.

a) *Glare Estimation:* There is some bright part in the centre of our eye usually known as glare. This glare acts as noise and causes error within the system. So it is necessary to remove glare. We usually use sobel filter to remove this glare. After removal of glare, the images we get are glare free. The image needs to be free of noise in order for further processing. Glare area is usually a small bright part in the Iris or Pupil. Glare inside the pupil or nearby the pupil can be modelled as a bright object on darker backgrounds. After using sobel filter the glare area will be removed from the desired region and we will get a glare free image.
b) *Sobel Operator:* The Sobel operator, sometimes called Sobel Filter, is used in image processing and computer vision, particularly within edge detection algorithms, and creates an image which emphasizes edges and transitions. It is named after Irwin Sobel, who presented the idea of an "Isotropic 3x3 Image Gradient Operator" at a talk at the Stanford Artificial Intelligence Project (SAIP) in 1968.[1] Technically, it is a discrete differentiation operator, computing an approximation of the gradient of the image intensity function. At each point in the image, the result of the Sobel operator is either the corresponding gradient vector or the norm of this vector. The Sobel operator is based on convolving the image with a small, separable, and integer valued filter in horizontal and vertical direction and is therefore relatively inexpensive in terms of computations. On the other hand, the gradient approximation that it produces is relatively crude, in particular for high frequency variations in the image. The Kayyali operator for edge detection is another operator generated from Sobel operator.
c) *Iris Boundary Detection:* We have to remove iris, eyelids, eyelashes and edges from the image in order to get only sclera area Basically Iris boundary is detected by taking the center of the iris and putting up cross points, these cross points provides us with iris boundaries. In this process, we get the boundaries of iris and other noise. Iris and Eyelash removal:- After detecting eyelids and eyelashes, we remove them by cropping and resizing the image.

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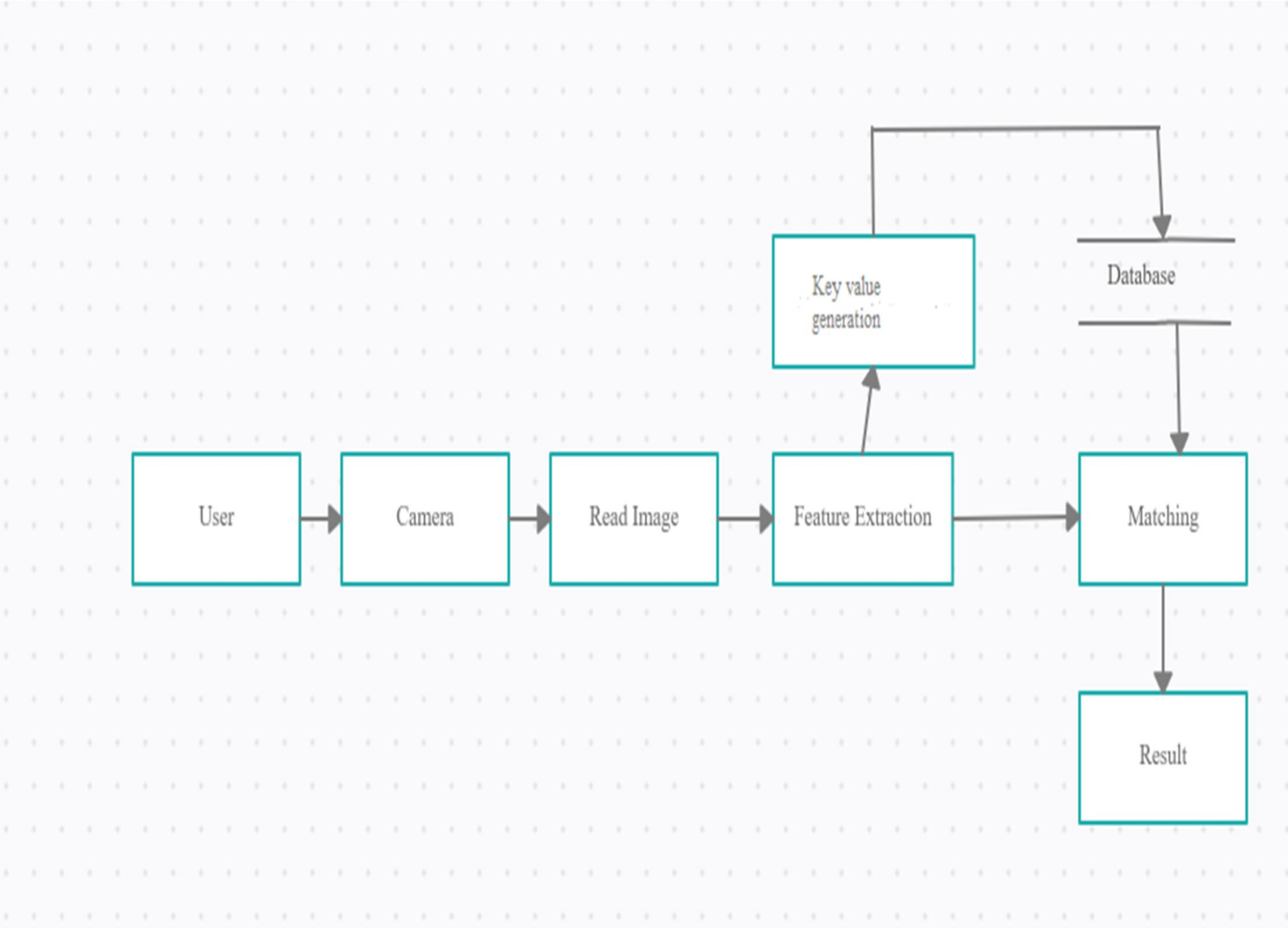
E. Feature Enhancement

It is a process of applying Gabor filter. This filter is used to enhanced the image. We need this function of image enhancement just because to convert our image into a blur image so that the excess part of our eye can be easily removed using the feature extraction process.

F. Canny Edge Detection

For iris segmentation, canny edge detection is used. It is edge detection operation that uses a multi-stage algorithm to detect a wide range of edges in images. This algorithm has several stages of operation. They are noise reduction, finding the intensity gradient of the image, non-maximum suppression, tracing edges through the image and hysteresis thresholding. The canny algorithm contains number of adjustable parameters, which can affect the computation time and effectiveness of the algorithm, size of the Gaussian filter and thresholds. The size of the Gaussian filter, the smoothing filter used in the first stage directly affects the results of the canny algorithm. Smaller filters cause fewer blurring, and permit recognition of small, jagged lines. A superior filter causes more smearing, blurring, out the value of a given pixel over a larger area of the image. Superior blurring radii are more useful for detecting larger, smoother edges – for instance, the edge of a rainbow. The use of two thresholds with hysteresis allows more flexibility than in a conventional threshold approach, but common problems of thresholding methods still concern. A threshold set too high can miss important information. On the other hand, a threshold set too low will falsely identify irrelevant information (such as noise) as significant. It is hard to give a standard threshold that works well on every image. No tried and hardened approach to this.



Block Diagram

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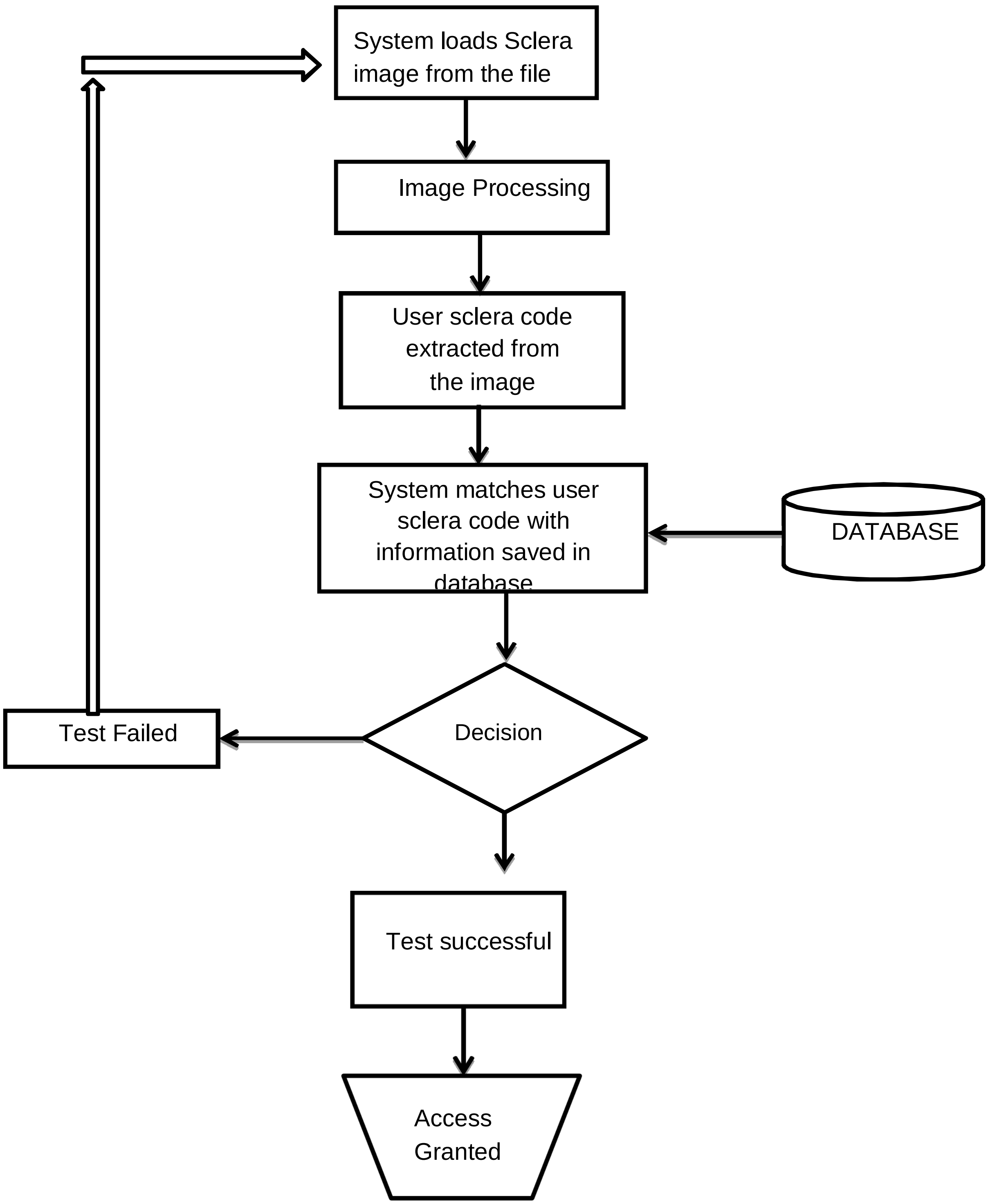

Flow Chart

IV. CONCLUSION

In this research, we have put forward one of the biometric method that is Sclera recognition. Our project will provide new alternative for human verification. This project mainly favours on capturing sclera images and processing and extraction from the image. Moreover we can combine it with other recognitions like iris and face recognition to perform multiple biometric recognitions. As we all know that off-angle sclera image segmentation and recognition will be an interesting and challenging research topic. Currently, the proposed system is implemented in Matlab. The processing speed can be dramatically reduced by parallel computing approaches.

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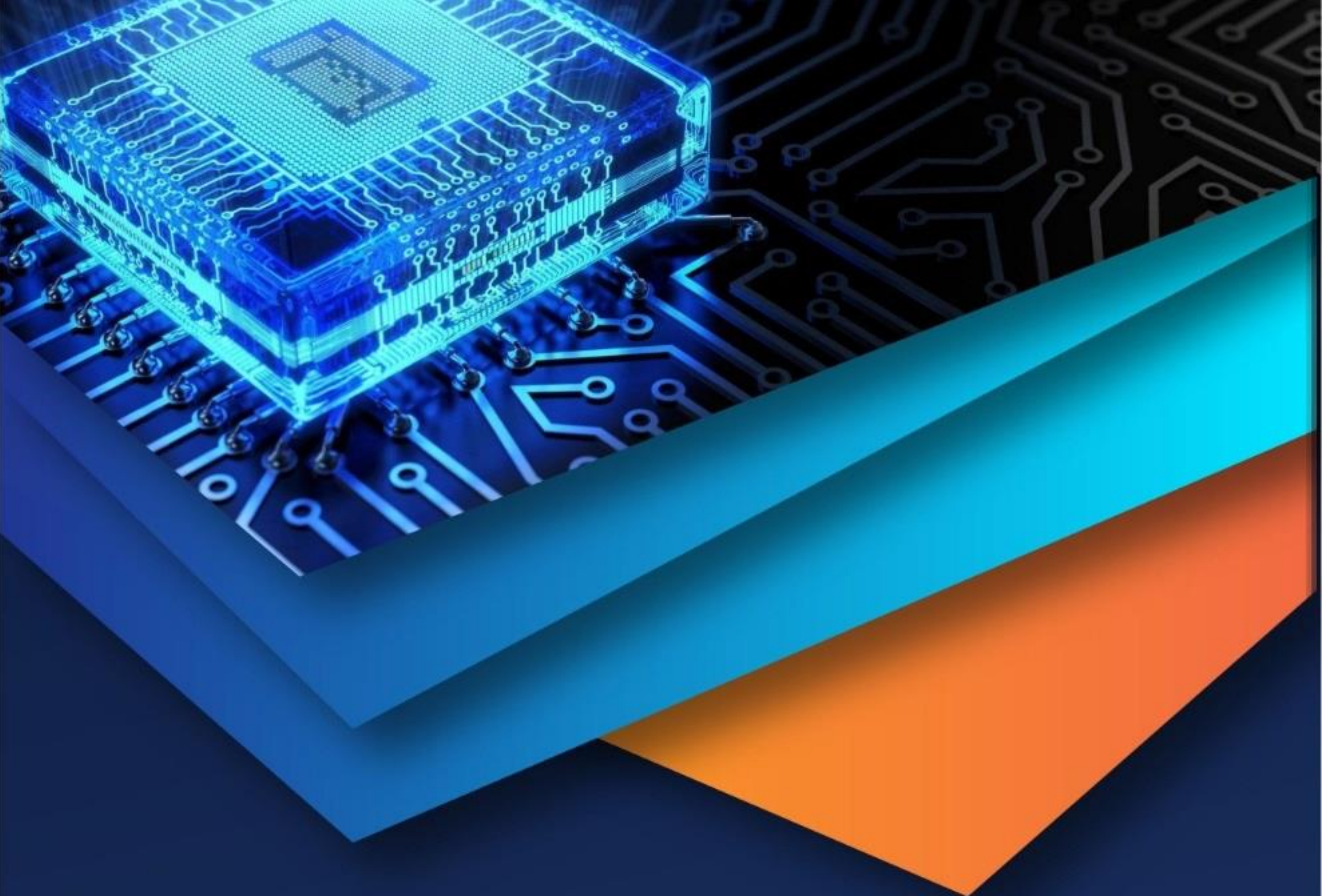

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