Iris Edge Detection with Bit-Plane Slicing Technique

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ABSTRACT
Today's emerging trend in security systems demands for more authenticate, reliable and fast algorithms to implement biometric system. To deal with the security, physical characteristics like face, iris, fingerprint, etc and behavioral characteristics like DNA, signature, voice etc., plays an important role than personal identification number (PIN) and passwords. The human physical and behavioral characteristics are the biometrics traits used to achieve security. In this busy world, the identification and / or verification should be fast and efficient. This paper provides the study of iris edge detection using bit plane slicing techniques which helps to extract edges as better iris features and get the better recognition results. It has been observed that Canny's edge detection is computationally more expensive but gives better results. The technique has been tested on CASIA V 1 and it has been observed that the fifth bit plane iris image is better image for feature extraction with Canny Edge Detection.

Keywords
Security**,** Biometrics, Biometric Authentication, Iris Recognition, Canny Edge Detection, Bit-plane Slicing

1. INTRODUCTION
Person authentication has always been an attractive goal in computer vision and biometrics. The increasing Intrusive attacks on banking sector have led to rapid development of personal identification or verification system based on Biometrics. An E-security is the most critical need to find accurate, secure and cost-effective alternative for PIN (Personal Identification Number) and password. [5] The basic need for every person is to secure their data, information and most importantly money. Biometric data is unique and non-transferable. That is why biometric solutions are useful to solve these problems. Biometric is the method which identifies and / or verify a person automatically by using either physiological or behavioural characteristics. [6]

Iris is the most reliable biometric among all the biometric traits such as fingerprint, face, palm, retina, voice, signature etc., because of its non-invasive nature, uniqueness and stability. [4]

Iris is the unique organ which offers highest accuracy in identifying any individual. Two irises are alike between two identical twins and even between left and right eye of a single individual. Irises are stable throughout the life. The iris pattern is formed only once by ten month of the age of gestation in the womb of a mother. [7] Iris has various features such as pigment frill, collarette, and crypts etc. (see Figure 1) [8]

The iris image may have some irrelevant information such as pupil, eyelashes, reflection etc. The main difficulty in iris recognition is to find perceptible feature points in the image and to keep their representation high with efficient way. Even the identification and/or verification process should provide high accuracy. This is achieved by localizing the iris image correctly. The localization step is crucial as the falsely represented iris may lead to corrupted iris template and generate the poor result. [9] The iris localization requires correct edge detectio

While capturing the image which is the first step in digital image processing; due to motion or interference some disturbance, blur etc., is added automatically in the image. This is called noise. The features can not be extracted correctly from such images. To improve the quality of image, enhancement techniques such as edge sharpening, noise removal etc are used. [1]

To extract the correct features, the correct region of interest is required. This region of interest is segmented to extract meaningful information from it. The segmentation process may include edge detection and edge detection can also be used for feature extraction.

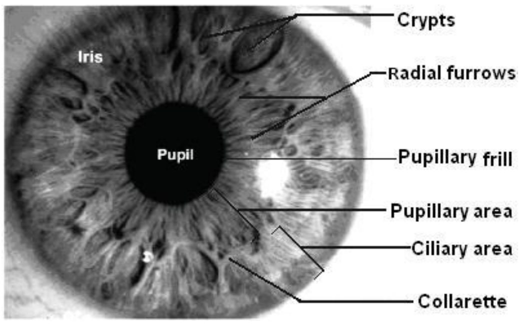

Fig 1: Structure of an Iris

This paper provides the study of iris edge detection using bit-plane slicing techniques which will help to extract edges as better iris features using Canny Edge detection technique and get the better recognition results. The content of this paper are as follows. The following section describes literature review. Iris localization is discussed in section 3. In section 4, different edge detection techniques are discussed. Section 5 shows the practical implementation of this paper. Section 6 discusses the results and its analysis and Section 7 concludes the paper.

2. LITRATURE REVIEW
Different edge detection techniques were used by various researchers to get better iris recognition. Bodade et al. had detected edges of UBIRIS database successfully and achieved the better recognition with complex wavelet. [4] Nabti et al., used multi-scale edge operator and achieved 99.5% iris recognition rate. [9] Liu et al. had also used canny edge operator on JLUBR-IRIS database which has 200 iris images. They achieved high accuracy and effectiveness in iris recognition. [10] Conjeti et al. used canny operator on CASIA database which has 756 iris images and the recognition rate achieved as 99.82%. [11] Bindra et al., used Sobel operator to analyse the texture information of an iris and achieved recognition rate as 90.90%. [12] The researchers have applied canny edge detection technique for iris edge detection but no

one has combined bit-plane slicing technique with edge detection.

Sai et al. Used bit-plane for content based image retrieval with pixel distribution. [13] But it was not applied on iris image. Bui et al., had applied bit plane for stenography. [14] Ardizzone et al., had applied bit plane to recover the digitized damaged photos. [15] Sathik et al., had used bit-plane slicing for feature extraction of coloured X-ray images. [16]

There are very few researchers who had used bit plane slicing for iris edge detection. The iris recognition rate depends on the iris localization and edge detection techniques used.

3. IRIS LOCALIZATION

Segmentation is a process to partition any image in group of pixels. It can be done locally [i.e. segmenting sub-images] or globally [i.e. segmenting whole image]. The number of pixels available in local segmentation is less than that of global segmentation. There are three views of global segmentation namely region approach, boundary approach and edge approach. [1] The original iris image from CASIA V 1 (see Figure 2) and its localized iris image (see Figure 3) is used for implementation. [17]

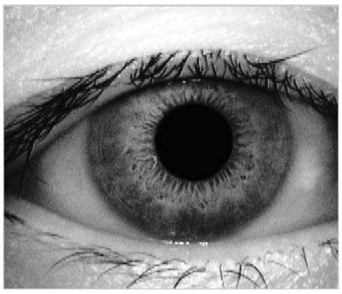

Fig 2: An Iris Image (CASIA V 1)

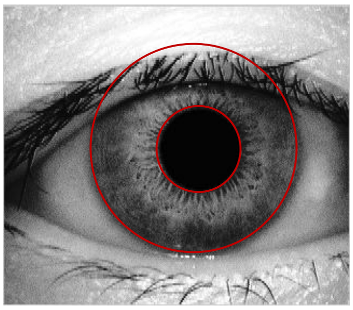

Fig 3: Result of Localized Iris

4. EDGE DETECTION

Edge detection is a process of identifying the areas in an iris image where a large change in intensity occurs. There are various operators available for edge detection such as Canny, Prewitt, Roberts, and Sobel etc. The Prewitt operator is very sensitive to noise. And it does not consider the high frequency variation. The Roberts operator works well only when the acquired image has very less noise and well defined edges. The Sobel operator is similar to Prewitt operator except it uses 3X3 mask called convolution kernel. [1, 2]

The Canny operator was invented by John F. Canny in 1986. It finds the edges by looking for the local maxima of the gradient of an image. The derivative of Gaussian filter is used to calculate the gradient. It uses first derivative to compute the edges and second derivative to compute directions of the edges. This method detects the strong and weak edges. By canny operator only those weak edges are detected which are connected to strong edges. This operator is based on three basic objectives i.e. low error rate, well localized edge points and single edge point response. [2, 7]

5. IMPLEMENTATION WITH BIT-PLANE

In this paper, the edge detection technique is used as a pre-processing technique where iris localization is more important. The iris localization can be done by finding the pupil [inner] boundary and iris [outer] boundary. Bit plane slicing is a technique for constructing a processor and it highlights the contribution made by a specific bit and each bit-plane is a binary image.

In place of highlighting the gray level images, highlighting the contribution made to total image appearance by specific bit is very important. Each pixel in an image is represented by 8 bits. Consider and imagine that the image is composed of 8 bits, say 1-bit planes ranging from bit plane 0 (LSB) to bit plane 7 (MSB). The plane 0 contains all lowest order bits in the bytes comprising the pixels in the image and plane 7 contains all high order bits. (see Figure 4, Figure 5). [1]

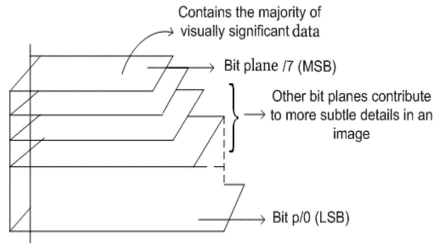

Fig 4: Bit-planes with details

Separating a digital image into its bit planes is useful for analysing the importance played by each bit of the image and it determines the adequacy of numbers of bits used to quantize each pixel. This is useful for image compression. In terms of bit-plane extraction for a 8-bit image, it is seen that binary image for bit plane 7 is obtained by proceeding the input image with a thresholding gray-level transformation function which maps all levels between 0 and 127 to one level (e.g. 0) and maps all levels from 129 to 253 to another (e.g. 255). Black means bit 0 and white means bit 1. [21]

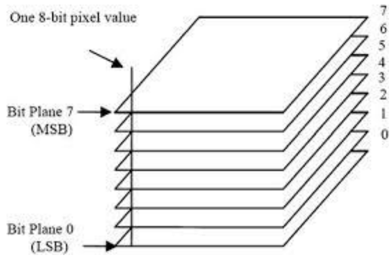

Fig 5: Bit-Planes

Slicing the image at different bit-planes plays an important role in image processing. An application of this technique is data compression. We can slice an image into the following bit-planes. Zero is the least significant bit (LSB) and 7 is the most significant bit (MSB):

1. 0 which results in a binary image, i.e. odd and even pixels are displayed
2. 1 which displays all pixels with bit 1 set: 0000.0010
3. 2 which displays all pixels with bit 2 set: 0000.0100

4. 3 which displays all pixels with bit 3 set: 0000.1000
5. 4 which displays all pixels with bit 4 set: 0001.0000
6. 5 which displays all pixels with bit 5 set: 0010.0000
7. 6 which displays all pixels with bit 6 set: 0100.0000
8. 7 which displays all pixels with bit 7 set: 1000.0000

Before applying edge detection techniques, bit slicing is applied on iris image to get separate bit planes. The 0^{th} bit plane consists of LSB (Least Significant bits) and 7^{th} bit plane is MSB (Most Significant Bits) which contains the majority of visually significant data. The change in the bit of LSB does not change the encoded gray value much. The implementation is done using MatLab R2012a with core2 Duo Intel processor with 2 GHz speed. The following steps were carried out.

Step 1: Acquire the Database

Step 2: convert image to gray scale

Step 3: Histogram Equalization

Step 4: Bit plane slicing

Step 5: Edge Detection with Canny

6. RESULT AND ANALYSIS

The implemented iris recognition system is tested with various images. It has been observed the results are similar with different images. This section displays the results to ensure the effect of each step.

6.1 Reading image from database

The implementation is done on freely available database i.e. CASIA 1.0 which includes 756 images. [17] The iris image is read from the stored database and its histogram is displayed. (see Figure Figure 6).

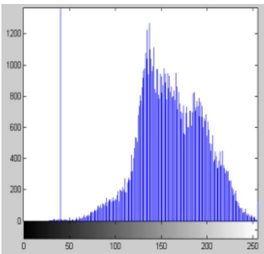

Fig 6: Histogram of Original Iris Image

6.2 Convert image to gray scale

Coloured image take more time for computation and more space for storage. But gray scale image takes less memory space for storage and less computation time. The CASIA images are by default gray in colour. There is no need to convert them in gray scale.

6.3 Enhance the Image

The contrast is increased by histogram equalization. For all the gray levels, uniform histogram is given. The contrast of the image is increased by evenly distributing the pixels of an image. It basically treats an image as a probability distribution and then finds the cumulative distribution. But this method may not always provide the better result. [3]

6.4 Bit-plane slicing and Edge Detection

The bit plane slicing is applied on iris image and then canny edge detection operator is applied on each bit plane. It is very difficult to find inner and outer boundaries of iris and the edge features in zeroth and first bit-plane. (see Figure 7).

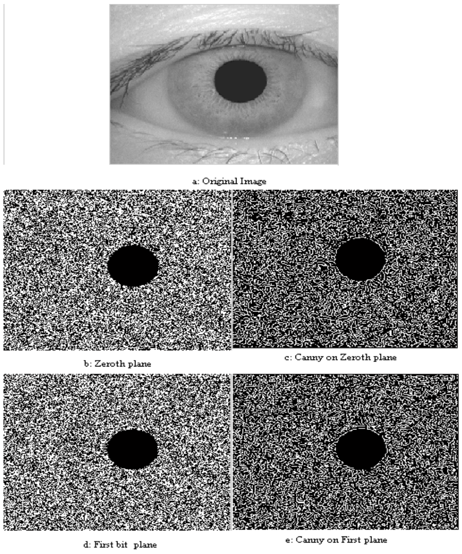

Fig 7: Canny Method on Zero and First Bit Plane

Different threshold values can be applied on canny operator to find edges. It detects wide range of edges in iris image. Some algorithms based on the result of edge detection and edge detection algorithms are not sufficient for illumination in an image. [19] Canny edge detection is used to generate the edge map image. The large intensity gradients are more likely to correspond to small intensity gradients. In most of the cases it is impossible to specify a threshold at which a given intensity gradient switches from corresponding to an edge into not doing so. Therefore canny uses threshold. Only the stronger edges can be detected by controlling the parameter of canny operator e.g. size of the Gaussian Filter, upper and lower threshold and sigma of Gaussian filter. [18]

From the result of second and third bit plane with canny, it is difficult to find inner, outer boundaries and edges correctly. The lower bit planes are completely black. But fifth, sixth and seventh bit planes shows inner and outer boundaries of iris and recognizes edges correctly. (see Figure 8, Figure 9, Figure 10) When compared, it has been observed that the sixth and seventh bit plane shows few edges of the iris than that of fifth bit plane. From fifth bit plane more edge features of iris are recognized as it contains the majority of visually significant data.

6.5 Comparison of Result

The proposed technique is compared with existing techniques where bit-plane slicing is not used. The results are better in our approach. (see Table 1).

Table 1. Comparison with Existing Techniques

Name	CRR (%)
Conjgeti et al [11]	99.82%
Raida et al [20]	92.00%
Hanane et al [22]	97.22%
Our Approach	93.25%

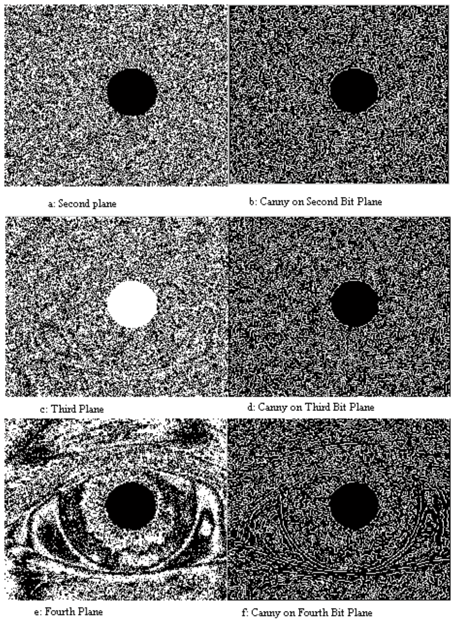

Fig 8: Canny Method on Second, Third and Fourth Bit Plane

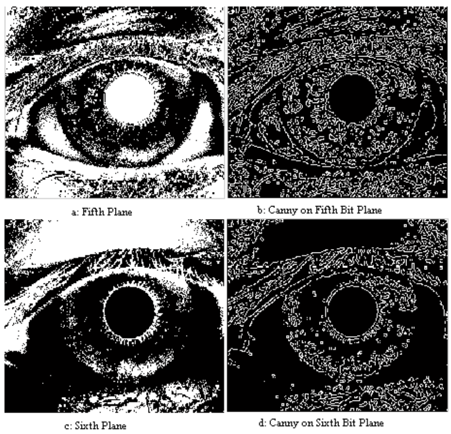

Fig 9: Canny Method on Fifth and Sixth Bit Plane

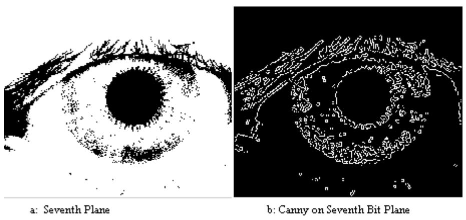

Fig 10: Canny Method on Seventh Bit Plane

7. CONCLUSION

Edge detection is the initial step in any recognition technique. canny operator finds all the strong edges and those weak edges which are connected to strong edges also. Therefore the edge features can be extracted easily and correctly with canny operator. Though canny operator provides better results, computationally it is more expensive. In this paper, the most commonly used edge detection technique was studied such as canny which is applied on all the seven bit planes and found that the fifth bit plane is better to recognize edges correctly. The implementation is done using MatLab R2012a on core2 Duo with 200 GHz speed.

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