

# Iris Image Compression Using JPEG & Its Effect on Recognition Performance

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**Abstract**— A biometric system provides automatic identification of a person based on a unique feature or characteristic possessed by the person. Iris recognition is proven to be one of the most accurate of all biometric technologies used today for identifying people. Iris recognition works by recognizing individuals from their iris texture with great precision in which system captures an image of an individual's eye, the iris in the image is then meant for the further segmentation and normalization for extracting its feature. So for storing these images the need for large databases of iris images is growing. If available storage space is not adequate for storing these images, compression will be a solution, which allows reduction in the space needed to store these iris images, although it may be at a cost of some amount of information lost in the process. In this paper compression of iris images using JPEG is implemented, in order to study their impact on recognition performance. Standard iris images are 600 times larger than the Iris Code templates, but it is administratively desired that iris data should be stored, transmitted, and embedded in media in the form of images rather than as templates. To get that goal with its implications for bandwidth and storage, a scheme is presented that combine region-of-interest isolation with JPEG compression at different quality factor. Study reveals minimal impact on recognition performance with compressed iris images.

**Index Terms**—Iris recognition, Hamming Distance(HD), JPEG, ROI, ROC Curve, segmentation, Canny Edge Detection, Hough Transform Gradient Calculation

## 1 INTRODUCTION

Biometrics is the science of automatically recognition of persons based on one or more unique physiological or behavioral characteristics. The Iris recognition has proved, to be one of the most accurate Biometrics technology used today. The purpose of 'Iris Recognition' is to recognize a person from his/her iris prints, which is currently a very active field of research. Many applications that require security such as banking, computer network access or physical access to a secure facility are moving away from the use of paper or plastic identity cards, or alpha-numeric passwords because these systems are very easy to defeat. A higher degree of security can be achieved by using unique physical and/or behavioral characteristics to identify a person and this is called biometrics. In order to use biometrics for identification, the biometric data must be collected by some means from the individuals. This may be a costly and time consuming process, and the data obtained is very valuable and it must be protected. Also the data collected will be huge amount & it puts limit on the available storage. To deal this problem, one possible solution is compression. In this paper, it is investigated that the iris image can be compressed without affecting the biometric templates. Data compression in biometrics is also important because governments, regulatory bodies, and international standards organizations always specify that biometric data must be recorded and stored in a raw form, rather than in (or in addition to) post-processed templates that may depend on

proprietary algorithms. Enrolling or storing raw image data is useful because it makes the databases more "future-proof" since they can benefit from inevitable future improvements in recognition algorithms, simply by enrolling a new the raw data. Also, the directive for, standards bodies like ISO [1] and industry consortia such as RTIC [2] that embed biometric data into smart cards is to avoid incorporating patented techniques into data formats and Standards, as that would effectively confer monopolies. But storing raw images instead of templates can simply increases the size of data thousand times, with problems such as greatly increased data transmission times and inability to fit the raw data in the allocated space in smart cards, which in the case of the RTIC specification [2] for iris images is a mere 4,000 bytes per eye. Hence the need of compression, and about the effects of image compression on recognition performance, becomes very important.

So in summary, both for fundamental scientific reasons related to information theory, and also for practical reasons related to Standards, data formats, and storage media, it is important that how much of raw image data is really needed for biometric recognition technologies to perform effectively? In this paper JPEG compression schemes is used for compression of iris image that retain rectilinear image formats but achieve severe compression at different levels, still offer very good recognition performance on the CASIA publicly available iris image database.

## 2. IRIS TEMPLATE EXTRACTION

Following flow chart will illustrate the steps involved in Iris template Extraction from eye image for iris Recognition process. [4]

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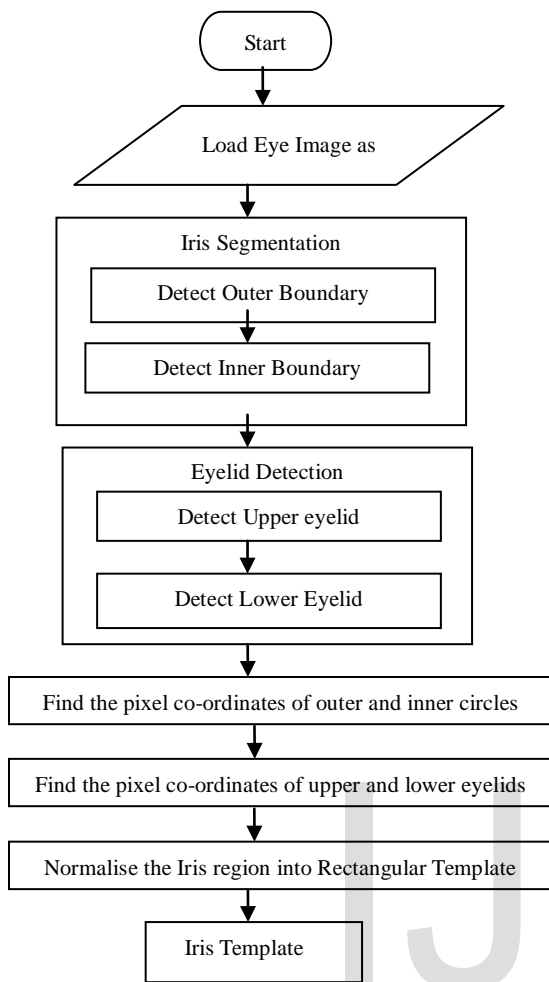


Figure 1. Flow chart of iris template extraction

## 2.1. Image Segmentation

The main objective here is to remove non useful information, namely the pupil segment and the part outside the iris (sclera, eyelids, skin). [3].The segmentation step detects the boundaries of iris region. The segmented region is then converted into template in the normalization step. In segmentation, firstly edges from the input eye image are detected using the edge detector step.

### Stages in Segmentation

- Edge detection.
- Finding a circle.
- Eyelid detection

#### 2.1.1 Edge Detection.

Edges characterize object boundaries and are therefore a problem of fundamental importance in image processing [4]. Edges in images are areas with strong intensity contrast i.e. a jump in intensity from one pixel to the next. In segmentation process to detect the iris boundary, it is necessary to create an edge map. The Canny edge detection principle is used to generate an edge map. The Canny edge detection algorithm consists of following steps:

- Smooth the image with a Gaussian filter,
- Compute the gradient of image.
- Apply nonmaxima suppression to the gradient image,
- Use double thresholding algorithm to detect and link edges.

#### ➤ Smoothing:

The smoothing of image is done to suppress the noise. Noise is associated with high frequency, the noise suppression means suppression of high frequencies. The input eye image is firstly smoothed using a Gaussian Filter.

#### ➤ Gradient Calculation:

The Motivation of gradient operators is to detect changes in image function. Change in pixel value corresponds to large gradient value. Gradient operators are based on local derivatives of image function. So, derivatives are larger at locations where image function undergoes rapid change. Gradient operators have effect of suppressing only the low frequencies in Fourier transform domain.

#### ➤ Nonmaxima Suppression:

In this approach, an edge point is defined to be a point whose strength is locally maximum in the direction of the gradient. This means that zero value is assigned everywhere except the local maxima points. At the local maxima points the value is preserved and all other values are marked as zeros. This process, which results in one pixel wide ridges, is called as non-maxima suppression.

#### ➤ Hysteresis Thresholding:

In spite of smoothing performed as a first step in edge detection, the nonmaxima suppressed magnitude image will contain many false edge fragments caused by noise and fine texture. The contrast of the false edge fragments is small. These false edge fragments in the nonmaxima suppressed image should be reduced. One typical procedure is to apply a threshold to nonmaxima suppressed magnitude image. The threshold T is decided such that a prominent edge map is created. All values below threshold are set to zero. After application of threshold to the non maxima suppressed magnitude image, containing the edges detected in the image is obtained.

#### 2.1.2 Hough Transform.

In above step after finding the edge map of input eye image by canny edge detector, next step is to find radius and centre co-ordinates of the outer and inner circular boundary of iris region. Here the radius and centre co-ordinates of both the circles are to be found. The Hough transform is used to determine parameters of simple geometric objects, such as lines, ellipses and circles, present in an image. The circular Hough transform is employed to find out the radius and centre coordinates of the circular boundary of pupil and iris outer boundary.

#### 2.1.3 Eyelids and Eyelashes Detection

The eyelashes and Eyelids do not contain any useful information. The segmented image obtained so far contains redundant information which is not required and acts like noise. So, this redundant information has to be eliminated and processed further. Firstly edges are detected using the canny edge detector and then horizontal lines are detected. Eyelids are isolated by first fitting a line to the upper and lower eyelid using the linear Hough transform.

## 2.2. Iris Normalization

Once the iris region is successfully segmented from an eye image, the next stage is to transform the iris region so that it has fixed dimensions in order to allow comparisons. The images of iris taken at different time or in different place have many differences, even though images are taken from the same person, because elastic deformations of the pupil will affect the size of iris. The dimensional inconsistencies between eye images are mainly due to the stretching of the iris caused by pupil dilation from varying levels of illumination.

For the purpose of achieving more accurate recognition results, it is necessary to compensate for such deformation. To compensate the difference and improve the precision of matching, iris normalization is necessary. In the normalization process the iris region is converted from rectangular co-ordinate system  $(x, y)$  to polar coordinate system  $(r, \theta)$ . The respective polar co-ordinates are given by,

$$r = \sqrt{x^2 + y^2} \quad \text{and} \quad \theta = \tan^{-1}(y/x)$$

The normalization process will produce iris regions, which have the same constant dimensions, so that two photographs of the same iris under different conditions will have characteristic features at the same spatial location. The rubber sheet model takes into account pupil dilation and size inconsistencies in order to produce a normalized representation with constant dimensions. The template is generated after normalization process. This is the template generated using rectangular to polar co-ordinate conversion. These kinds of templates are generated for each individual and are stored in the database.

## 3. JPEG COMPRESSION

JPEG (Joint Photographic Experts Group) is an international compression standard for continuous-tone still image, both grayscale and color. This standard is designed to support a wide variety of applications for continuous-tone images. JPEG transformation is based on Discrete Cosine Transformation. [5]

### 3.1 Block of 8 × 8

JPEG compression technique start by subdividing the input image into 8 × 8 Blocks, which are processed left to right, top to bottom.

### 3.2 Discrete Cosine Transformation (DCT)

After dividing image in to 8×8 next step is to passed through the DCT program. The purpose of the DCT is to transform the value of pixels to the spatial frequencies which are much related to the level of detail present in an image. A high spatial frequency corresponds to high levels of detail, while lower frequencies correspond to lower levels of detail.

### 3.3 Quantizer.

The next step in the compression process is to quantize the transformed coefficients. Quantization is simply the process of reducing the number of bits needed to store an integer value by reducing the percentage of the integer. The JPEG algorithm implements quantization using a quantization matrix. Each DCT coefficient is divided by the corresponding quantizer step-size parameter in the quantization matrix and rounded to the nearest integer as

$$\text{Quantization value (i, j)} = \frac{\text{DCT(i, j)}}{\text{Quantization matrix(i, j)}}$$

The result is rounded to nearest integer.

From the formula it is clear that the quantization values will be virtually zero as we move to higher value of  $(i, j)$ .

### 3.4 Zigzag ordering:

The Next step in JPEG process is coding of the quantized image. In this the quantized image is arranged in a row using the Zig Zag sequence. The reason for this zig-zag traversing is that we traverse the 8×8 DCT coefficients in the order of increasing the spatial frequencies.

### 3.5 Entropy coding:

Final step in JPEG compression will be Entropy coding. It creates a fixed or variable-length code to represent the quantizer's output and maps the output in accordance with the code.

Decoder of JPEG compression perform in exactly reverse manner as Encoder performs

## 4. PROPOSED WORK

Figure 2 will illustrate flow chart of the proposed work.

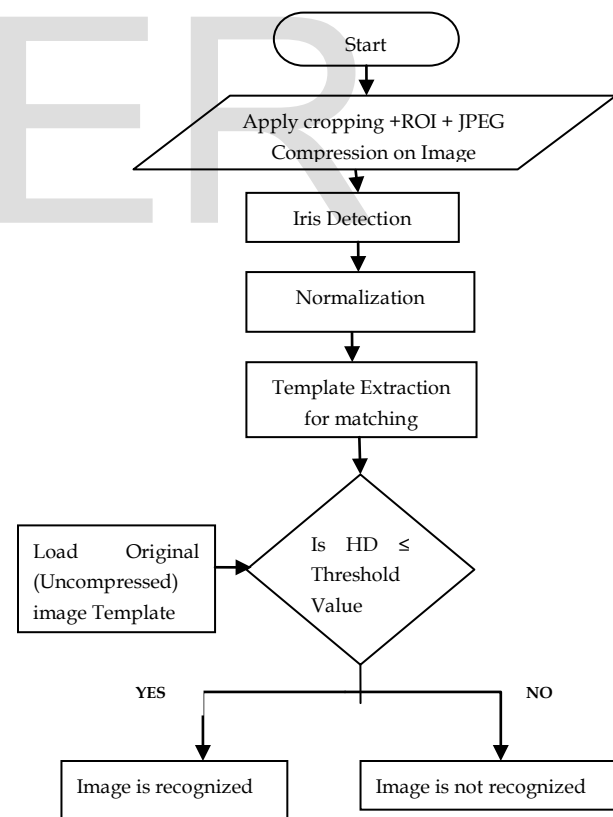


Figure 2. Flow chart of proposed work

First by using Hough transform we are extracting the iris template of the original image as explained in flow chart of figure 1 & stored in data base. Than original image is

compressed by using JPEG algorithm using different quality factor & each compressed iris eye image template is also extracted & stored for compression purpose. Then we compare the original image template with different JPEG compressed image template using Hamming Distance (HD) criteria. Based on that we are concluding that whether compressed image is recognized or not.

#### 4.1. Simple cropping

Our first step is to reduce image data size from the standard iris image format of  $320 \times 280$  pixels with 8 bits grayscale data per pixel, consuming 89600 bytes, is to crop the image to a smaller region containing the iris, because the total eye image contain region which are not essential for iris recognition and then we perform JPEG compression on this cropped image.

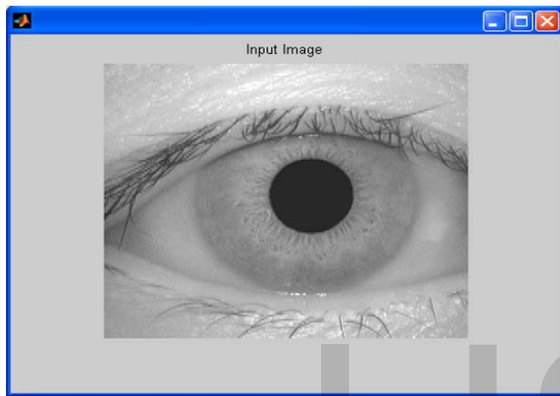


Figure 3. Original Eye Image

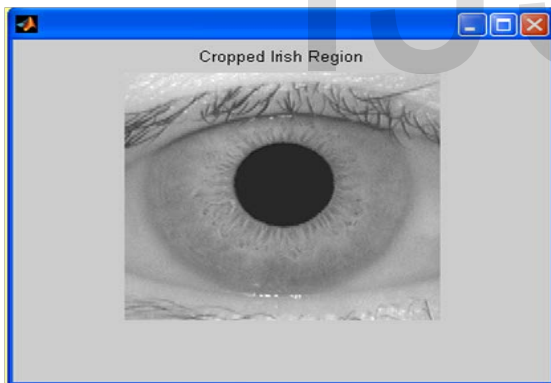


Figure 4. Cropped Eye Image

Figure 3 shows original image & figure 4 shows image obtain after applying cropping. The cropping tool manually correctly localized the iris in all images and produced from each one a new cropped image with the iris centered in it. The new gallery of grayscale eye images with is obtained & then perform JPEG compression by various factors specified as quality factors (QF).

#### 4.2 JPEG compression with Region of interest (ROI) segmentation.

The JPEG coding scheme [6, 7] efficiently allocates bytes on an “as needed” basis, that means the cost of encoding uniform regions of an image is almost zero, but image areas containing busy textures such as eyelashes & consume much

of the available information budget. In uniform regions, the only non-zero DCT (discrete cosine transform) coefficient in each block of 64 frequency components that encode an  $8 \times 8$  pixel block (data unit) is the DC coefficient specifying their average gray value; all other coefficients are 0 if the data unit is a truly uniform region, or else become 0 after lossy quantization, & their cost in the Huffman (run-length) coding stage is essentially nil. But JPEG encoding of iris images can be made more effective if we replaced all non-iris parts of the image with a uniform gray value. This kind of substitution of pixel values within a rectilinear image array is preferable, from the by Standards bodies, than actual extraction and mapping of pixel data from a normalized (“unwrapped”) iris because it is desirable to be as shape-agnostic and as algorithm-neutral as possible[8] JPEG coding schemes fits themselves well with region-of-interest (ROI) differential assignment of the coding budget [9]. Also the even Part 3 extension of the old JPEG standard, support variable quantization for explicitly specifying different quality levels for different image regions. This method was used for biometric face recognition by Hsu and Griffin [10], who demonstrated that recognition performance was degraded by only 2% for file sizes compressed to the range of 10,000 – 20,000 bytes with ROI specification. In this paper it is investigated that how much compression of iris images can be achieved with minimal impact on iris recognition performance, using the ROI idea without “unwrapping” the iris but retaining a rectilinear pixel array format for the reasons mention earlier.

Non-iris regions must be encoded in a way that distinguishes sclera from eyelids or eyelashes regions, so that compression algorithms should be able to determine both types of iris boundaries. Since the substitution gray levels are uniform, their coding cost is minimum and could be further reduced by using larger data units. Examples of such ROI segmentation within the rectilinear image array format are shown in below Figure 5. For any quality factor the result of iris ROI isolation is nearly two-fold reduction in file size while maintaining a simple rectilinear image format and easy localization of eyelid boundaries in later stages.

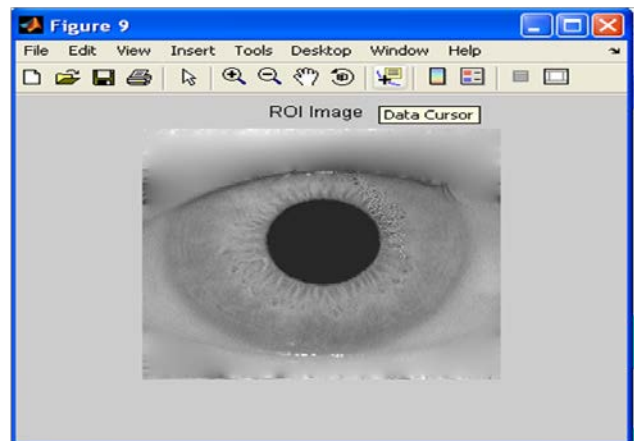


Figure 5. Cropped & ROI Eye Image

## 5. RESULT AND DISCUSSION

In this paper the effect of iris image compression on recognition performance by using JPEG as a compression algorithm



was studied[11]. A cropped & JPEG compressed iris image is shown in figure 6 where as Figure 7 show the same image but now compressed by JPEG algorithm & ROI isolation

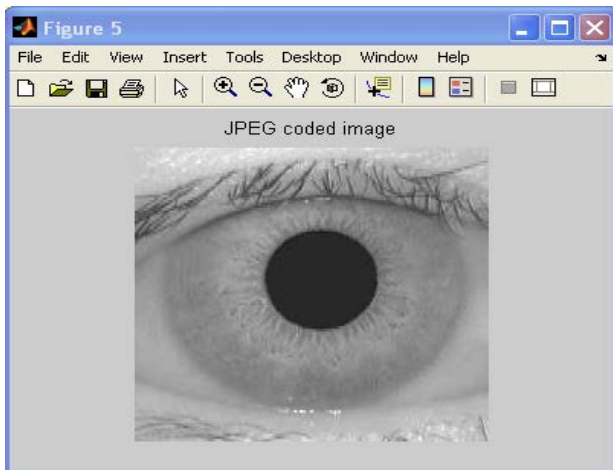


Figure 6. Cropped & JPEG compressed eye Image without ROI

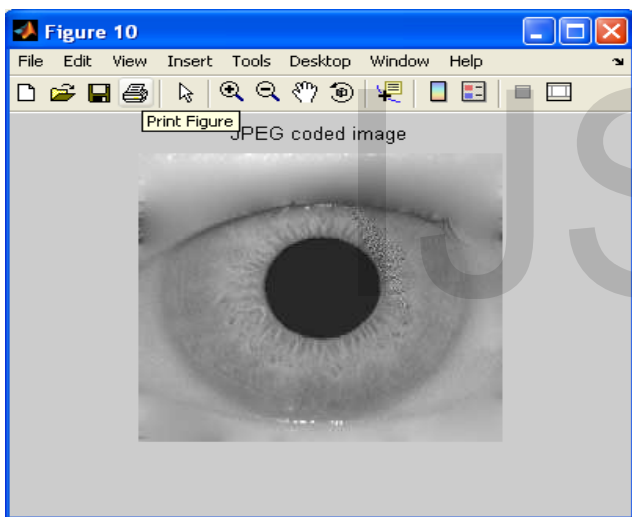


Figure 7 Cropped+ ROI & JPEG compressed eye Image

Biometric recognition performance is usually measured by generating ROC (Receiver Operating Characteristic) curves, which plot the trade-off between two error rates (False Accept and False Reject Rates, FAR and FRR, also called False Match and False non- Match Rates) as the decision threshold for similarity scores is varied from conservative to liberal[11]. It is common to tabulate specific points on such trade-off curves, such as the FRR when the decision threshold causes an FAR of 1 in 1,000 or of 1 in 1,000 and the point at which the two error rates are equal,  $FRR = FAR = EER$ , the Equal Error Rate. Such ROC curves and tabulations are presented in Fig. 8 for the CASIA gallery, both for baseline performance (uncompressed and uncropped: Green curve) and for three JPEG quality factors (colored curves).

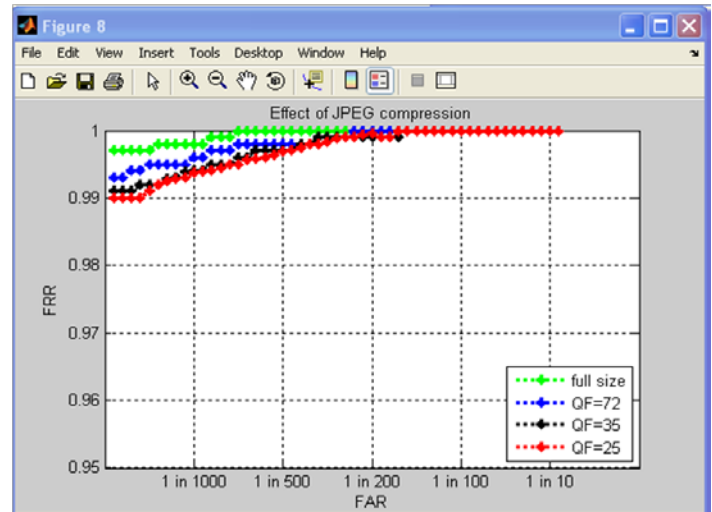


Figure 8 ROC curve for different Quality Factor for JPEG compression without ROI.

Figure 8 shows the ROC curve obtained for JPEG compression. Green line shows the performance of original image, blue line shows the performance of compressed image at quality factor of 72, black line shows performance of compressed image at quality factor of 35 & red line shows performance of compressed image at quality factor of 25. It has been observed from ROC curve that the recognition performance is degraded if we decrease quality factor for JPEG compression.

Figure 9 shows the ROC curve obtained for JPEG compression with ROI. As seen from ROC curve we can analyze that performance will remain somewhat same as without ROI but advantage of ROI is that it reduces the size of iris image two times as compare to without ROI. It has been also observed from ROC curve that the recognition performance is degraded if we decrease quality factor for JPEG compression.

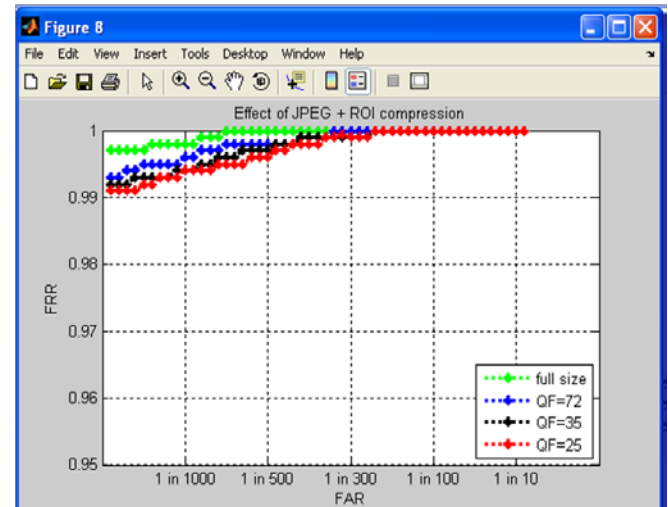


Figure 9: ROC curve for different Quality factor for JPEG compression with ROI

## 6. CONCLUSION

In this paper the effects of image compression on iris recognition performance by using JPEG as compression

algorithm is studied. The iris template of each compressed image & original image, is compared using hamming distance method which leading to the surprising conclusion that even images compressed severely from their original full-size originals, to few Kilo bytes (KB), by using different quality factor it remain serviceable .If quality factor is decreased to very low value it will effect on recognition performance. It is important to use region-of-interest (ROI) isolation of the iris within the image so that the coding budget is allocated almost to the iris & can get highly compressed image. The average HD between such IrisCodes obtained before and after image compression indicate that only about 3% to 5% of the IrisCode bits change as an effect of image compression even though the image is compressed to very small size.

[16] A.V. Kurume "A Novel Image Compression Based on Lifting Wavelet Transform and Modified SPIHT" International Journal of Advanced Research in Computer Science and Software Engineering Volume 3, Issue 6, June 2013

[17] A.Alice Blessie, J. Nalini and S.C.Ramesh " Image Compression Using Wavelet Transform Based on the Lifting Scheme and its Implementation "IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 3, No. 1, May 2011

[18] Amara Graps "An Introduction to Wavelets" *IEEE Computational Science and Engineering, Summer 1995, vol. 2, num. 2, published by the IEEE Computer Society, 10662 Los Vaqueros Circle, Los Alamitos, CA 90720, USA,*

[19] Robert W.Ives , Randy P.Broussard ,Lauuren R.Kennell , David I.Soldan " Effect of image compression on Iris Recognition system performance "Journal of Electronic Imaging17(1).011015(Jan-Mar 2008)

## REFERENCES

[1] International Standard ISO/IEC 19794-6: "Information technology – Biometric data interchange formats – Part 6: Iris image data." ISBN 0-580-46456-3, 2005.

[2]Registered Traveler Interoperability Consortium (RTIC). "Technical Interoperability Specification for the Registered Traveler Program (Version 1.0 – Final),"2006.Available.at:<http://www.rtconsortium.org/>

[3] J. Daugman, "Biometric personal identification system based on iris analysis," U.S. Patent 5 291 560, 1994.

[4] Daugman, J.G., "How Iris Recognition Works", IEEE Transactions on Circuits and Systems for Video Technology, Vol. 14, Number 1, January 2004

[5] Gregory K. Wallace "The JPEG Still Picture Compression Standard "Multimedia Engineering Digital Equipment Corporation Maynard, Massachusetts Submitted in December 1991 for publication in IEEE Transactions on Consumer Electronics

[6] National Institute of Standards and Technology, Iris Challenge Evaluation. Available from: <http://iris.nist.gov/ice/>

[7] G.K. Wallace, "The JPEG still picture compression standard," Comm. of the ACM, vol. 34, no. 4, pp. 30–44, 1991.

[8] J. Daugman & cathryn Dowling, "Effect of Serve Image compression on .iris recognition performance ," IEEE Trans. on Information & Security, March, 2008.

[9] International Standard ISO/IEC 10918: "Information technology – Digital compression and coding of continuous-tone still images," 1994. <http://www.jpeg.org>

[10] R.L.V. Hsu and P. Griffin, "JPEG region of interest compression for face recognition," IDENTIX Document No. RDNJ-04-0102, 2005. 2

[11] S. Rakshit and D.M. Monro, "An evaluation of image sampling and compression for human iris recognition," IEEE Trans. on Forensics and Information Security, in press, 2007.

[12] J. Daugman and C. Downing, "Epigenetic randomness, complexity, and singularity of human iris patterns," Proceedings of the Royal Society, B, vol. 268, Biological Sciences, pp. 1737–1740, 2001.

[13] J. Daugman, "How iris recognition works," IEEE Trans. Circuits and Systems for Video Technology, vol. 14, no. 1, pp. 21–30, 2004.

[14] R.L.V. Hsu and P. Griffin, "JPEG region of interest compression for face recognition," IDENTIX Document No. RDNJ-04-0102, 2005.

[15] M.S. Abdullah, N. Subba Rao" Image Compression using Classical and Lifting based Wavelets" *International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 8, August 2013*