

Iris Recognition with Fake Identification

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Abstract

Iris recognition, the ability to recognize and distinguish individuals by their pattern, is the most reliable biometric in terms of recognition and identification performance. However, performance of these systems is affected by the heterogeneous images (regarding focus, contrast, or brightness) and with several noise factors (iris obstruction and reflection) when the cooperation is not expectable from the subject. Current Iris recognition system does not deal with the noise data and substantially increase their error rates in these conditions. An Iris classification method is proposed on the segmented and normalized iris image that divides the image into six regions, followed by independent feature extraction in each region. This will provide the iris signature in terms of binary values, then that are compared with each region for the identification. In addition to this Fake identification is also done in this paper. Fake, the original image is forged by fixing lenses over the iris portion. This can be identified by using fast Fourier transform.

Keywords: Noncooperative Iris Recognition, Iris Classification, Feature Extraction, Biometrics, Fake Identification.

1. Introduction

The use of biometric systems has been increasingly encouraged by both governments and private entities in order to replace or increase traditional security systems. Biometric is based on a physiological or behavioural characteristic of the person. A biometric system provides automatic recognition of an individual based on some sort of unique feature or characteristic possessed by the individual. Biometric systems have been developed based on fingerprints, facial features, voice, hand geometry (Muron.A 2001), handwriting, the retina, and the iris. Biometric systems work by first capturing a sample of the feature, such as recording a digital sound signal for voice recognition, or taking a digital colour image for face recognition. The sample is then transformed using some sort of mathematical function into a biometric template. The biometric template will provide a normalized, efficient and highly discriminating representation of the feature, which can then be objectively compared with other templates in order to determine identity. Most biometric systems (Gabor.G 1946) allow two modes of operation. An enrolment mode for adding templates

to a database, and an identification mode, where a template is created for an individual and then a match is searched for in the database of pre-enrolled templates.

Assuming that, in spite of noise, the iris was accurately segmented, we propose a classification strategy more robust to noise factors. I observed that, in most cases, the noisy data is localized (Proenca.H 2006) in some of the iris subparts. My method is based on the division of the segmented iris into six regions, followed by the independent feature extraction in each one. Further, through the comparison between signatures extracted from correspondent iris regions, we obtain six dissimilarity values that are fused through a classification rule. The hope is that most of the iris regions are noise-free and that accurate recognition can be achieved, even in highly noisy images. In section 2 basics about iris recognition is discussed. In section 3 proposed methodology is explained and section 4 and 5 deals about result implementation and fake identification respectively.

2. Iris Recognition

Iris is commonly recognized as one of the most reliable biometric measures: it has a random morphogenesis and no genetic penetrance. The iris is a protected internal organ of the eye, located behind the cornea and the aqueous humour. It is the only internal organ of the body that is normally visible externally. Images of the iris adequate for personal identification (Proenca .H 2007) with very high confidence can be acquired from distances of up to about 3 feet (1 meter). The human iris begins to form during the third month of gestation. The structures creating its distinctive pattern are complete by the eighth month of gestation. In fact, the iris patterns are characterized by high level of stability and distinctiveness. Each individual has a unique iris; the difference even exists between identical twins (Daugman.J.G 2004) and between the left and right eye of the same person.

The overall iris recognition system can be given by Fig.1. In 1987 L. Flom and A. Safir studied the problem (Daugman.J.G 1993) and concluded that iris morphology remains stable through all human life, as well estimated the probability for two similar irises on distinct persons at 1 in 1072.

The cooperative behaviour demanded to the users and the highly constrained imaging conditions clearly restrict the range of domains where iris recognition can be applied. It is highly probable that image capturing on less constrained conditions (either at-a-distance, on-the-move, with minor users' cooperation and within dynamic imaging environments) lead to the appearance of extremely heterogeneous (Ma.L 2007) images and with several other types of data in the captured iris regions (e.g., iris obstructions due to eyelids or eyelashes, reflections, off-angle or motion blurred images).

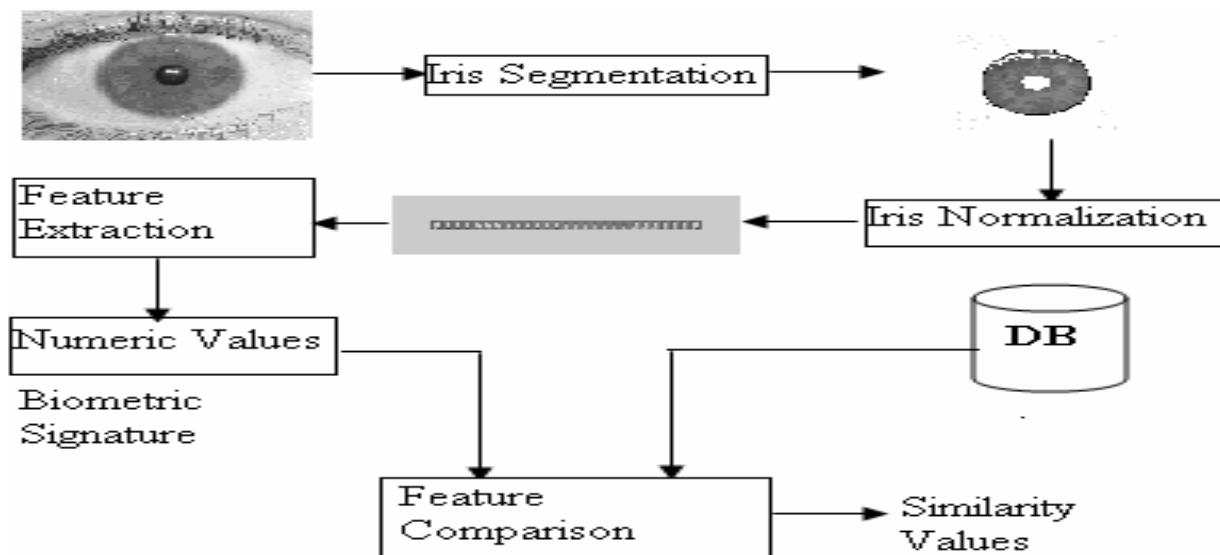


Fig-1: Stages of Iris Recognition

The emerging needs for a safer and quicker access (buildings, weapons, and restricted areas) requires non-cooperative techniques. In this paper, I consider a non-cooperative technique where the user has no active participation in the image-capture process and is not even aware of the recognition process.

As an example, we can think of a building access where users do not need to look through a small hole to have their irises recognized (MA.L 2004), but instead, an image-capture system captures the necessary information from their irises as they approach the door. This is much less invasive and will enable the dissemination of iris recognition systems to everyday applications. Obviously, these image-capture conditions tend to acquire images with more heterogeneous characteristics with respect to reflection areas, brightness and contrast or focus conditions.

Human iris recognition process is basically divided into five steps,

- ❖ Iris Acquisition
- ❖ Localization
- ❖ Normalization
- ❖ Feature Extraction
- ❖ Matching

The first stage of the iris recognition is the iris Acquisition. The eye image can be obtained by using CCD Cameras (Flom.L 1987). For the academic purpose, The CASIS, MMU and the UBIRIS (Chinese academic) provided about thousands of iris images in free of cost. We use both of these CASIA, MMU and UBIRIS databases.

After the image acquisition, (Vatsa.M 2005) the next stage of the iris recognition deals with iris segmentation. This consists of localizing the iris inner (pupillary) and outer (scleric) borders. In 1993, Daugman proposed an integro-differential operator to find both the iris inner and outer borders. Similarly, T.Camus et. al., proposed integro- differential (Kalka .N 2006) operators that search over the IN3 space, with the goal of maximizing the equations that identify the iris borders. Wildes achieved iris segmentation through a gradient-based binary edge map construction followed by circular Hough transform. H.Proenca et. al., proposed a method based on Wildes'' method, which, together with a clustering process, achieved robustness for non cooperative environments.

It is possible to varying the pupil's size depending upon various images and in the imaging distance. In order to compensate these variations, it is usual to translate the segmented iris region into a fixed length and dimensionless polar coordinate system. This stage is usually accomplished through the method proposed by Daugman. The method is termed as Daugman''s Rubber Sheet Model. From the view point of feature extraction, previous iris recognition method can be roughly divided into three major characteristics: Phase-based method, Zero- crossing representation method and texture-analysis based method. Daugman used multiscale quadrature wavelet to extract texture phase structure information of the iris to generate a 2,048-bit iriscode and compared the difference between a pair of iris representation by computing their Hamming distance.

Finally, the obtained iris signature is compared with the database (Wildes.R.P 1997), producing a numeric dissimilarity values. If this value is higher than a threshold, the system outputs a non-match, meaning that each signature belongs to different irises. Otherwise, the system outputs a match, meaning that both signatures were extracted from the same iris. In this stage, it is common to apply different distance metrics (Hamming, Euclidean, Weighted Euclidean), or methods based on signal correlation.

3. Proposed Methodology

3.1. Noncooperative Iris Recognition

The non-cooperative iris recognition is the process of automatic recognition where individuals using images of their iris captured at a distance and without requiring any active participation. It is shown in the following fig. 2

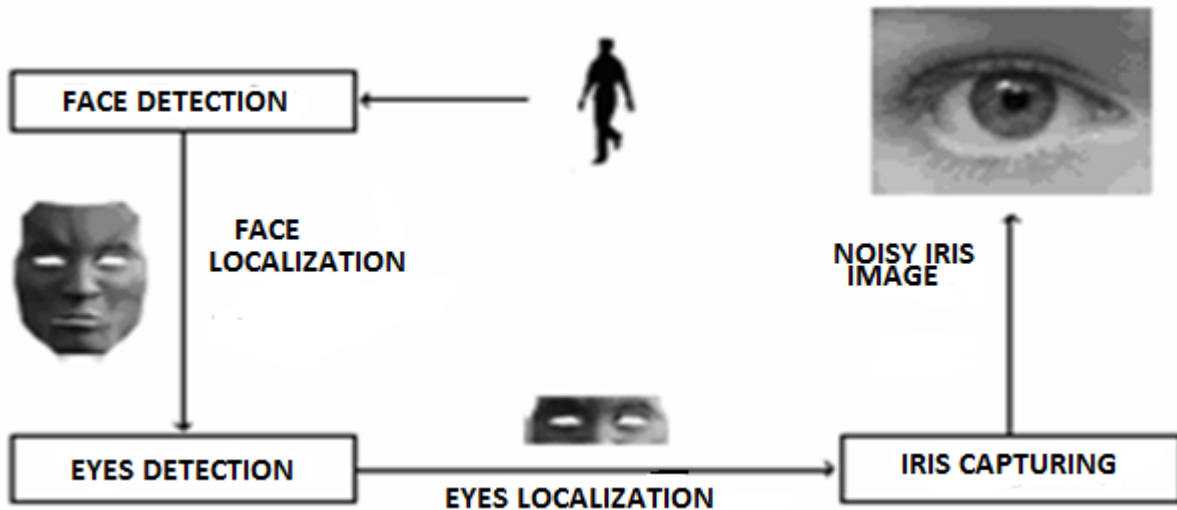


Fig-2: Non-Cooperative System

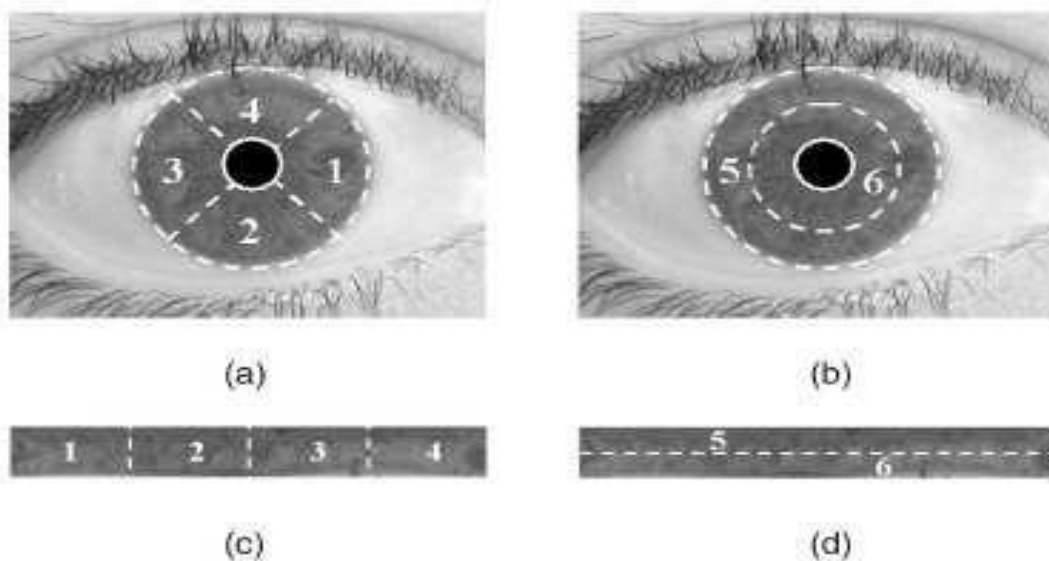


Fig-3: Multiple Signatures

The main drawback of real time implementation of Iris recognition is lies in the segmented image. Where most cases the eye image contains noise such that eyelids, eyelash. These noisy patterns spread across iris and gives less active components of iris patterns. So that the segmentation part of iris is not possibly acquired and it not at all useful for further stages of iris recognition system. The non-cooperative system is possible by applying a new algorithm namely, multiple signature. i.e., the human iris is going to be divided into six regions.

In terms of non cooperative, this increasing the probability of capturing very heterogeneous factor with several noise factors. In most cases, the noisy data is localized in some of the iris subparts. Our method is based on the division of the segmented iris into six regions, followed by the independent feature extraction in each one. Further, through the comparison between signatures extracted from correspondent iris regions, we obtain six dissimilarity values that are fused through a classification rule. The hope is that most of the iris regions are noise-free and that accurate recognition can be achieved, even in highly noisy images. To maintain a good effectiveness of iris recognition, the multiple signature algorithms is applied in the segmentation module.

In the context of non-cooperative recognition, the most relevant value is the accuracy degradation as function of the images" quality. We observed that our method is clearly less dependent of the image characteristics, since it presented the smallest accuracy degradation (Tuceryan 1994) between both sessions - just about 0.14%. This is in contrast with all the remaining methods, especially those proposed by Martin-Roche et al., Daugman and Camus and Wildes. It must be stressed that our method is the one that presented the highest accuracy on images from the second session, indicating that it is well adapted to deal with noisy images. The multiple signature algorithm based on segmentation is shown below:

In fig 3, (a) Division of the iris in four different parts. (b) Division of the iris in "outer" and "inner" parts. (c) Correspondent regions of (a) in the normalized iris image. (d) Correspondent regions of (b) in the normalized iris image.

By comparing with other systems, Wildes" method achieved the best results in absolute terms, having 98.74% accuracy on the first session images. However, as the image quality decreases, its accuracy degraded more than 2%. This fact may indicate that, if we incorporate other noise factors, its accuracy will be strongly affected, which discourages its use in the non-cooperative setting. The implemented variants of this method, both the preprocessing methods and the alternative edge detection algorithms, didn"t get significant improvements when compared to the original method.

My proposal's computation time is about 17% higher than that of Wildes' algorithm; these 17% are used in the feature extraction and clustering process. We consider that with proper algorithm optimization this computation time gap (about 0.3 seconds) will become irrelevant.

Division of the whole iris into six regions is the main concept behind multiple signatures. Here Regions 1 to 4 correspond to successive quadrants of the iris. Regions 5 and 6 correspond, respectively, to the outer and inner parts of the iris.

The main motivation for this division was the observation that the most common types of noise (iris obstructions and reflections) are usual, respectively, in the upper/lower and left/ right portions of the iris. Also, reflections resultants from natural and artificial lighting environments are predominantly localized, respectively, in the outer and inner iris regions. The proposed division strategy minimizes the number of regions simultaneously affected by each type of noise.

Common feature extraction proposals usually focus on the lower and middle-low frequency components of the signal. This implies that small portions of non-detected noise can corrupt the whole biometric signature and decrease the recognition accuracy.

Based on this, we proposed a new iris classification strategy that divides the segmented and normalized iris into six regions and makes an independent feature extraction and comparison for each of these regions. Iris classification is achieved through a fusion rule that uses a threshold set to combine the dissimilarity values resultant from the comparison between correspondent iris regions.

This indicates that the proposed method is adequate for less constrained image capturing environments, such as in a non cooperative setting, and broadens the range of domains where iris recognition can be applied. However, we stress that these results are dependent on the previous accurate iris segmentation, which is highly challenging, given the dynamics of non cooperative environments. The requirement of optical frameworks that are able to capture iris images with enough quality and of real-time face and eye localization methods is assumed too.

4. Implementation Result

4.1 Iris Databases

There are presently seven public and freely available iris image databases for biometric purposes: CASIA, MMU (Camus .T 2002), BATH (Tuceryan 1994), UPOL (Dorairaj.V 2005),

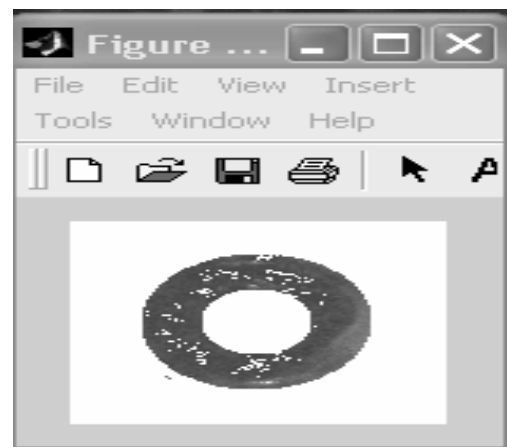
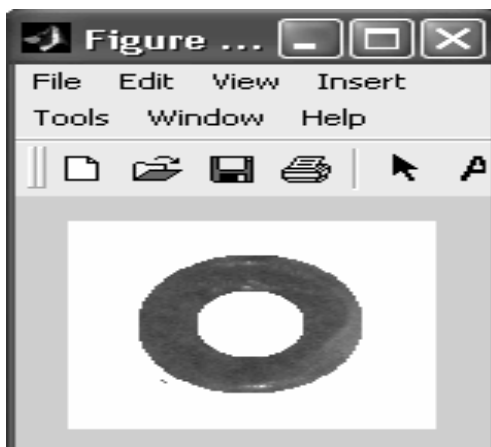
ICE, and UBIRIS. The CASIA database is by far the most widely used for iris biometric purposes. However, its images incorporate few types of noise, almost exclusively related with eyelid and eyelash obstruction, similarly to the images from MMU and BATH databases. UPOL images (Camus .T 2002) were captured with an optometric framework, obtaining optimal images with extremely similar characteristics. Although ICE and WVU databases contain images with more noise factors, their lack of images with significant reflections within the iris rings constitutes a weak point regarding the simulation of Noncooperative imaging conditions. Oppositely, images of the UBIRIS database were captured under natural lighting and heterogenous imaging conditions, which explains their higher heterogeneity. Based on the manual verification of the iris segmentation accuracy in each of the images, we selected 800 images from 80 subjects of the UBIRIS database.

4.2 Description of Experiments

We implemented the recognition method described by Daugman (Flom.L 1987), (Vatsa.M 2005) and compared the obtained results when following the method as described by the author and using the proposed iris division and classification strategies. Initially, we made the feature extraction and comparison using the whole segmented iris, extracting a total of 2,048 bits. Further, according to Fig. 3, we divided the iris into six regions and, through feature extraction, obtained 512 and 1,024 bits, respectively, for the signatures extracted from the iris regions 1 to 4 and 5 to 6.

The Iris recognition method is divided into the following stages:

Segmentation: The segmentation is the first phase of the Iris recognition. This phase can extract only the iris part from the human eye. We implement the circular edge detection method by using canny edge detector for segmentation.

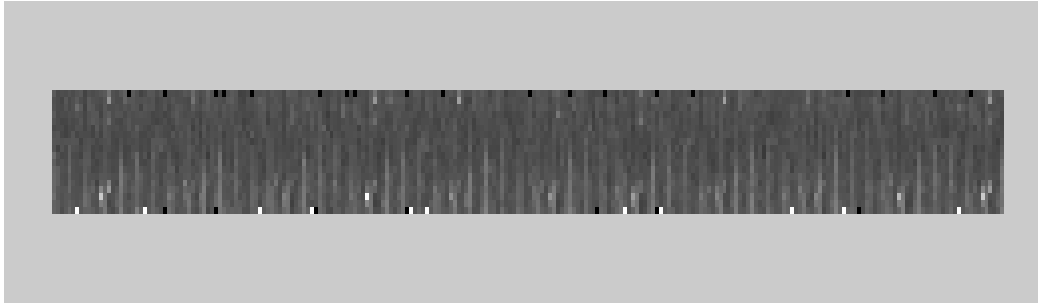


(a)

(b)

Fig-4: (a) Required Segmented Result.

(b) Poor Performance Result

Fig-5: Required Normalization Result with Size of 240×20 .

Initially the segmented result is obtained by removing the pupil and the eyelash. These are removed by using the threshold values, so the performance of the segmentation is not satisfied. Then the segmentation is done without removing eyelash and pupil.

Normalization: After the segmentation of both iris borders, to compensate for the varying size of the pupil and capturing distance, we translated the images into a dimensionless polar coordinate system, according to the process known as the Daugman Rubber Sheet (Flom.L 1987), (Vatsa.M 2005). Generally the segmentation phase will remove the pupil and other than the iris. In order to reduce the complexity of normalization process the segmentation phase itself extracts the required part (as shown in figure 4) from the iris. The output of the normalization will show as below.

Multiple Signature: When we talk about noncooperation, the captured iris images are normally with the noisy one. That is, most of the images are with obstruction and reflection. So the introduction of multiple signature is necessary here. Generally the size of the normalized image is 240×20 . This is going to be divided into six regions as four 60×20 patterns and two 240×10 patterns. The concept of multiple signatures is given as below.

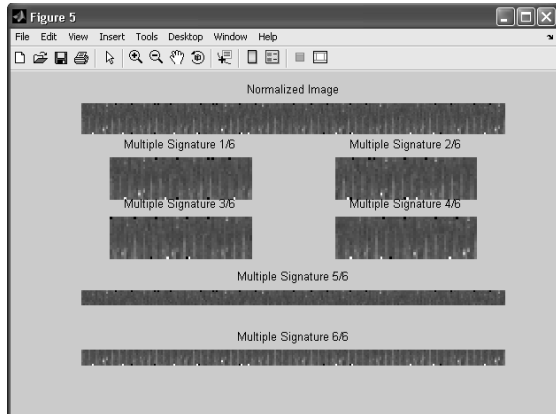


Fig-6: Multiple Signature 1/6, 2/6, 3/6, 4/6 are 60×20 Patterns and Multiple Signature 5/6 and 6/6 are 240×10 patterns

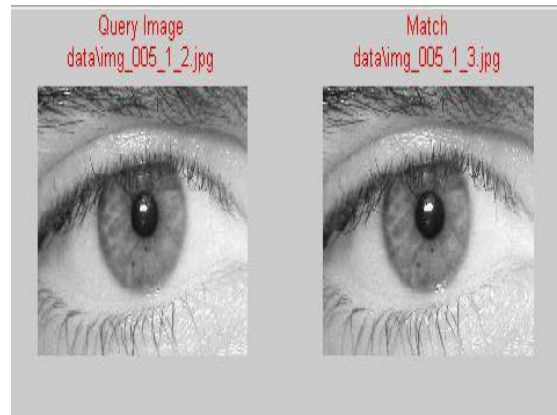


Fig-7: The Input Image Data\img_005_1_2.jpg is Matched with the Database Image data\img_005_1_3.jpg. Here 005 Indicate the 5th Person.

Feature Extraction: This iris data encoding was accomplished through the use of two-dimensional Gabor filter.

Feature Comparison: The binary feature comparison allowed the use of the Hamming distance as the similarity measure between two iris signatures. The output of the final iris recognition is given as above fig.

5. Fake Identification

The fake identification module enables the user to find whether the query image is an original or forged one. If the given image is found to be a fake one, there is no need for iris recognition for that particular image. This can be identified as given in Figure below. That is the difference between the original image and the fake image is shown here. In order to identify the fake image, the FFT (Fast Fourier Transform) (Dorairaj.V 2005) is applied on the given image. When the lenses are fixed over the iris portion the quality of the real image is going to be affected. This added advance can be used for fake identification.

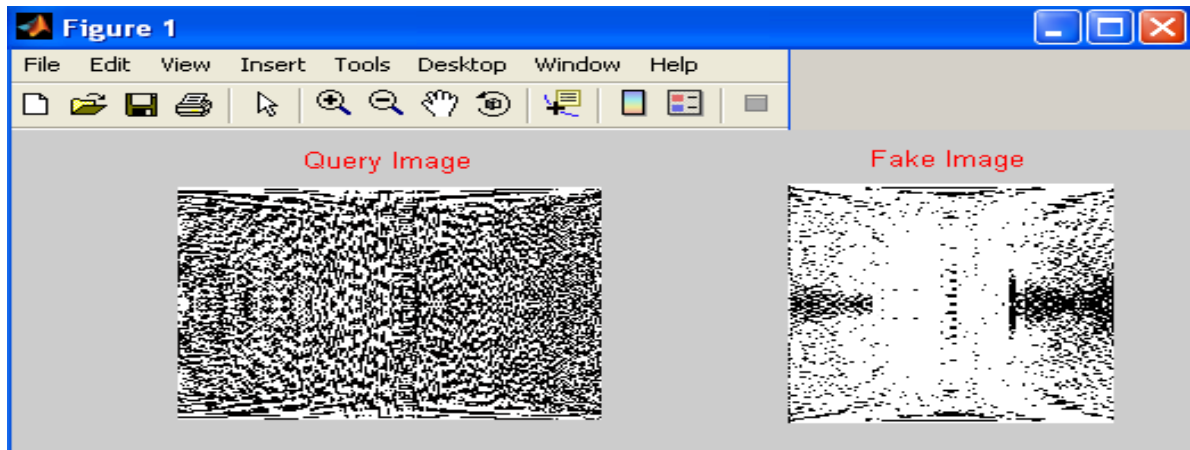


Fig-8: Comparison of Original Image with Fake Image After Applying FFT

6. Conclusion

In this paper, I addressed the problems motivated by the existence of noise in the captured iris images and the correspondent increase of the error rates, with particular relevance to the false rejections, in the context of non cooperative iris recognition. Also fake identification is introduced for the lens images fixing over the iris portion.

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