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FULL REFERENCE IMAGE QUALITY ASSESSMENT FOR BIOMETRIC DETECTION

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Abstract—Biometrics means the identification of a person by using the physiological or behavioral characteristics of that person. It is an essential component in identification, and is being used in large-scale biometrics deployments. With the improvement in assessing power and image analysis techniques, biometric authentication systems are becoming popular. But now a day's these biometric systems are attacked by using several fake biometrics. Hence proposed software based fake detection method that can be used in fingerprint recognition system. The proposed system uses some general image quality measures extracted from the image to differentiate between the real and fake samples. It detects different types of fraudulent access attempts through the use of Full Reference Image Quality Assessment methods and finally SVM classifiers are used for the classification**.**

Keywords— Image Quality Assessment (IQA), Biometrics, SVM **.**

I. INTRODUCTION

Biometric authentication has been receiving considerable attention over the last years due to the increasing demand for automatic person recognition. A biometric system is a pattern-recognition system that distinguishes a person based on the feature vector extracted from a specific physiological or behavioral attribute of that the person. Compared with traditional access control systems based on passwords, biometric fingerprint recognition systems have the advantage that biometric data cannot be lost, and it is based on physical attributes of a person which cannot be stolen as other types of recognition can. Some of the examples of biometric systems include fingerprint, face, iris, hand geometry, and keystroke identification. As with all security measures, a biometric system is dependent on various threats including sensor attacks, replay attacks, and attacks on the database. Fake users first capture the original identities of the genuine user and then they make the fake sample for authentication but biometric system have many methods to detect the fake users and that's why the biometric system is more secure, Because each person have their own unique trait specifications. Most of the earlier protection methods are based on the analysis of some specific properties of a given characteristic that makes a system less secure and more complex. Hence proposed a security method through the use of Image Quality Assessment.

An input biometric sample may have a broad area of quality. Quality of an image represents the quantity of degradation present in an image. The quality of an image cannot be determined by only few parameters like brightness, contrast or sharpness. It requires a normalized way to assess the image quality despite of the type of distortion that has affected the image. In general, quality assessment can be divided into two categories. One is subjective visual quality assessment, and the other one is objective visual quality assessment. As the name implies, the former is done by humans. It shows the ultimate sensible judgment of humans concerning an image, and also the most genuine measure of visual quality among all available means. In this method, quality assessment of an image is done by the human beings, i.e. the human subjects are used to accomplish the task of determining the visual quality. The quality assessment by humans can be obtained by the Mean Opinion Score Method (MOS). In objective visual Quality Assessment, algorithms are used in assessing the quality

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of an image, i.e. we are estimating the perceived image quality automatically. The objective IQA can be classified mainly into three types based on the availability of the reference image namely,

1. Full Reference Image Quality Assessment(FR-IQA)
2. Reduced Reference Image Quality Assessment(RR-IQA)
3. No Reference Image Quality Assessment(NR-IQA)

In Full Reference method, a reference image need to be known and the quality of the distorted test samples can be obtained by comparing with the reference image which is considered to be of high image quality. The image quality measures can be categorized as Error Sensitivity measures, Structural Similarity measures, and Information Theoretic measures [1][2]. Error Sensitivity measures are based on measuring the errors or signal differences between the distorted and reference images. Some of the measures are Mean Squared Error (MSE), Peak Signal to Noise Ratio (PSNR), Maximum Difference (MD) etc. Structural Similarity measures are on the basis of measuring the distortions in an image that due to the variations in lightning such as contrast or brightness changes that are considered adversely from the structural ones. Structural Similarity Index Measure (SSIM) is one of the widely used measures in almost all practical applications.

In Reduced Reference Method, it acquires some information concerning the reference image, but not the actual image itself separately from the distorted image. The feature vector extracted from the reference image is used to assess the image quality.

In No Reference IQA, a reference image is not known. Hence assessment of image is completely based on some common statistical properties of the natural image.

In the present work we propose a software based protection method through the use of Full Reference Image Quality Assessment. It provides a better level of protection against the spoofing and non-spoofing attacks. It presents the advantages: user-friendly, speed and fewer complexes. Since this method operates on the whole image without considering any specific characteristics of a given modality, the computational load needed for the processing is much reduced. The system uses only some general image quality measures, which is easy to compute and classified using SVM classifier.

The rest of the paper is arranged as follows. In the next section, we discuss the proposed method, the features used for the calculation. In section III, screen shots are given. And finally we conclude our paper in section IV.

II. PROPOSED METHOD

Proposed system is software based fake detection method that can be used in biometric systems through the use of Full Reference Image Quality Assessment. A fake image acquired in an attack attempt will always have some different quality than a real sample. In this work, we propose a parameterization using 17 general Full Reference Image Quality measures. A general diagram of the quality measures implemented in the proposed work is given in the Fig. 1. This method operates on the whole image without considering any specific characteristics.ie; it does not require any preprocessing steps in advance to the computation of the Image Quality measures. Hence the computational load needed for the processing is much reduced. After the computation of the quality features, the feature vector extracted from a given sample is classified as real or fake using SVM classifier. Details about the quality measures implemented are given in the following parts of this section.

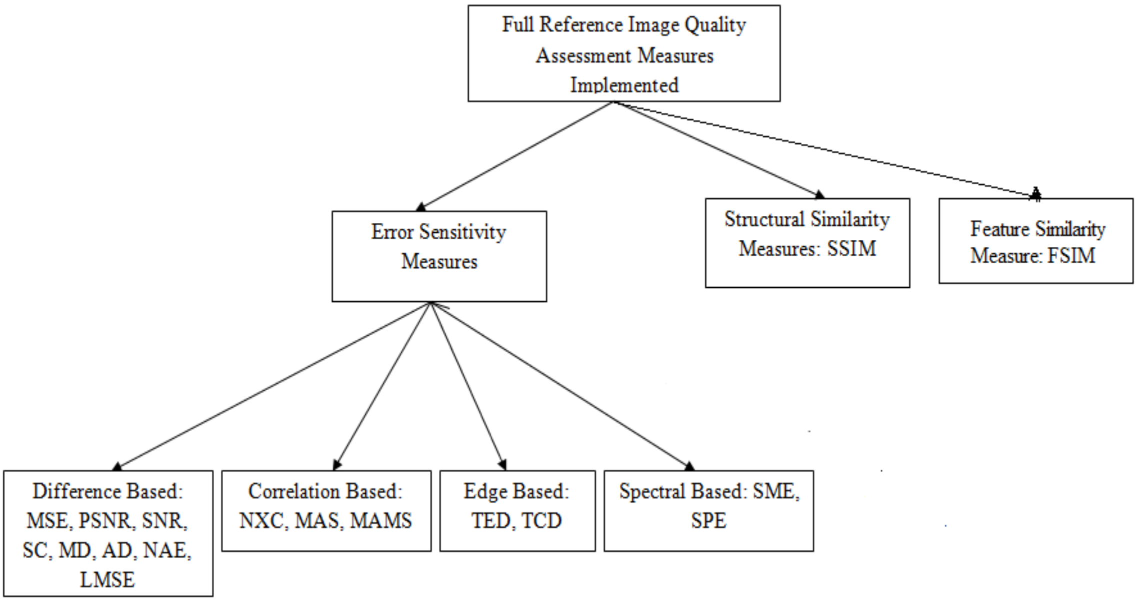

Figure1. Full Reference Image Quality Measures implemented

A. Full-Reference IQA measures

In Full Reference method, a reference image need to be known and the quality of the distorted images can be obtained by comparing with the reference image which is considered to be of high image quality. Mainly they are classified as three sections: Error Sensitivity measures, Structural Similarity measure and Feature Similarity measure.

1. Error Sensitivity measures: The measures under this group are image quality assessment methods based on computing the errors between the distorted and the reference images. These features can be classified here into four different categories according to the image property measured.

- **Pixel-wise Difference measures**

The features included in this category compute the deformity between two images on the basis of their pixel-wise differences. Some of the measures included in this section are: Mean Squared Error (MSE) [3][4], Peak Signal to Noise Ratio (PSNR), Signal to Noise Ratio (SNR), Structural Content (SC), Maximum Difference (MD), Average Difference (AD), Normalized Absolute Error (NAE), and Laplacian Mean Squared Error (LMSE).
The definitions for each of these features are given in the table below. In these I and I’ denotes the original and the reference images respectively of size N×M.

- **Correlation based measures**

The features included in this category can be obtained by computing the statistics of the angles between the pixel vectors of the original and distorted images. Some of the measures included in this section are: Normalized Cross- Correlation (NXC), Mean Angle Similarity (MAS) and Mean Angle Magnitude Similarity (MAMS). In the MAS and MAMS description below, $\alpha_{i,j}$ denotes the angle between two vectors, defined as,

$$\alpha_{i,j} = \frac{2}{\pi} arccos \frac{\langle I_{i,j}, I'_{i,j} \rangle}{\|I_{i,j}\| \cdot \|I'_{i,j}\|}$$

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Where $\langle I_{i,j}, I'_{i,j} \rangle$ denotes the scalar product.

- **Edge based measures**

The features included in this category can be obtained by considering the degradation in the edges and corners, which shows the structural distortion of an image. Edges and corners represent the most informative features of an image and are deployed in much quality assessment applications. Here includes two quality measures: Total Edge Difference (TED) and Total Corner Difference (TCD). The formal definitions for computing these features are included in the table. i) Canny edge detector is used to build the binary edge maps I_E and I'_E. ii) Harris corner detector is used to compute the number of corners N_{cr} and N'_{cr} in the images I and I'.

- **Spectral distance measures**

The Fourier Transform is an important image processing tool which is used to decompose an image into its sine and cosine components. The output of the transformation represents the image in the Fourier or frequency domain, while the input image is the spatial domain equivalent. In the Fourier domain image, each point represents a particular frequency contained in the spatial domain image. Fourier transform is an important image processing tool. It has a wide range of applications. Two spectral related measures included in this work are: Spectral Magnitude Error (SME) and Spectral Phase Error (SPE). In the description given in the table, F and F' are the respective Fourier transforms of I and I' and arg (F) denotes the phase.

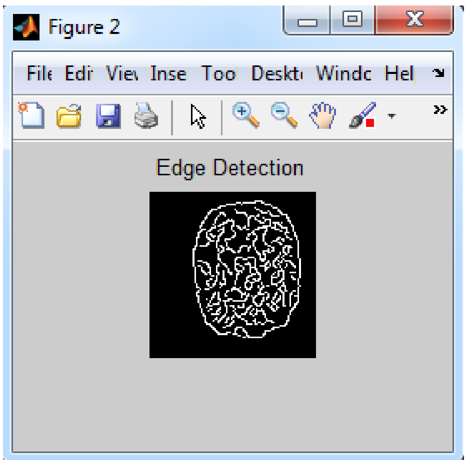
2. Structural Similarity measure: Image quality assessment (IQA) aims to use computational models to measure the image quality consistently with subjective evaluations. The well-known structural-similarity (SSIM) index brings IQA from pixel-based stage to structure-based stage. The Structural Similarity Index Measure (SSIM) [5] [6], has the simplest formulation and has gained widespread popularity in a broad range of practical applications. This is a method for measuring the similarity between two images. Therefore, a measurement of SSIM should provide a good approximation of perceived image quality. The Structural Similarity (SSIM) Index quality assessment index is based on the computation of three terms, namely the luminance term, the contrast term and the structural term. The overall index is a multiplicative combination of the three terms.

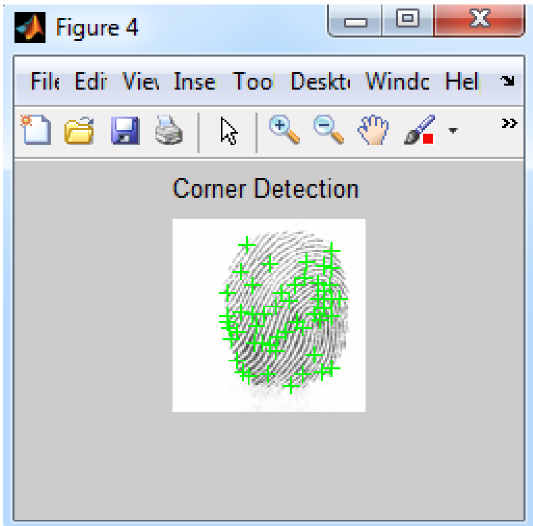
3. Feature Similarity measure: The visual information in an image is often very dispensable, while the HVS realizes an image mainly on the basis of its low-level features. In other words, the salient low-level features carry important information for the HVS to clarify the scene. Hence, noticeable image deformations will lead to noticeable changes in image low-level features, and hence a better IQA metric could be formulated by comparing the low-level feature sets between the reference image and the distorted image. On the basis of the physiological and psychophysical manifestation, it is found that visually identifiable features coincide with those points where the Fourier waves at different frequencies have congruent phases. That is, at points of high phase congruency (PC) we can extract highly informative features. Thus, for computing FSIM, PC [8] is used as the primary feature. Meanwhile, considering that PC is contrast invariant but image local contrast does affect HVS' perception on the image quality, the image gradient magnitude (GM) is computed as the secondary feature to encode contrast information. PC and GM are complementary and they reflect different aspects of the HVS in assessing the local quality of the input image. After computing the local similarity map, PC is utilized again as a weighting function to derive a single similarity score [7].

Table 1: List of image quality features implemented.

#	Measures	Description
1	Mean Squared Error (MSE)	MSE (I, I') = $\frac{1}{NM}\sum_{i=1}^{N}\sum_{j=1}^{M}(I_{i,j}-I'_{i,j})^2$
2	Peak Signal to Noise Ratio (PSNR)	PSNR (I, I') = $10\log(\frac{\max(I^2)}{\text{MSE (I,I')}})$
3	Signal to Noise Ratio (SNR)	SNR (I, I') = $10\log(\frac{\sum_{i=1}^{N}\sum_{j=1}^{M}(I_{i,j})^2}{N.M.\text{MSE (I,I')}})$
4	Structural Content (SC)	SC (I, I') = $\frac{\sum_{i=1}^{N}\sum_{j=1}^{M}(I_{i,j})^2}{\sum_{i=1}^{N}\sum_{j=1}^{M}(I'_{i,j})^2}$
5	Maximum Difference (MD)	MD (I, I') = $max\left\|I_{i,j}-I'_{i,j}\right\|$
6	Average Difference (AD)	AD (I,I') = $\frac{1}{N.M}\sum_{i=1}^{N}\sum_{j=1}^{M}(I_{i,j}-I'_{i,j})$
7	Normalized Absolute Error (NAE)	NAE (I, I') = $\frac{\sum_{i=1}^{N}\sum_{j=1}^{M}\|I_{i,j}-I'_{i,j}\|}{\sum_{i=1}^{N}\sum_{j=1}^{M}\|I_{i,j}\|}$
8	Laplacian Mean Squared Error (LMSE)	LMSE (I, I') = $\frac{\sum_{i=1}^{N-1}\sum_{j=2}^{M-1}(h(I_{i,j})-h(I'_{i,j}))^2}{\sum_{i=1}^{N-1}\sum_{j=2}^{M-1}(h(I_{i,j}))^2}$
9	Normalized Cross-Correlation (NXC)	NXC (I, I') = $\frac{\sum_{i=1}^{N}\sum_{j=1}^{M}(I_{i,j}.I'_{i,j})}{\sum_{i=1}^{N}\sum_{j=1}^{M}(I_{i,j})^2}$
10	Mean Angle Similarity (MAS)	MAS (I, I') = $1-\frac{1}{N.M}\sum_{i=1}^{N}\sum_{j=1}^{M}(\alpha_{i,j})$
11	Mean Angle Magnitude Similarity (MAMS)	MAMS (I, I') = $\frac{1}{N.M}\sum_{i=1}^{N}\sum_{j=1}^{M}(1-[1-\alpha_{i,j}]\left[1-\frac{\|I_{i,j}-I'_{i,j}\|}{255}\right])$
12	Total Edge Difference (TED)	TED (I, I') = $\frac{1}{N.M}\sum_{i=1}^{N}\sum_{j=1}^{M}\left\|I_{E_{i,j}}-I'_{E_{i,j}}\right\|$
13	Total Corner Difference (TCD)	TCD (I, I') = $\frac{\|N_{cr}-N'_{cr}\|}{\max(N_{cr},N'_{cr})}$
14	Spectral Magnitude Error (SME)	SME (I, I') = $\frac{1}{N.M}\sum_{i=1}^{N}\sum_{j=1}^{M}(\|F_{i,j}\|-\|F'_{i,j}\|)^2$
15	Spectral Phase Error (SPE)	SPE (I, I') = $\frac{1}{N.M}\sum_{i=1}^{N}\sum_{j=1}^{M}\left\|\arg(F_{i,j})-\arg(F'_{i,j})\right\|^2$
16	Feature Similarity Index (FSIM)	See [7]
17	Structural Similarity Index (SSIM)	See [5]

III. SCREENSHOTS





IV. CONCLUSION

We present a software based fake detection method to detect different types of fraudulent access attempts through the use of Full Reference Image Quality Assessment. Due to Image quality measurements it is easy to find out real and fake users because fake identities always have some different features original. This method operates on the whole image without considering any specific properties of the given modality. Hence the computational load needed for the processing purpose is much reduced. The system uses 17 general image quality measures which are easy to compute and classified using SVM classifiers.

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