Efficient Information-Theoretic-Statistical (ITSM) Equation for Face Recognition Technique: Comparison with Statistical Technique and Information-Theoretic Technique.

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Abstract—Spontaneous recognition of human faces is a challenging problem that has install important concern from signal processing researchers in Last years. This is owing to its many uses in various fields, including security and forensic analysis. Notwithstanding this interest, face recognition is yet one of the most challenging troubles. Up to this time, no way gives a good solution to all attitudes. In this paper we present a neoteric mathematical technicality for face recognition, which we call, (ITSM), is Accredit on our lately disseminated efficient information-theoretic-statistical equation (ITSM), which Merge three mathematically balanced equations. The first one is entropic equation (EE), the second one is histogram equation (HE), and the third one is the standard statistic (SSIM). (ITSM) Tested against versus (SSIM) and (ITSSIM) beneath Gaussian noise, so we got good results even beneath a large scale of PSNR. The face recognition with (ITSM) certified on both above measures of a test image and a database images. We performed the performance evaluation with (MATLAB) using part of the Famous (AT&T) gray Image Database that made up of (49) face images, from which we chose seven person and for each one we chose seven Perspectives (poses) with different facial emotions. The Target of this paper is to present an efficient technicality for face recognition that may work in real-time milieu. Through the implementation of our information, facial recognition has been proven with a method (ITSM) Hybrid (information - theoretic-statistical) that surpasses the known statistical technicality of face recognition (SSIM) and a technicality based on information theory known as (ISSIM).

Keywords—Information-Theoretic-statistical Similarity (ITSM); Statistical Similarity (SSIM); Information-Theoretic similarity (ISSIM); face recognition Technique; Image Processing.

I. INTRODUCTION

If we wanted to dive into the subject of image processing and pattern recognition, we must pay attention and research on its most applied and beautiful topics is face recognition, as it was the fastest growing and most developed in the past three decades. There are many applications of face recognition, including control and control over access and video surveillance, finding the identity of a credit card user, and also in forensic medicine and many more ways. Those uses
Mentioned make the topic ready and enjoyable for research. See [1, 2, 3] for surveys. The trends have been developed to know the face [4, 5] grant an overview of face recognition technique.

Techniques used for face recognition achieved progress Remarkable, due to efforts made by hundreds of researchers and funding bodies, and that these efforts were a major reason for its spread in many practical applications. With these efforts, there were many published researches on this topic, and in parallel with thousands of published papers on other topics. Data sets were created and used in successful methods to evaluate the performance of different methods.

Notwithstanding there is a lot of work and huge research, but there are also problems that we find when we want to automatically recognize the face. These problems are mainly due to Antiques that fuzzy the image lineaments and features, Such as divergence in illumination, facial expression, and head situation. Techniques that may offer efficient traits elicitation with a high discrimination strength and low computational intricacy are Very important Command[6]. Depending on the way of considering spectral analysis, face-recognition systems may be split into two main denominations: infrared (IR) and visible (VIS).

maybe The main problem in all computers is the similarity gauge of images, as well as in the human system for vision, commonly must grasp likeness system between any two pictures, that the subject of image recognition is a very important topic from the foot because of the many applications that can be used in many fields, including from these applications Knowledge of letters (OCR), the benefit of the human being from the electronic system, knowing the identity of each person, and monitoring. There are many suggested ways to recognize the facial image [3], in references [7-13]. In these references, some methods of image recognition have been classified as totalitarian methods, holistic features, and hybrid.

For example, the Image Similarity measure (SSIM) [14] has been relied upon to create conformity algorithms to face and object recognition systems; this is a specimen of many algorithms designed for this topic

This work provides a modern methodology for face recognition based on (information-theoretic -statistical) methodology rather than the statistical methodology of (SSIM) and the information-theoretic methodology of (ISSIM). The new face recognition technique, which we call it as (ITSM), is dependent on from our (information-theoretic-statistical) similarity measure (ITSM) proposed in [15]. (ITSM) has been modulating to meet the demands of advantage extraction for the face recognition technique. Methods of Automatic face recognition pursue to recognize the identity of certain face picture in comparison with pictures in their memory. A virtual test database is created that represents images saved in memory for facial recognition. In our work, our testing set is the (AT&T) renowned face database [16]. Thus, the duty of the facial recognizer is finding the most trait vector similar among the testing group to the trait vector for the given test (training) image.

That the suggested approach (ITSM) submits higher performance than the criterion (SSIM) and information-theoretic (ISSIM) in facial recognition technicality, This was shown and confirmed by the simulation results

In [17], amended transcriptions of (SSIM) are suggested in an endeavor to be used in recognition. In [18], lieu of the accustomed path for applying statistics or structural Techniques only, the Authors suggested a methodology that integrates higher-order clarification styles extracted by Zernike flashes with amended transcriptions (M-SSIM) of (SSIM). The resulted Individual measurements from jumbled (SSIM) and Zernike-based approaches provide a powerful recognition tool with fabulous results.

In [15], the researchers suggested (HSSIM) information-theoretic image similarity. And in [19], the restricted redactions of (HSSIM) are proposed to be used in recognition.

Many similarity measures are suggested and used for sundry aims; see [20-27]. Many ways were substantive and implemented using entropy Kinds to handle the face recognition problems and edge detection [28-32].

This paper is organized as follows: part II shows the mathematical basis of statistical and information-theoretic measures. Part III shows the design of new information-theoretic- statistical measure (ITSM) to be utilized in face recognition. Part IV shows experiential results and debates possible amendments and improvements to the system. part V offers Notes concluding.

I. SIMILARITY MEASURES

we can be defined measure of similarity as a dimension (based on a specified norm) between different data points. The performance of several algorithms relies on choosing a (good) distance function through an input data group. While the similarity is an amount that clarifies the strength of the relationship among tow database items, variation deals with the measurement of
dissimilarity among two data items. In this work, we suggest (information-theoretic-statistical) measure and study its performance in comparison with a famous (statistical measure) and (information-theoretic measure).

A. SSIM Overview: A Structural Similarity Measure

Who is interesting in many image processing systems are methods of automatic detection of similarity such as those used to squeezing enhancement and verification of identity, etc. The suggestion of the statistical image quality measure (SSIM) in 2004 was one of the most important achievements in the similarity of images [14]. It was evident in many applications. It was applied to evaluate image sharpness and many algorithms for image processing methods. Statistical measurements such as mean and standard deviation were the basis for the technique (SSIM) to find a definition of the distance function that can measure the structural similarity between the reference and distorted images of training. In the form:

$$\frac{2\mu_x\mu_y + C_1}{\mu_x^2 + \mu_y^2 + C_1} \frac{2\sigma_{xy} + C_2}{\sigma_x^2 + \sigma_y^2 + C_2}$$ (1)

Where $\rho(x,y)$ is the (SSIM), $x$ (the reference image or test image) and $y$ (ordinarily a distorted Release of $x$). The statistical parameters $\mu_x, \mu_y, \sigma_x^2, \sigma_y^2$ are the means and variances of lighting level (pixel values) in the two images $x$ and $y$, while $\sigma_{xy}$ symbolize the statistical covariance between $x$ and $y$. The constants $C_1$ and $C_2$ are given as: $C_1 = (K_1L)^2$ and $C_2 = (K_2L)^2$, with $K_1$ and $K_2$ are tiny constants, and $L = 255$ (the maximum pixel value). The Authors in [14] assured that these constants (parameters) have little effect on (SSIM) performance.

In [17], This approach has been proven its ability to give a high degree of similarity under conditions that are not tainted by noise, while it is low performance when increasing the amount of distortion or noise, in addition to that, it may give an amount of similarity to two pictures that differ from one another the reason is due That this scale depends entirely on the statistical features of the image, which some of its correlations may be hidden from us. In [17] and [30], (SSIM) have been Merge with edge finding filters (such as Cranny’s) to output excellent results particularly when the images are different from each other.

B. An Information-Theoretic Technique for Image Similarity (ISSIM)[19]

If we utilize the information-theoretical analysis in the image processing system if we imagine that the image is random variables of two-dimensional (2D) The common graph between the two pictures can be known as the common occurrence of intensity levels (pixel values) of the two images. If you seriously noticed, you would only find us thinking about the gray image, where the gray image contains most of the similarity information for two pictures under the similarity test A and B. Suppose that the two pictures are the same size and that the pixel density values are symbolized by $i$ and $j$, respectively. Note that $i$ and $j$ together extent from 0 to $L = 255$. Now the joint-histogram, Symbolized by $h_{ij}(A,B)$, represents the joint probability of every pixel (determine by its 2D location, as the two images have one size) to pick on the value $i$ on the first image $A$ and the value $j$ on the second image $B$. Now each entry in the joint-histogram will represent the number of times the intensity level $i$ in any of the two images matching to the intensity level $j$ in the other image.

In [33], the researchers designed a similarity error estimate for the symmetrically available entries for the joint histogram (around the relationship $x=y$) as follows:

$$E(x,y) = \sqrt{\frac{\sum_{i,j} (H_{ij} - H_{ij})^2}{2L^2}}$$ (2)

Where $H_{ij}$ and $h_{ij}$ are Symmetrical sites entries of the joint histogram amidst two images, and $h_i$ is the ordinary image histogram of the original image histogram. $C$ is a highly small positive constant, inserted fundamentally to avoid division by zero, and $L = 255$ is the maximum pixel value.

It is very easy to show that the above relationship is not negative, that is:

$$E(x,y) \geq 0$$ (3)
To be utilized as a similarity measure and compared with (SSIM), an arrangement operation is necessary to guarantee that the range of the measure is preserved inside the interval [0,1]. In [15], maximal error estimate $E_m(x,y)$ was used for normalization as follows:

$$e_a(x,y) = \frac{E(x,y)}{E_o(x,y)}$$  \hspace{1cm} (4)

The normalization process will ensure that:

$$0 \leq e_a(x,y) \leq 1$$  \hspace{1cm} (5)

The researchers relied on the above-mentioned error estimate, proposal an information - theoretic similarity measure (which was called HSSIM) as follows:

$$\lambda_a(x,y) = 1 - e_a(x,y)$$  \hspace{1cm} (6)

Where:

$$0 \leq \lambda_a(x,y) \leq 1$$  \hspace{1cm} (7)

If we refer to the famous (SSIM) by $\rho(x,y)$, then we have a similar inequality between 0 and 1 as follows:

$$0 \leq \rho(x,y) \leq 1$$  \hspace{1cm} (8)

Then a new definition of error measure. After the implementation of the test, they determined the maximum information – theoretic error for the complete test $E_m$ as follows:

$$E_m = \max_{p(x,y)} \{ E(x,y_{pr}) \}$$  \hspace{1cm} (9)

Then they define information–theoretic error scale $e(x,y)$ as follows:

$$e(x,y) = \frac{E(x,y)}{E_m}$$  \hspace{1cm} (10)

The database-based normalization process will include (or more precisely, test-based):

$$0 \leq e(x,y) \leq 1$$  \hspace{1cm} (11)

After the previous normalization process enables the researchers suggest information - theoretic similarity measure for face recognition (Which is called ISSIM) to as follows:

$$\lambda(x,y) = 1 - e(x,y)$$  \hspace{1cm} (12)

where it is evident that:

$$0 \leq \lambda(x,y) \leq 1$$  \hspace{1cm} (13)

Note that $\rho(x,y) = 1$ for totally identical (similar) images, while $\rho(x,y) = 0$ to get for totally various images. In workable applications for face and image similarity, (SSIM) and (ISSIM) take on values above zero and less than one.

In our work this we intend to design a measure for face recognition based on two information-theoretic-statistical equations as follows.
C-Information-Theoretic-Statistical technique (ITSM)

In [15], we proposed a modern and unique image similarity method based on the combined of the statistic and information theory for approach image similarity, the main domains of interest are three mathematically balanced equations. The first entropic equation (EE) based on information theoretic measures. The second histogram equation (HE) based on image histogram and joint histogram. The third one is a standard statistic (SSIM).

Entropic Equation (EE)

The main fields of interest in this equation are the Shannon entropy theory (entropy and joint entropy). The foundations for entropy are in information theory, which is the theory mathematical for communication developed in the Basic work of Shannon. Application of information theory methods in image processing is possible, assuming that we can treat images as random variables, the main axis of this theory is the concept of entropy (Shannon) and the ability to efficiently construct a scale for identifying similarities between images without losing data. Entropy is defined as the expected value of information in the image. Entropy enters in many applied fields including statistical mechanics, statistics, coding theory, and related fields. It was also used by newly emerging scientific fields, such as the field of image similarity and image recognition. The most widely used and important entropy is in The applications are the Shannon entropy, which gives in mathematical form as follows:

The entropy of a discrete random variable $x$ with the values in the set $\{x_1, x_2, ..., x_n\}$ is defined as:

$$E(x) = -\sum_{i=1}^{n} p_i \log p_i$$

(14)

where $p_i = p_i[x = x_i]$

We can expand the previous definition of entropy from a single random variable to a marriage of random variables. The joint entropy of a pair of random variables is symbolized $E(x,y)$ in this research, with a joint distribution $p_{ij}$ given.

$$E(x,y) = -\sum_{i=1}^{n} \sum_{j=1}^{m} p_{ij} \log p_{ij}$$

(15)

Now our proposed entropic equation (EE):

$$EE = \frac{(E_x + a) \cdot (2 \cdot E_{xy} + a)}{(E_x^2 + E_{xy}^2 + a)}$$

(16)

Where $E_x$ is the entropy for the image $x$ which estimate by using reference image histogram $H(x)$, $E_y$ is the entropy for the image $y$ which estimate by using distorted image histogram $H(y)$, and $E_{xy}$ is the joint entropy of a pair of images $x$ and $y$ which estimate by using reference image and distorted image joint histogram $H(x,y)$, and $a$ is a small constant $= 0.05$.

Or the equation EE can written as the formula;

$$EE = \frac{(-\sum_{i=1}^{n} H(x) \log H(x) - \sum_{j=1}^{m} H(y) \log H(y) + a) \cdot (2 \cdot (-\sum_{i=1}^{n} \sum_{j=1}^{m} H(x,y) \log H(x,y) + a))}{(-\sum_{i=1}^{n} H(x) \log H(x))^2 + (\sum_{j=1}^{m} H(y) \log H(y))^2 + a)}$$

(17)

Histogram Equation (HE)

The image histogram is a function describing the distribution of the intensity levels in an image. For each intensity level, the corresponding histogram value equal to the number of the pixels with the same intensity.

The joint-histogram represents the joint-probability of two or more random variables (images in our case). For the two-dimensional joint-histogram, the pixel values of two images are used as the coordinate axis. Given two images $x$ and $y$ and pixel intensity values $i$ and $j$, $H_{ij}(x,y)$ represents the probability of a pixel to have the value $i$ on the image $x$ and $j$ on the image $y$.

Hence, each entry is the number of times intensity $i$ in one image corresponds to intensity $j$ in the other. If the joint histogram is normalized, it becomes an estimate of the joint probability distribution function (PDF) of intensities in the images [16].

Previously, traditional methods were used to find the similarity of images depending on the density of the histogram. These methods are applicable if there are a limited number of images in the database because if the database contains a large number of images, this leads to the failure of the method. Because, there are identical histograms For completely different images, for example, a set of data that resembles the faces, such as the gray and Brazilian database, therefore this should be avoided (Pass & Zabih) [16] Instead of the histogram, I suggest a joint histogram that includes many additional information while preserving the
features of the histogram. The joint histogram works by choosing the local pixel features to create a multidimensional histogram. The image histogram a beautiful mathematical formula is given by:

\[ H(x) = \{ H_i(x), \quad i \in (1, 2, \ldots, N) \} \]  

(18)

The most significant histogram in applications is joint histogram, whose mathematical formula is given by: Let \( H_{ij}(x, y) \) the two-dimensional joint histogram for the images \( x \) and \( y \), respectively, represents the probability of the pixel density value \( i \) of the image \( x \) occurring with the pixel density value \( j \) of the image \( y \). Therefore the normalized joint histogram is known for two pictures \( x \) and \( y \) in size \( M \times N \) As follows:

\[ H(x, y) = [H_{ij}] \]

Now our proposed Histogram Equation (HE):

\[ HE(x, y) = \frac{(H_x, H_y, (2 \cdot H_{xy})}{(H_x^2 + H_y^2 - (H_{xy})^2)} \]  

(20)

Where \( H_x \) is the histogram of reference image, \( H_y \) is the histogram of noisy image and \( H_{xy} \) is a joint histogram of the reference image \( x \) and the noisy image \( y \).

At the hub of statistics, the main field and worthy of Interest in image similarity is the well-known standard of similarity of statistical images (SSIM)

\[ EE(x, y) = \frac{3 \cdot SSIM(x, y) - 2 \cdot SSIM(x, y)^2 + b}{(1 - SSIM(x, y))^2 + (1 - SSIM(x, y))^2 + b} \]  

(21)

Where \( b = 0.015 \) is an arbitrary constant and the symbol \( (SI) \) is indicate to (SSIM).

Ordinarily, \( x \) and \( y \) are a reference image and a distorted version of the same image, respectively. EE The proposed Entropy equation in eq.(16), HE The proposed Histogram equation in eq.(20), and the equation SI is the measure of the previously famous (SSIM) represented by eq.(1). Whereas \( b = 0.015 \) is an optional positive variable that is too small to balance the equation and avoids dividing by zero and entering it to raise the stability ratio in the equation. The results are approximately identical if we chose other constants.

In fact, what distinguishes our proposed equation (ITSM measure) and makes it worthwhile and unique is the use of all its elements simultaneously when implementing it to find similarities between images or distinguish images as in faces.

It is clear that \( 0 \leq \xi (x, y) \leq 1 \).  

(22)

Depending on the above error estimate an information-theoretic-statistical (ITSM) similarity measure can be proposed as follows:

\[ (ITSM) = \xi (x, y) = 1 - \xi (x, y) \]  

(23)

Where:

\[ 0 \leq \xi (x, y) \leq 1 \]  

(24)

Our algorithm includes all of the above concepts and can run all these tools and find similarities between images or recognize images with very good accuracy and reliable in security and other purposes and this is one of the most distinctive features of (ITSM measure) that make it unique.
Is the wonderful mix among three mathematical equations, entropic, histogram, and the basic equation in image similarity which are statistical approaches. Whereas, the previous papers in the measure adopted either the statistical approach such as the famous measure, (SSIM) in 2004 or to the information theory approach such as (ISSIM) in 2014. Hybrid technique (ITSM) taken the features structural from the structural similarity measure due to its performance in the field of image processing, entropy and histogram from information theory, so the main characteristics of the proposed hybrid algorithm are all the properties of the main components of the image, i.e. extracting the statistical properties of the image in a statistical way (SSIM) and properties The theory of information for the image using the information theory equations (equations of entropy and histogram) proposed in [15], and therefore we can summarizing the properties of the equation (21) as a combination of the properties of the components. (ITSM) Was tested under a noise environment using Gaussian noise and a wide range of (PSNR). In particular, this discussion examines the possibility and how statistical theory and information theory are used to establish performance bounds for image similarity or recognition (distinguishing them). Our proposed methodology was applied to real and actual data under many circumstances that include contaminated and pure data.

**THIRD. A FACIAL RECOGNITION APPROACH BASED ON Information-Theoretic-statistical**

In face recognition between a face image \(x\), which we assumed to be a reference image and an image \(y_{p,r}\) of a number \(P\) of people, each person (whose database number is \(p\) such that \(p \leq P\)) has \(R\) of the facial images in different positions (each position is classified by the variable \(r\)); thus the set of facial images In the database \(N = R \cdot P\). We choose one of the numbered modes as \(r = a\) that correspond to the person \(p\) who serves as a reference image. Then we conduct two tests:

In the first case, the pose \(a^th\) is kept in the database and then begins with the recognition process. This task is easy, but it is considered a way to test the performance of the proposed measures and compare them. In the second test, it removes the pose \(a^th\) and begins to recognize, but this task is difficult because it may consider different poses of the same image is different images. Between a reference face \(x\) and a person \(p\) in the database, we can comparison by ITSM as:

\[
\xi(x, p) = \max_{y_{p,r}} \{\xi(x, y_{p,r})\}
\]

(25)

The value of \(\xi(x, p)\) refer to the amount of confidence that we can put in the recognition process. Certainly, in the ideal case \(\xi(x, p) = 1\), that is only if the reference face pose exists in the database being used. The recognition depends on the formula below.

\[
p_t = \arg\{\max_{p}\{\xi(x, p)\}\}
\]

(26)

A similar process to find the best match by SSIM-based statistical face recognition. Given by formula

\[
\rho(x, p) = \max_r \{\rho(x, y_{p,r})\}
\]

(27)

The previous formula with the recognition decision-based. Together given the formula below:

\[
p_s = \arg\{\max_{p}\{\rho(x, p)\}\}
\]

(28)

And for ISSIM-based information-theoretic face recognition, we can determine a similar operation to discover the better match as the next formula:

\[
\lambda(x, p) = \max_{p}\{\lambda(x, y_{p,r})\}
\]

(29)

The previous formula with the recognition decision-based. Together given the formula below:

\[
p_f = \arg\{\max_{p}\{\lambda(x, p)\}\}
\]

(30)

**Recognition Confidence**
In majority of cases: (ITSM), (SSIM) and (ISSIM) approve such that:

\[ p_t = p_2 = p_f. \]

Nevertheless, the confidence in recognition varies a great deal. By “confidence in recognition” we mean over there is a “good” distance between the peaks know in (26) and (28) and (30) the next-in-altitude peaks who may be confuse the resolution when two peaks (using the same measure) are nearby in magnitude.

Presently, confidence in recognizing the trial image \( x \) using a measure \( \mu \), first, in the above measure we find the 2nd peak (max) \( \mu(x, p)|p = 1, \cdots, P \), thereafter, we finding the vary between the max and the 2nd max for each measure, which we called hither the M-difference. It is referred to by \( \partial(\mu, x) \), which may be \( \partial(\xi, x), \partial(\rho, x) \) or \( \partial(\lambda, x) \). The MM-difference for that measure is the resulting quantity for this.

The mathematical definition of confidence in recognizing the reference image \( x \) utilize the similarity measure \( \mu \) is :

\[ \partial(\mu, x) = \max_p \{\xi(x, p)\} - \max_p \{\xi(x, p)\} \]

Whereas \( \max_p \{\xi(x, p)\} \) is the 2nd max of the similarities curve between the original (reference) image \( x \) and other people in the database (note exhausted that all poses for each person in \( \mu(x, p) \) as per (25)). We have:

We will see in the next Section that for all of the cases under testing, ITSM outperforms the statistical similarity SSIM and the information similarity ISSIM as we always have:

\[ \partial(\xi, x) > \partial(\mu, x) \quad \forall x \]

Subsequently, we expect a successful role for (ITSM) in face recognition where the decision it gives is clear in most cases. This difference can reach \( 0.5 \) in easy cases, where it represents half the value of the total measure \( 1 \). Certainly, we can get the best results and most clear when the reference image is included in the database, although this case is not realistic.

II. EXPERIMENTAL RESULTS AND PERFORMANCE:

A. Image Database

The database we used is a structured database for facial images known as the gray base or AT&T base [16] that was used in many facial recognition systems and image similarity systems. This database was divided into two groups, the first for separate testing purposes and the second for training purposes during the training period, we used in this research (49) image, which contains images of seven people for each person seven shots of different facial expressions. We will show a sample of this rule. See Figure (1) below. In our work, we will adjust the size of images (dimensions) to be \( 92 \times 92 \) pixels.

![Fig (1): A sample of faces images in the base (AT&T) used for testing and training](image-url)
B. Testing

We used the MATLAB simulation program as a tool for training and to test the proposed facial recognition system presented in this paper.

Performance of the Suggested (information-theoretic-statistical) algorithm (ITSM) is tested and then compared with the famous structural similarity measure (SSIM) and (Information-Theoretic Technique) for Image Similarity (ISSIM),

The beautiful algorithm (ITSM) was tested in two different states, and the results showed its effectiveness and accuracy of its results in face recognition.

Case 1- Test Image Included in the Database

The experiment showed excellent results and a high estimate for (SSIM), (ISSIM) and (ITSM). In this case, where the test image (the reference situation) belongs to the database used for training, although this case is considered ideal and less realistic than the second case, Through the comparison, it showed the strength of (ITSM) the proposed versus (SSIM) and (ISSIM) in the faces recognition as our hybrid scale surpassed the other two measures to a far extent.

Case 2- Test Image Excluded from the Database

In this case, we will remove the reference test image from the dataset used in training. However, the recognition remains very good and our hybrid scale (ITSM) is superior to (SSIM) and (ISSIM) in recognizing the face despite the difference in shots and expressive poses.

We used the distance between the first and second maximum peaks of the similarity curve for each of the recognition methods mentioned in the research. To compare performance, the more distance, the more confident closely the decision to get to recognize the person.

The below figures show the results of the recognition and performance analysis of (ITSM)

![Fig 2: It shows the seven Poses of the second person in the database. Including reference Pose is indicated](image1)

![Fig 3: It shows the seven Poses of the sixth person in the database. Including reference Pose is indicated](image2)
Fig-4- shows the comparison between the proposed hybrid technique (ITSM), the famous statistical technique (SSIM), and the information-theoretic technique (ISSIM) of a test image of person number 2. Is included the Reference pose in the dataset (as in Figure 2).

Fig-5- shows the comparison between the proposed hybrid technique (ITSM), the famous statistical technique (SSIM), and the information-theoretic technique (ISSIM) of a test image of person number 6. Is included the Reference pose in the dataset (as in Figure 3).

Fig-6- shows the comparison between the proposed hybrid technique (ITSM), the famous statistical technique (SSIM), and the information-theoretic technique (ISSIM) of a test image of person number 6. Is excluded the Reference pose in the dataset (as in Figure 2).
Fig. 7. shows the comparison between the proposed hybrid technique (ITSM), the famous statistical technique (SSIM), and the information-theoretic technique (ISSIM) of a test image of person number 6. is included the Reference pose in the dataset, is excluded the Reference pose in the dataset (as in Figure 3).

Fig. 8. shows the comparison between the proposed hybrid technique (ITSM), the famous statistical technique (SSIM), and the information-theoretic technique (ISSIM) of a test image of person number 2. is excluded the Reference pose in the dataset (as in Figure 2). It is clear that ITSM $\xi(x,p)$ gives more confidence than SSIM and ISSIM $\mu(x,p)$ as $d(\xi,x) > d(\mu,x)$.

Fig. 9. shows the comparison between the proposed hybrid technique (ITSM), the famous statistical technique (SSIM), and the information-theoretic technique (ISSIM) of a test image of person number 6. is excluded the Reference pose $x$ in the dataset (as in Figure 3). It is clear that ITSM $\xi(x,p)$ gives more confidence than SSIM and ISSIM $\mu(x,p)$ as $d(\xi,x) > d(\mu,x)$. 
In this paper, we will present a new and beautiful face-recognition technique called (ITSM) that mixes the two approaches statistical and information-theoretic, to be the innovated technique (information-theoretic-statistical). The test and comparison were done in a simulation program (MATLAB) using (49) images as part of the image database (AT&T), where contains seven images of people each image of a person contains seven poses of different facial expressions. As the experimental results showed, the proposed hybrid measure (ITSM) excels in performance and the ability to discover recognition (SSIM) statistical and (ISSM) information-theoretic faces. Given the ease and avoidance of complexity in the proposed system, we believe that it is a system Very appropriate to use and implement in low-cost hardware and software in real-time. In future work, the authors intend to expand previous studies on local analysis to the measure defined above.

III. CONCLUSION & DISCUSSION

In this paper, we will present a new and beautiful face-recognition technique called (ITSM) that mixes the two approaches statistical and information-theoretic, to be the innovated technique (information-theoretic-statistical). The test and comparison were done in a simulation program (MATLAB) using (49) images as part of the image database (AT&T), where contains seven images of people each image of a person contains seven poses of different facial expressions. As the experimental results showed, the proposed hybrid measure (ITSM) excels in performance and the ability to discover recognition (SSIM) statistical and (ISSM) information-theoretic faces. Given the ease and avoidance of complexity in the proposed system, we believe that it is a system Very appropriate to use and implement in low-cost hardware and software in real-time. In future work, the authors intend to expand previous studies on local analysis to the measure defined above.

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