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A Robust face locater using WLD and DoG for SSPP

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Abstract *–The technology is growing in a rapid manner. As the technology is growing, security is more important. The core objective of this project is to extract the facial features using the local appearance based method for the accurate face identification with single sample per person problem. Generally face recognition is done by using two approaches: Holistic method and Local appearance based method. The Local appearance based method detects facial features such as eyes, nose, mouth and chin and also detects properties of and relations (e.g. areas, distances, angles) between the features are used as descriptors for face recognition. This project proposed a feature extraction and face recognition approach based on Weber's Local Descriptor (WLD) and Difference of Gaussian (DoG)for the SSPP. The Gabor filter is used to extract the hybrid features and the pyramids are generated after the face granulation. By this granulation, facial features are segregated at different resolutions to provide edge information, noise, smoothness, and blurriness present in a face image. In features extraction stage, WLD descriptor represents an image as a histogram of differential excitations and illumination changes, elegant detection of edges and powerful image representation. These combined features are useful to distinguish the maximum number of samples accurately and it is matched with already stored original face samples for identification. This proposed approach reduces the computation time and also increases the efficiency.*

Index Terms: *Difference of Gaussian, Weber Local Descriptor, face granulation, SSPP*

1, INTRODUCTION

"Biometrics" means "action preference and identification" but the term is usually complicated with interlacing unique features to diagnose someone. However, identifying the biometrics has a bounteous relevance as interfacing has become natural. A number of biometric attributes have been formulated and are used to authenticate the person's identity. The concept is to implement the special features of a person to name the exact person. By implementing special features we mean implementing the features such as iris, palm print, fingerprint and signature, etc., this method of identification based on biometric features are chosen over normal passwords: The human to be diagnosed is needed to be present physically at the moment of identification. Diagnosing based on biometric proficiencies eliminate the need to think of a password. The organization is basically a pattern recognition system which makes a personal identification by finding out the legitimacy of a specific behavioral characteristic possessed by the user. A Biometric system can be either an 'identification' system or an authentication system, which are defined below.

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A. *Identification* – Biometrics can be implemented to identify a person's individuality even without the person's awareness. For instance, surveillance camera usage in a crowd and implementing face recognition technology can identify matches against the database created and predefined.

B. *Verification* **–** Biometrics can be implemented to check a person's identity. For instance, one can please any physical access to a protected field by using finger scans. The process of getting and diagnosing information by some persons is termed to as perception or agreement. Processing of an image includes improvement in its appearance and efficient representation. So the field consists of not only feature extraction, analysis and recognition of images, but also coding, filtering, enhancement and restoration.

The whole process of image processing and analysis starts from the getting the visual data output and ends in giving out a description of the setting. The important constituents of the processing system are digitizer, image sensor, storage unit and display unit.

C. *Face Recognition – A Survey*

Recognition [1]-[7] is a computer based diligences for automatically identifying or cross checking a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected facial features from the image and a facial database. It is generally implemented in security based systems and can be compared to other biometrics such as eye iris generation or fingerprint systems [5]. Recognition or diagnosing technology is used to reduce data from facial images with the help of a face recognition device, without any human interaction [3]. Unlike face detection or recognizing technology, face recognition technology uses image processing algorithms to recognize and then compare human facial images with the ones that are stored in the database on the face recognition device. It is enabled device examines the characteristics of complete human face [2].

One of the manners to do this is by equating selected facial characteristics from the image and the database. It is generally used in secrecy systems or secret data communication and can be compared to other biometrics such as fingerprint or eye iris recognition systems [5]. For instance, an algorithm may analyze the proportional position. These characteristics are then applied to search for other images with feature extraction [7] and matching. Other algorithms normalize a template of images and then compress the images, only securing the data in the signal that is applied to face recognition [4]. An earlier successful scheme is dependent on matching techniques applied to facial characteristics, furnishing a compressed face representation.

2, EXISTING SYSTEM

Face analysis methods are tools for face recognition. But this can't be applied to the single sample because of "within subject changeability". When nerves are under forceful facial expression changes, the discriminant analysis method can't be applied. LDA (Linear Discriminant Analysis) is one of the discriminant analysis techniques. But it dropped down to get more performance values, due to the distribution of the data set are induced by large changes, which still present in each cluster technique. LDA uses a Fisher face based algorithm. It applies the dataset to retrieve multiple images of the same human. PCA (Principal Component Analysis) is also not applicable for the sample per class problem. LBP (Local Binary Pattern) is not only implemented for detection of faces, but also for recognizing it. To process an image, it is first mandatory to decrease the image to a series of numbers that can be derived by the system. Each number representing the brightness value of the signal at a specific place is called a picture element termed to be a pixel. A distinctive digitized signal may have 512 × 512 much larger images are going common. Once the signal is being digitized, there are three basic operations that can be outcome on it in the system. For an operational value, a value in the output image depends on a single pixel value in the input signal. For local operations, several conterminous pixels in the input image decide the value of an output pixel. In global features, all of the input signals lead to an output image value. These operations, taken individually or in combination, are the means by which the image is compressed or restored or enhanced.

A signal is increased when it is altered so that the data it contains is more clearly apparent, but enhancement can also include making the signal more visually invoking. There are two familiar classifications to recognize a face. One approach transforms images into specific transformation fields. Of all works such as Eigen face, face core identification. Gabor filters, an approach are to derive out primary lines. Somehow, this technique is a little complicated because it is rarely tedious to extract discriminant values. Of these, the ridges on the face are quite overlapping and crossing each other, which elaborates the feature extraction work.

3, PROPOSED SYSTEM

The proposed system uses a robust face finder called WLD (Weber's Local Descriptor) for the SSPP. By implementing WLD features the face can be detected and recognized. Although only one classifier is trained, and using that frontal, occluded and face images is identified.

This proposed system is divided into various categories. It includes five modules: (1) image acquisition, (2) Preprocessing, (3) Feature extraction, (4) granulating the face images, (5) Face recognition or face identification. The preliminarymodule is applicable for acquisition of input images. Then the image is preprocessed to go through some feature extraction levels and they are extracted by using Difference of Gaussian. Finally face recognition is done only after the process of granule computing phases. The face granulation is implemented to form the Difference of Gaussian (DoG) [10] pyramids. Future interest lies in how to exploit the proposed descriptor for the domain of face identification and also be enhanced by applying feature level fusion to improve the performance with less time for the Single Sample derivation.

A. Granular Computing & DoG

The input image is preprocessed to eliminate the noise and also to determine the edges. After that the hybrid features are extracted from the face image. The hybrid features include both the local features and global features. Subsequently the face granulation is done to generate the Difference of Gaussian (DoG) pyramids to recognize the face by using the Euclidean distance. It is an orthogonal transformation. DoG parameters are employed here to rebuild the original image.

Thus, they save some low frequency elements of discrete cosine transform and cut down lots of high frequency components. It implements inverse transformation to get a continued image which is similar to the exact input image. The original image is invisible due to some distortion. It is because, it contains more important information. Feature extraction imparts altering the amount of resources needed to describe a set of data accurately.

Its analyses of complex data one of the important issues from the number of variables included. Analyses with plenty of inputs basically need an enormous amount of space and computation power or a classification algorithm which gives the training sample and generalizes poorly to new samples. After preprocessing the hybrid features are extracted from the face image. The hybrid features include both the local features and global features.

B. Block Diagram Of Proposed System:

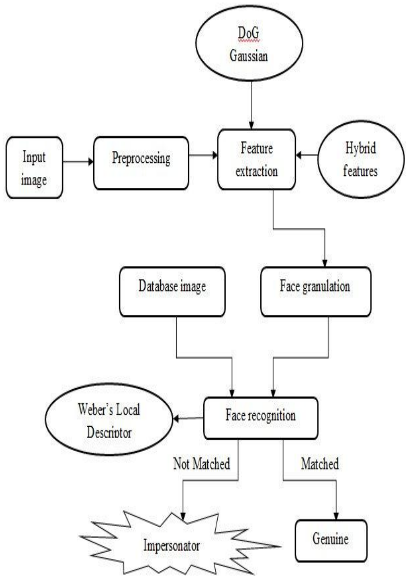

Fig.1 Full block diagram of proposed system

C. Face Recognition

Recognition is the process that assigns a mark to an object depends on the information provided by its descriptors. Having extracted the hybrid features in the feature extraction step, the Face granulation is done to produce out the Difference of Gaussian (DoG) pyramid formation. The DoG pyramids are produced to analyze the Euclidean distance to discern the face images valiantly. Feature extraction is a common term for algorithms for constructing similarities of the variables to obtain these issues while still depicting the data with enough accuracy. Somehow, if no such proficient knowledge is available general dimensionality reduction techniques may help.

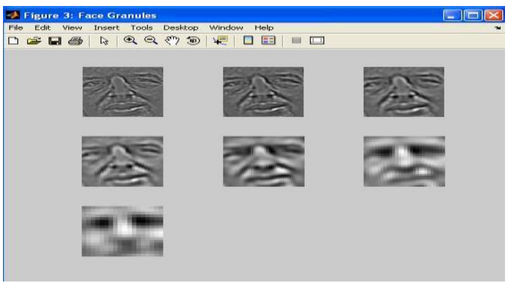

Fig. 2 Granular Computed values

Thus the face image vectors have been diagnosed and thus the comparison is done accordingly. The face granules values are brought outwit the use of pixel classification among the single input image. *Fig. 2* gives us the clearest idea of getting out the output values based upon the identification of face vector values along with the different usage of granules computed and taken as successive outcomes. The performance is to be measured based on the comparison with the normal input image and the classified granules computed image. Each granule node distributes and describes about the successive granule nodal values spontaneously.

4, ALGORITHMS

A. Algorithm for Difference of Gaussian

In imaging science, difference of Gaussians is a feature enhancement algorithm that involves the subtraction of one blurred version of an original image from another, less blurred version of the original. In the simple case of grayscale images, the blurred images are obtained by convolving the original grayscale images with Gaussian kernels having differing standard deviations. Blurring an image using a Gaussian kernel suppresses only high-frequency spatial information. Subtracting one image from the other preserves spatial information that lies between the ranges of frequencies that are preserved in the two blurred images. Thus, the difference of Gaussians is a band-pass filter that discards all but a handful of spatial frequencies that are present in the original grayscale image.

1. Mathematics of Difference of Gaussians

Given a m-channels, n-dimensional image

$$I: \{\mathbb{X} \subseteq \mathbb{R}^n\} \rightarrow \{\mathbb{Y} \subseteq \mathbb{R}^m\} \qquad \text{------------------ (1)}$$

The difference of Gaussians (DoG) of the image I is the function

$$\Gamma_{\sigma 1,\sigma 2} : \{\mathbb{X} \subseteq \mathbb{R}^n\} \rightarrow \{\mathbb{Z} \subseteq \mathbb{R}\} \qquad \text{-------------------- (2)}$$

obtained by subtracting the image I convolved with the Gaussian of variance σ_2^2 from the image I convolved with a Gaussian of narrower variance σ_1^2, with $\sigma_2 > \sigma_1$. In one dimension, Γ is defined as:

$$\Gamma_{\sigma 1,\sigma 2}(x) = I * \frac{1}{\sigma_1\sqrt{2\pi}} e^{-(x^2)/(2\sigma_1^2)} - I * \frac{1}{\sigma_2\sqrt{2\pi}} e^{-(x^2)/(2\sigma_2^2)} \qquad \text{------------------- (3)}$$

and for the centered two-dimensional case :

$$\Gamma_{\sigma,K\sigma}(x, y) = I * \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/(2\sigma^2)}$$

$$- I * \frac{1}{2\pi K^2\sigma^2} e^{-(x^2+y^2)/(2K^2\sigma^2)} \qquad \text{------------------- (4)}$$

which is formally equivalent to:

$$\Gamma_{\sigma,K\sigma}(x, y) = I * \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/(2\sigma^2)}$$

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$2\pi K2\sigma 2\, e^{-(\;\; +y2)\;(2K2\sigma 2)}$ ------------------ (5)

which represents an image convoluted to the difference of two Gaussians, which approximates a Mexican Hat function.

(a) (b) (c)

Fig 3 (a) Original image, (b) Difference of Gaussian 1st level (c) Feature extraction

As a feature enhancement algorithm, the difference of Gaussians can be utilized to increase the visibility of edges and other detail present in a digital image. A wide variety of alternative edge sharpening filters operate by enhancing high frequency detail, but because random noise also has a high spatial frequency, many of these sharpening filters tend to enhance noise, which can be an undesirable artifact. The difference of Gaussians algorithm removes high frequency detail that often includes random noise, rendering this approach one of the most suitable for processing images with a high degree of noise. A major drawback to the diligence of the algorithm is an inherent reduction in overall image contrast produced by the operation. When utilized for image enhancement, the difference of Gaussians algorithm is typically applied when the size ratio of kernel (2) to kernel (1) is 4:1 or 5:1. In the example images to the right, the sizes of the Gaussian kernels employed to smooth the sample image were 10 pixels and 5 pixels. The algorithm can also be used to obtain an approximation of the Laplacian of Gaussian when the ratio of size 2 to size 1 is roughly equal to 1.6. The Laplacian of Gaussian is useful for detecting edges that appear at various image scales or degrees of image focus. The exact values of the sizes of the two kernels that are used to approximate the Laplacian of Gaussian [10] will determine the scale of the difference image, which may appear blurry as a result.

Differences of Gaussians have also been used for blob detection in the scale-invariant feature transform. In fact, the DoG [10] as the difference of two Multivariate normal distribution has always a total null sum and convolving it with a uniform signal generates no response. It approximates well a second derivate of Gaussian (Laplacian of Gaussian) with K~1.6 and the receptive fields of ganglion cells in the retina with K~5. It may easily be used in recursive schemes and is used as an operator in real-time algorithms for blob detection and automatic scale selection.

B. Weber's Local Descriptor

Weber's Local Descriptor is very powerful and robust local descriptor. It is based on the fact that human perception of a pattern depends on not only the change of a stimulus (such as sound, lighting, et al.) but also the original intensity of the stimulus.

1. Weber's Law

Ernst Weber, an experimental psychologist in the 19th century, observed that the ratio of the increment threshold to the background intensity is a constant. This relationship, known since as Weber's Law, can be expressed as:

where ΔI represents the increment threshold (just noticeable difference for discrimination); I represent the initial stimulus intensity and k signifies that the proportion on the left side of the equation remains constant despite of variations in the I term. The fraction ΔI/I are known as the Weber fraction.

2. Weber's Local Descriptor

Motivated by Weber's Law, we propose a descriptor WLD. It consists of two components: its differential excitation (ξ) and orientation (θ). ξis a function of the Weber fraction (i.e., the relative intensity differences of its neighbors against a current pixel and the current pixel itself). θ is a gradient orientation of the current pixel.

3. Differential Excitation

It uses the intensity differences between its neighbors and a current pixel as the changes of the current pixel. By this means, I hope to find the salient variations within an image to simulate the pattern perception of human beings. Specifically, a differential excitation ξ (x_c) of a current pixel x_c is computed. For that first calculate the differences between its neighbors and the center point using the filter f00:

$$\xi(x_c) = \arctan\left[\frac{v_s^{00}}{v_s^{01}}\right] = \arctan\left[\sum_{i=0}^{p-1} \frac{x_i - x_c}{x_c}\right] \text{ ----------------(7)}$$

$$v_s^{00} = \sum_{i=0}^{p-1} \Delta x_i = \sum_{i=0}^{p-1} x_i - x_c \qquad \text{---------------- (8)}$$

$$v_s^{01} = \text{current pixel } (x_c) \qquad \text{---------------- (9)}$$

Arctangent function is used to limit the output to prevent it from increasing or decreasing too quickly when the input becomes larger or smaller.

4. Orientation

The orientation component of WLD is the gradient orientation, which is computed as:

$$\theta(x_c) = \gamma_s = \arctan \frac{v_s^{11}}{v_s^{10}} \qquad \text{---------------- (10)}$$

$$v_s^{11} = x_7 - x_3, \qquad \text{---------------- (11)}$$

$$v_s^{10} = x_5 - x_1 \qquad \text{---------------- (12)}$$

5. Characteristics of WLD

The proposed descriptor, WLD, is based on Weber's Law. It has several advantages, such as detecting edges elegantly, robustness to noise and illumination change, and powerful representation ability. WLD is based on a physiological law. It extracts features from an image by simulating a human sensing his/her surroundings. WLD uses the ratio of the intensity differences v_s^{00} to v_s^{01} motivated by Weber's Law. As expected, WLD gains powerful representation ability for textures. Filtered images produced by WLD, from which one could conclude that a WLD extracts the edges of the images perfectly even with heavy noise. Furthermore, the results of texture analysis show that much of the discriminative texture information is contained in high spatial frequencies such as edges. Thus, the WLD works well to obtain a powerful feature for textures. WLD is robust to noise appearing in a given image. Specifically, a WLD reduces the influence of noise, as it is similar to the smoothing in image processing. A differential excitation is computed by a sum of its *p*-neighbor differences to a current pixel. Thus, it reduces the influence of noisy pixels. Moreover, the sum of its *p*-neighbor differences is further divided by the intensity of the current pixel, which also decreases the influence of noise in an image.

The proposed descriptor is a simple, yet very powerful and robust local descriptor. This descriptor consists of two components: differential excitation and orientation. It is inspired by Weber's Law, which is a psychological law. It states that the change of a stimulus (such as sound, lighting) that will be just noticeable is a constant ratio of the original stimulus. When the change is smaller than this constant ratio of the original stimulus, a human being would recognize it as a background noise rather than a valid signal. Motivated by this point, for a given pixel, the differential excitation component of the proposed Weber Local Descriptor (WLD) is computed based on the ratio between the two terms: one is the relative intensity differences of a current pixel against its neighbors (e.g., 3×3 square region); the other is the intensity of the current pixel. With the differential excitation component, we attempt to extract the local salient patterns in the input image.

In addition, we also compute the gradient orientation of the current pixel. That is, for each pixel of the input image, we compute two components of the WLD feature (i.e., differential excitation and gradient orientation). In this case, the WLD feature is computed pixel wise. Thus, WLD is a dense descriptor.

5, CONCLUSION AND FUTURE ENHANCEMENT

The proposed novel discriminative descriptor is called WLD. It is inspired by Weber's Law, which is a law developed according to the perception of human beings. The WLD features are computed by using Difference of Gaussian (DoG) for both differential excitation and orientations at certain locations. Besides the performance comparison with the other methods, it is also compared to the computational cost of WLD with LBP. The analysis shows that the computation of WLD is much faster compared with LBP for the Single Sample per Person Problem (SSPP). The proposed feature selection approach reduces the computation time considerably, without affecting the recognition performance. Furthermore, for training only one image per person is used which makes it useful for practical face-recognition applications. This paper has also evaluated the performances of the FERET datasets. The results clearly showed that the Weber's Local Descriptor based face representation attains a good result.

The direction of future enhancement lies in how to exploit the proposed descriptor for the domain of face recognition of identical twins and also be enhanced by applying a feature level fusion to improve the recognition performance with less computation time for the Single Sample per Person Problem.

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