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Research Paper

FACE RECOGNITION BASED ON SLTP METHOD UNDER DIFFERENT EMOTIONS

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The popularity of Face Recognition (FR) systems have increased due to their use in widespread applications, such as biometric (identification and authentication), security (Banks, airports, etc.) and surveillance (missing children or tracking down fugitive criminals) systems, as well as image and video indexing systems. FR has been a strong field of research since the 1990s, but is still far from reliable and more techniques are being invented each year. FR research area main difficulties are, some people faces recognition might not work as well as for others (for example, long hair or beard, emotions, lighting, and background might give extra difficulty). Most of the research experts strongly believe that emotions of a person play the crucial role in decision making. The effective and quality decisions are made when the person is in a normal state of emotion but not in an abnormal state of emotions. This paper introduces recognition of a face under different emotions based on Soft Local Ternary Patterns (SLTP). This method performance is evaluated on the MATLAB and results are compared in terms of recognition rate.

Keywords: Face Recognition, Emotions, Recognition rate, LBP, LTP, SLTP

INTRODUCTION

The biometric recognition of individuals based on their physiological or behavioral characteristics, such as the face, speech, fingerprint, iris, and signature provides a powerful alternative to traditional authentication schemes presently applied in a multitude of security and surveillance systems (Anil K Jain *et al*., 2006). Recognition is a challenging research area in terms of both software and hardware. In this paper, we presented Face Recognition system.

Facial biometrics is one of the fastest growing areas of biometrics. It is a form of computer vision that uses the face to identify or to verify a person. FR is a challenging

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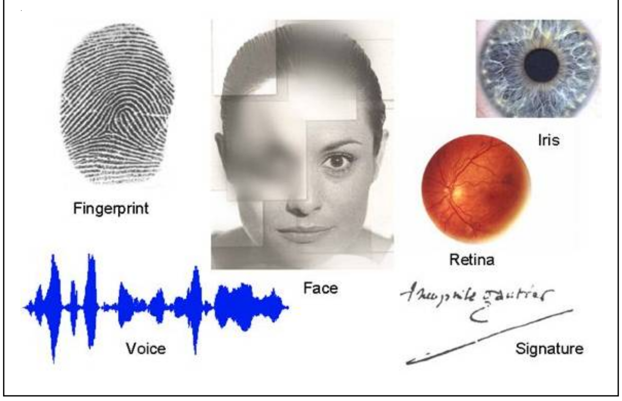
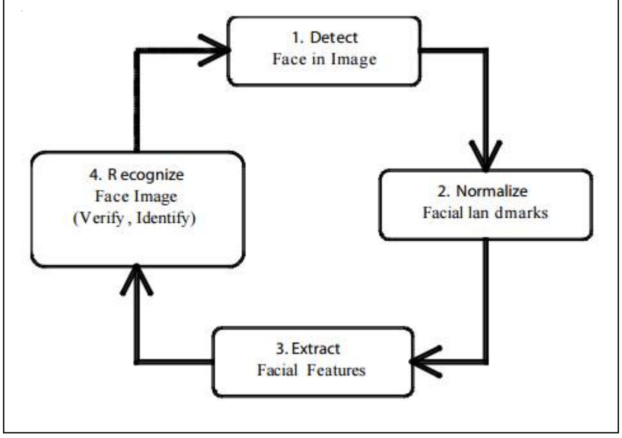
Figure 1: Biometric-Based Recognition Techniques



problem in the field of image analysis, computer vision, and pattern recognition due to its numerous practical applications in the area of biometrics, information security, access control, law enforcement, smart cards, and surveillance system. There are many existing systems to identify faces and recognized them. But those systems are not so efficient to have automated face detection, identification, and recognition. A lot of research work is going in this direction to increase the visual power of a computer. This paper presents how to recognize a human's face, even under varying condition of emotions (sad, happy, fear, anger, and surprise) (Zhao *et al*., 2003).

The general block diagram for FR system is having four main blocks: Face detection, Normalization, Feature extraction, and Face recognition (shown in the Figure 2) (Chellappa *et al*., 2010). Face detection is the process of localizing and extracting faces from scenes. So, the system positively identifies a certain image region as a face. The face normalization is used to reduce the effect of useless and redundant information such as background, hair, cloths, etc. The next step feature extraction involves obtaining relevant facial features from the data. Finally, the system does recognize the face. These steps depend on each other and often use similar techniques. All steps pose very significant challenges to the successful operation of an FRs.

Figure 2: Block Diagram of a Basic Face Recognition System



The rest of this paper is organized as follows. We briefly discuss different recognition technologies Section II, while section III presents an overview of the existing and proposed FR methods. In Section IV, we discuss face recognition results compared with existing techniques. Finally, this paper is concluded in Section V.

RECOGNITION TECHNOLOGIES

Leading biometric technologies are face, speech, fingerprint, iris, and signature. Recognition systems are capable of doing verification, identification, segmentation, classification, tracking, and detection.

A. Speech recognition

Speech is the most natural form of human communication and speech processing has been one of the most exciting areas of the digital signal processing (DSP). Speech recognition (is also known as Automatic

Speech Recognition (ASR)) is the process of converting a voice signal to a sequence of words, by means of an algorithm implemented as a computer program. It can be used in different types of domains like education sector (to check the pronunciation of words), domestic sector (like car locking systems, washing machines, refrigerators, etc.), and also for several security configurations (Rabiner and Juang, 1993). From previous several decades, human beings tried to create technologies that could recognize correct speech. ASR is one of the fastest growing areas in the framework of speech science and engineering. The primary aim of ASR systems is to develop the new techniques and systems for speech input to machines (Anusuya and Katti, 2009). The training process of an ASR system is shown in Figure 3.

Figure 3: Speech Recognition System: (a) The Training Process of ASR System, (b) Testing Process After Giving the Input Voice Query, (c) Testing Process When The Query is Not Matched

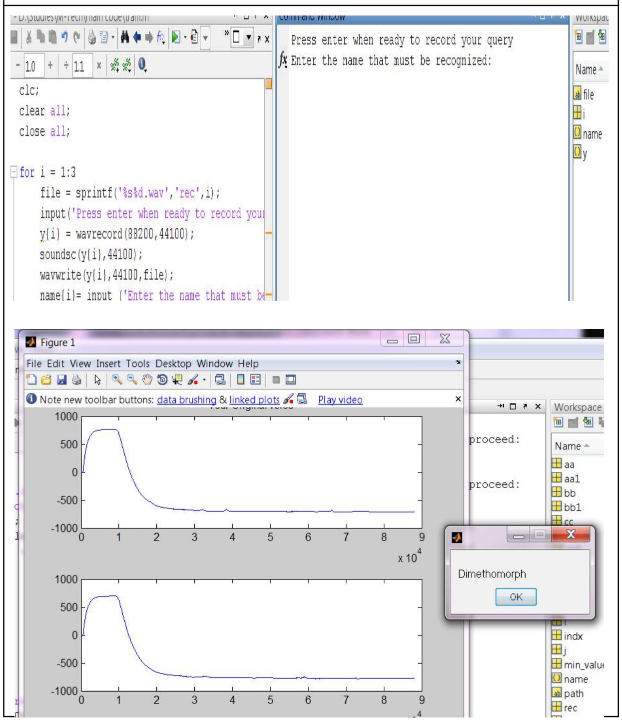
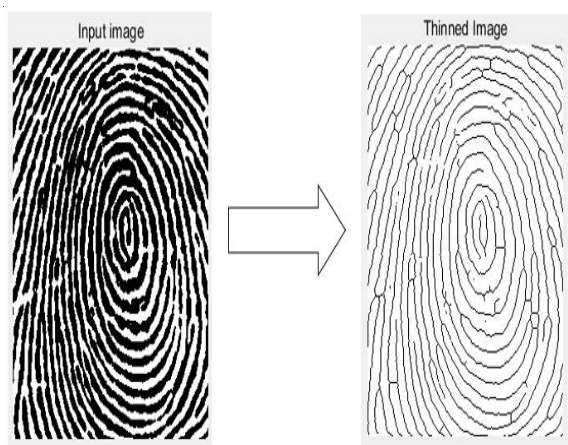


Figure 3 (Cont.)

B. Fingerprint recognition

Fingerprint recognition also one of the popular technology in the biometric system as fingerprint remains unchanged throughout the life of a person. It refers to the automated method of verifying a match between two human fingerprints (Ravi*et al*., 2009). Fingerprints are unique in nature and fingerprints of one person are different from another person's fingerprints. It is a challenging problem in the access control mechanism and for attendance system due to its numerous practical applications in the area of biometrics, voter registration and identification, passport verification, Driver's license and professional ID card verification, etc.

Figure 4: Fingerprint Recognition System



C. Iris Recognition and Signature Recognition

Every person has unique physical features and iris recognition (or eye recognition) is one of the distinguishable features. It can be used for access control and to enhance the security mechanism. The iris is captured via an infrared (IR) imaging process, which distinguishes the iris from the pupil and sclera portions of the eye (Majekodunmi and Idachaba, 2011). The signature recognition is a behavioral biometric, used for person recognition. The signatures are classified into two types offline (static) and online (dynamic). In static mode, users write their signature on paper, digitize it through an optical scanner and in dynamic mode, users write their signature in a digitizing tablet, which acquires the signature in real time.

Figure 5: Iris Recognition System

FACE RECOGNITION SYSTEM

The aim of FR is to identify or verify one or more faces from the image. Different approaches to recognize human faces, such as feature-based, appearance-based, and color-based. The feature-based approach recognizes a human's face based on human facial features, such as eyes and nose. This method gives higher accuracy rate, but not suitable for power limited devices and also requires lots of computing and memory resources. The appearance-based recognition work on distinguished regions in the image, it is of great importance to find such regions in a highly repetitive manner. Hence, a color-based algorithm is more reasonable for applications that require low computational effort. In general, each method has its own advantages and disadvantages. More complex algorithm typically gives very high accuracy rate but also requires lots of computing resources.

Figure 6: Face Recognition: (a) Single Person (b) Multi Person

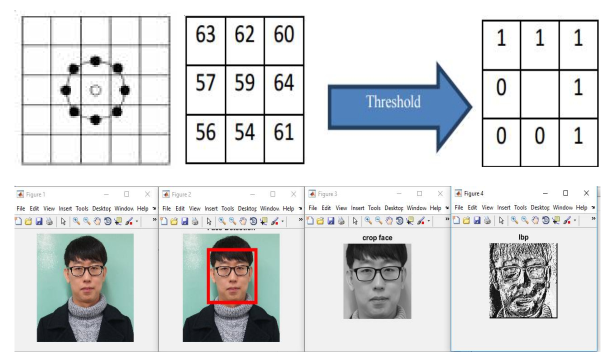
The key issue in emotional recognition is to find operative features in emotion appearance. For the past few years, emotion recognition for decision making has received substantial attention from researchers in numerous applications like holistic and logical descriptor techniques. FR is a fundamental task for operations like emotion recognition, face detection, decision making, face tracking, and security systems. To build flexible systems to run on handheld personal computers and mobile phones, efficient and most robust FR algorithms are required. Most of the existing algorithms use pixel values as features, however, they are sensitive to noises and uneven light conditions.

1) Local Binary Pattern (LBP) Operator

Timo Ojala introduced LBP as a means of summarizing local gray-level structure [8]. The operator assigns a label to every pixel of an image by thresholding the 3x3 neighborhood (Xp) of each pixel with the center pixel (Xc) value and considering the result as a binary number. Then, the histogram of the labels can be used as a texture descriptor. It consists of two binary values 0 (background) and 1 (foreground). The eight circular neighborhoods surrounding a center pixel is shown in Figure 7. The operator gives the binary value of 1 if the Xp is larger than Xc and 0 if otherwise. The operation mathematically be expressed as

$$LBP(x) = \sum_{i=0}^{7} S(Xc - Xp)2^i \qquad ...(1)$$

Figure 7: FR Using LBP Operator: (a) Procedure of The LBP Operator, (B) LBP Recognition



Later the LBP operator was extended to use different size of neighborhood to deal with different scales of textures (Nagaraju *et al*., 2015). Its key advantages are highly discriminative power, computational efficiency, easy to understand and invariant to monotonic gray level changes. But it is sensitive to small fluctuations of pixel values and noise.

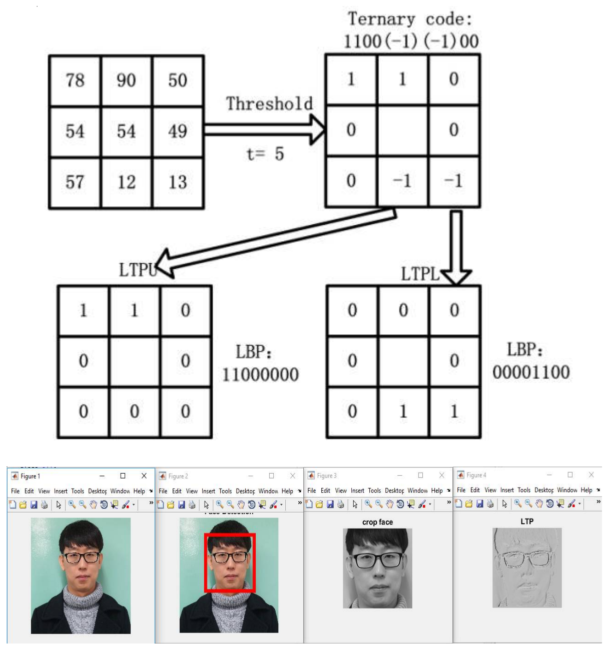
2) Local Ternary Patterns (LTP) Operator

The LTPs are new 3-valued texture operator that can be used to overcome limitations which arises in LBP operator [10]. LTP method consist three values -1 (noise), 0 (background), and 1 (foreground). The LTP will define a threshold (t) and any pixel value within the interval of –t and +t, thus assigns the value 0 to that pixel, while the user assigns the value 1 to that pixel if it is above this threshold and a value -1 if it is below it when compared to the central pixel value. The LTP operator is defined mathematically with function shown in equation (2).

$$LTP(i) = \begin{cases} 1, & (Pi - Pc) \geq t \\ 0, & (Pi - Pc) < t \\ 1, & (Pi - Pc) - t \end{cases} \qquad ...(2)$$

To get rid of the negative values, the LTP values are divided into two LBP channels, the

Figure 8: FR Using LTP Operator: (a) Procedure of the LTP Operator, (b) LTP Recognition



upper LTP (LTPU) and the lower LTP (LTPL). The LTPU is obtained by replacing the negative values in the original LTP by zeros. The LTPL is obtained in two steps, first, we replaced all the value of 1 in the original LTP to be zeros then we changed the negative values to be 1. The LTP operator procedure is shown in Figure 8.

This method main advantage is better to extract facial texture features and robustness to illumination. However, this technique is very less effective for uncertainty in the face images because the selection of optimal threshold is a difficult task. In this paper, we proposed Soft Local Ternary Patterns operator for overcome these limitations.

1) **Soft Local Ternary Patterns (SLTP) Operator:** Fuzzy logic is one of the enhanced soft computing techniques to remove ambiguity in the face images with an optimal threshold. The soft computing is integrated with LTP operator and named it as SLPT operator. With LTP technique if the pixel value is within in the series of threshold say t and –t then 0 (three valued code) is assigned and for the value is larger than t is assigned 1 and for the value less than –t is assigned -1. This technique gives better results than traditional LTP. In the LTP method, threshold value selection is difficult. If t is larger the micro patterns are removed as noisy pixels and if the t is smaller noise could not be removed properly. To overcome this uncertainty fuzzy logic rules are applied in between t and –t.

Rule0: It is defined as more negative Äpi is greater the certainty that makes background of face image and assigned -1.

Rule1: It is defined as more positive Äpi is greater the certainty that makes foreground of the face images and assigned 1.

The pixel value in between more negative and more positive is considered as uncertainty pixel value. This uncertainty can be removed efficiently with fuzzy rules. We computed mean as m0 and standard deviation as 5Øß0 with rule0 within the range of 0 and –t. Mathematically the rule0 is defined as in equation (3).

$$\mu 0 = \begin{cases} 0, & if\ \Delta pi \geq (m0+\sigma 0) \\ \dfrac{(x-m0)\wedge 2}{2\sigma 0 \wedge 2}, & (if\ \ m0-\sigma 0) \leq \Delta pi < (m0+\sigma 0) \\ -1, & if\ \Delta pi < (m0+\sigma 0) \end{cases} \quad ...(3)$$

We computed mean as m1 and standard deviation as 5Øß1 with rule1 within the range of 0 and t. Mathematically the rule1 is defined as in equation (4).

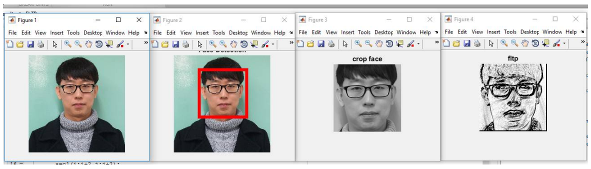
$$\mu 1 = \begin{cases} 0, & if\ \Delta pi \geq (m1+\sigma 1) \\ \dfrac{(x-m1)\wedge 2}{2\sigma 0 \wedge 2}, & (if\ \ m1-\sigma 0) \leq \Delta pi < (m1+\sigma 1) \\ 0, & if\ \Delta pi < (m1-\sigma 1) \end{cases} \quad ...(4)$$

Finally LTP operator is computed as in equation (5).

$$LTP(i) = \sum_{i-0}^{7} di.2^{i} \quad ...(5)$$

where di value may be in set {-1,0,1} of values. The SLTP exploits the computational power of predicting the threshold by adapting to the decision making with the greater efficiency.

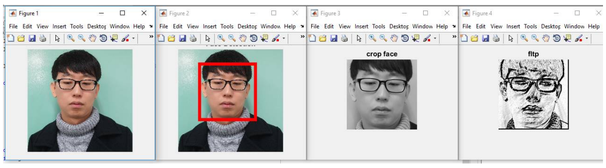
Figure 9: Face Recognition Using FLTP Operator



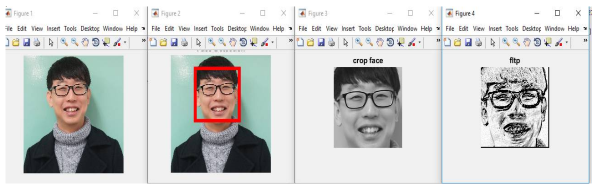
RESULTS

This proposed SLTP recognition system recognizes a human's face, even under varying condition of emotions (sad, happy, fear, anger, and surprise) shown in the Figure 10.

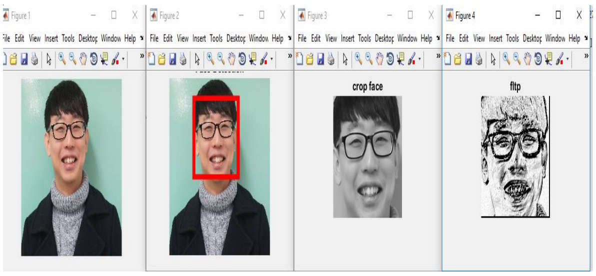
Figure 10: Face Recognition Using SLTP Operator



(a) Sad

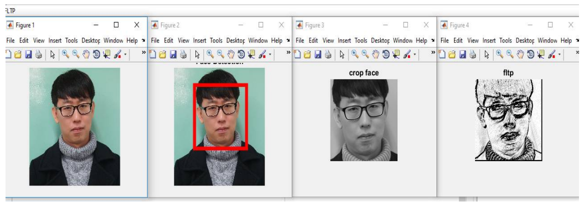


(b) Happy

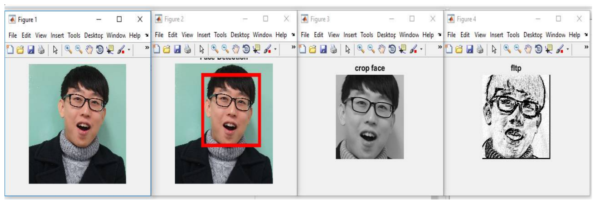


(c) Fear

Figure 10 (Cont.)



(d) Anger



(e) Surprise

The performance of the face recognition method can be measured with recognition rate, defined as follows:

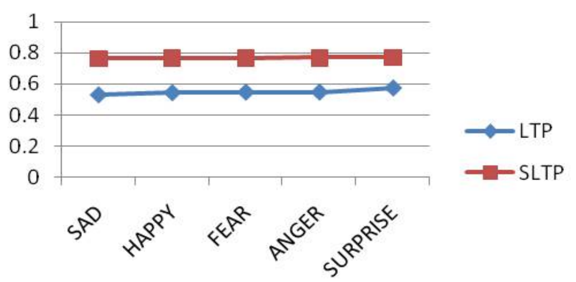
Recognition rate = number of correct recognition / number of face * 100%.

The experimental results are shown in the Table 1.

Table 1: Comparison Between LTP and SLTP Operator

Method	Recognition Rate				
	Sad	Happy	Fear	Anger	Surprise
LTP	0.5325	0.5454	0.5492	0.5497	0.5754
SLTP	0.7657	0.7666	0.7670	0.7685	0.7696

Figure 11: LTP Vs SLTP



In this paper five emotions considered and SLTP operator produced better recognition rate for all emotions compared to LTP operator shown in the above Figure 11.

CONCLUSION

In the decision making system, emotions play a vital role. In this paper SLTP operator is developed as the face analysis technique to find a kind of emotions used in decision making system. The SLTP contains three steps first is to detect face images from non-face images by localizing the size and shape of the image. Second is feature extraction by cropping face image into smaller features like lips, left eye, right eye, eye pair, nose, and mouth. Third is to analyze features to find the kind of emotions used in decision making system. This technique is suitable to select improved and efficient feature for identifying polluted pixels and to develop optimal threshold to recognize facial emotions for decision making which produced reliable results. This method is suitable for the images having low contrast, rotation variant and noise faces for emotion recognition. However it nosedives for intentional emotions. Future work is going on to recognize intentional emotions.

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