Face Recognition System using Local Feature Descriptors: A Survey

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Abstract— Face recognition is evergreen and rapidly growing research field in the area of Artificial Intelligence and Automation, Computer Vision. It is used to finding an individual's identity. There are various methods used to represent a face. In this paper i am going to introduced about what are the various existing techniques used to represent the face and the difference of choosing local approach compare to holistic approach to represent the facial images. The most common local techniques used like LBP, ELBP, LTP, LDP, LTrP, & LDN. And also give the brief idea about these local techniques.

Index Terms— Biometrics, Feature Extraction, Feature Vector, Face Recognition, Local Patterns, Local Directional Number Pattern.

I. INTRODUCTION

The Human Facial recognition is one of the most important areas in the field of human computer Interaction, smart environment, automated access control, and various medical applications.

In the recent years automated persons identification is highly researched because for protected access to computer, buildings, mobile phones, ATM's and Video surveillance.

Person's identification techniques are broadly classified into three types, Knowledge based approach, Token based approach & Biometric based approach. Knowledge based approach works that something that an individual knows about for making a person's identity purpose like knowing about the password and PIN. Token based approach works that something that an individual have for making an identity of an individual for example, passport, credit card, license, id-card, or keys. And Biometric based approach works based on the physiological and the behavioral characteristics of the human beings. But however, in knowledge based approach sometimes passwords can be easily guessed and user ID can be shared, sometimes PIN can be forgotten. In token based approach badges can be duplicated, cards can be shared and keys can be lost or stolen. To overcome these knowledge and token based problems there is another special technique called Biometric is used [1].

1.1 What is Biometrics?

Biometric technique is an automated method of identifying individual by means of comparing feature vector derived from their Behavioral and Physiological characteristics. This method is most convenient and secure authentication for an individual because like password it cannot be guessed, stole or forged. This method is based on the human's behavioral and physiological characteristics [2], [5].

Physiological characteristics include based on the measurement and data derived from direct measurement of a part of the human body the most common physiological characteristics include:

a. Face scan
b. Finger scan
c. Iris scan
d. Retina scan
e. Hand scan etc.

Behavioral characteristics include based on measurement and data derived from an action. The most common behavioral characteristics include:

a. Signature scan
b. Voice scan
c. Keystroke scan

Among them face recognition technique is most popular because no user physical interaction is required and also it can work with very few inexpensive camera. This method is accepted by most of the user and the researcher's. Face recognition is used to identify the individual's identity by using face images.

Biometric techniques can work either in verification mode or identification mode:

In the verification mode, the system authenticates a person's identity by comparing the captured biometric image with her own biometric template(s) which is stored in the system database. Here in this mode, an individual who desires to be recognized claims an identity is usually via a identification number (eg. PIN), a user name, or a smart card, and the system conduct a one-to-one comparison to determine whether the individual who claims is true or not. Identity verification is typically used for positive recognition, where the aim is to prevent multiple people from using the same identity. In the identification mode, the system recognizes an individual by searching the templates of all the users in the database for a match. Therefore, the system conducts a one-to-many comparison to establish an individual's

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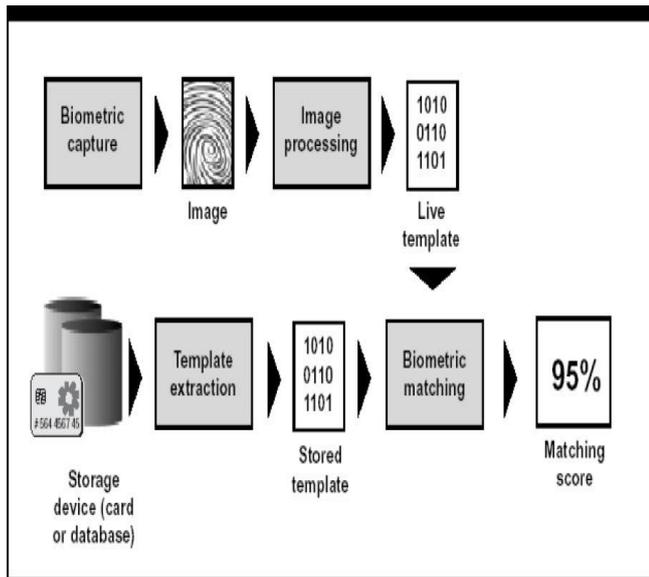identity. Figure1 shows an example of verification process [1], [2], [3], [4], [6].

Figure 1: Example of the verification Process [3].

There are several methods used to identify individual's identity by using face recognition method. These methods like PCA, ICA, LDA, and Gabor face, Local Binary Pattern (LBP), Extended LBP, Uniform patterns, Improved LBP, Mean LBP, Local Ternary Pattern, Local Directional Number Pattern etc. During the last few decades LBP have shown an increasing interest for face recognition in the field of the digital image processing. Due to non-parametric characteristics, LBP review the images more efficiently by comparing the reference pixel with the surrounding pixels. LBP is very simple and easy to understand and it can tolerate in monotonic illumination variations. It is mainly developed for the texture classifications and excellent performances in the face recognitions. But LBP is very sensitive to non-monotonic illumination changes like age, expressions, and random noise conditions and hence the performance degrades.

To overcome these problems Zhang et el. developed a more robust facial feature based on the local directional number pattern to get the better result than simpler LBP. But this method is still having problem due to non-monotonic illumination variations. To overcome these problems Rivera et al. proposed Local Directional Number Pattern (LDN) for robust face recognition that encodes the structural information and the intensity variations of the faces texture. LDN encodes the structure of a local neighborhood by analyzing its directional information.

II. REVIEW ON FACE RECOGNITION SYSTEMS

Currently there are two approaches to extract facial features of images: geometric facial features and appearance based features method.

The geometric feature based method computes the locations and shape information's of different facial components example like nose, mouth, eye, distance between nose and the eye region. These facial components are then used to form the feature vector which represents the geometry of the face. The method like local & global graph algorithm is used to represent the face of geometric facial feature based approaches. But there is a limitation with this approach this method always required very accurate and consistent facial features recognition, which will be very difficult in a different environments and situations.

Whereas, the appearance based method uses images filters like Gabor Wavelets applied either on the whole face image or some specific region of the face image to extract the feature vector which will helpful to extract the appearance changes in the face images. Image filter applied on the whole face, to create the holistic features or some specific face region to create the local features. The appearance based method's performance is good in controlled environment but their performance degrades in environmental changes [7]. The methods which are used in the holistic based are Eigen faces using Principal Component Analysis (PCA), Fisherfaces using Fisher linear discriminant (FLD). And the method used in the local features is Gabor features, EBGM, LBP. Among them LBP method is better in terms of performance.

A. Local Binary Pattern(LBP)

T. Ahonen et al. in [8] defines LBP is a simple 3*3 matrix which having one centre pixel and eight surrounding neighbor pixels. The binary result is obtained by computation of the reference pixel with all the eight neighboring pixels. LBP is mainly used for texture analysis of the image it works better in monotonic illumination variations but however, it performance degrades with non-monotonic illuminations variations like random noise etc. and also LBP don't capture the dominant information in large scale structure due to very less number of the surrounding pixels.

B. Extended LBP(ELBP)

Simple LBP method lacks to capture the dominant information in very large structures to overcome this problem, an Extended LBP is developed which takes use of different sizes of neighborhood pixels surrounded in a circular space (P,R) where P is the one of the neighborhood pixel and R is the distance between the centre pixel and the neighborhood pixel. But this method still suffering from non-monotonic lightning variations [9], [10].

C. Local Ternary Pattern(LTP)

LBP method is very sensitive to random noise to overcome these problems Tan & Triggs developed a generalization of LBP called the Local Ternary Pattern(LTP). LTP is a 3 coded values, in which gray levels in a zone of width $\pm$ t around ic are quantized to zero, one above this are quantized to +1, and one below to it quantized to 1. The problem with this method is that we need to set always the threshold value which is not a simple [10], [11].

D. Local Derivative Pattern(LDP)

Zhang et al. in [12] developed the Local Derivative pattern for face recognition; they considered the LBP as the non-directional first order local pattern operator and extended it to the higher order derivative (nth order) called the Local Derivative pattern which captures the more dominant information compared to simple LBP. To calculate the nth order LDP, $(n-1)^{th}$ –order derivatives are calculated along 0^0, 45^0, 90^0, & 135^0. But this method generates 32-bit binary code which increases the feature length compared to LBP.

E. Local Tetra Pattern (LTrP)

Murala et al. in [13] found that 1D relationship of LDP can be extended to 2D relationship in both horizontal and vertical directions in 0^0 & 90^0. But this pattern generates 96 bit code

which increases the feature length and high redundancy problems.

F. Local Directional Number Pattern(LDN)

In the previous research showed edge magnitudes are largely insensitive to lighting changes to overcome these problems Rivera et al. proposed a method called local directional number pattern (LDN). LDN is a six bit binary code which is assigned to every pixel of the input image which represents its intensity transitions as well as the structure of the texture. Here Micro-pattern is obtained by computing the edge response of the neighborhood using a compass mask (Kirsch mask) and by taking the top directional numbers i.e the most positive and the negative direction numbers of those edge responses which indicates the directions of the bright and the dark areas in neighborhood.
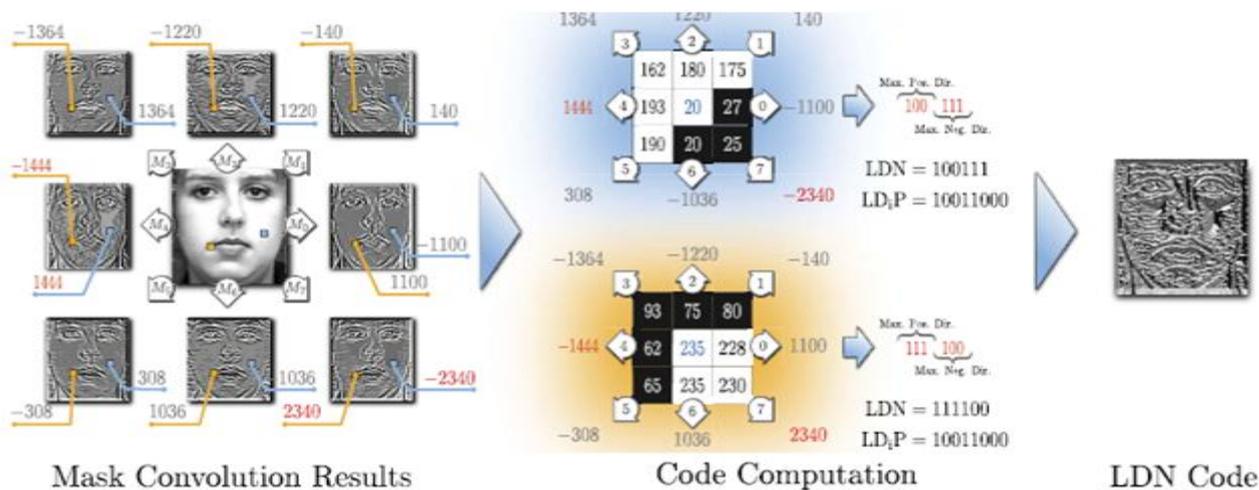

Figure 2. LDN code Computation by convolving Kirsch mask with original image [14].

Figure 3. Kirsch template in eight directions [15].

From these top positive and negative directions a LDN 6-bit micro-pattern is generated and obtained an LDN image. This LDN image is later divided into blocks and from each block an LDN histogram (LH) is calculated. These LH is concatenate to form the feature vector called the face descriptor. The objective is to compare the encoded feature vector from one person with all other candidate's feature vector with the Chi-Square dissimilarity measure between

Two feature vectors F1 and F2, of length N. The feature vector with the lowest measured value indicates the match found.

Rivera et al. in [15] extended the LDN to Local Directional Texture Pattern (LDTP) for to distinguish person's expressions, and different landscapes scenes.

III. CONCLUSION

In this paper we have focused and studied various user authentication and identity techniques and biometric technique is useful compared to other traditional techniques for individual's identity and why we choose face recognition compared to other techniques. And studied various face recognition techniques and choosing local pattern a better face recognition technique compare to geometric and holistic. The various user authentication techniques for face recognition are PCA, Gabor Face, LBP, ELBP, LTP, LDP, & LDN. LBP is 3*3 matrixes which generates the 8-bit LBP code by computing between the reference pixel and the surrounding pixel. But LBP is not so dominant in very large scale structures and very sensitive to non-monotonic illumination change so to overcome this problem in this paper we have seen other modification of LBP like ELBP, LTP, LDP, LTrP, and LDN. Among them LDN is very

compact that is six-bit code which is generated by convolving the kirsch compass mask with the original image and it reduces the feature length compared to LBP and LDP which is 8-bit and 32-bit code respectively. This method works better in monotonic and non-monotonic illumination variations.

REFERENCES

[1] S. Prabhakar, S. Pankanti, and A. K. Jain,"Biometric recognition: Security and privacy concerns," *IEEE Security Privacy,* vol. 1, no. 2, Mar. /Apr. 2003, pp. 33-42.

[2] Debnath Bhattacharyya, Rahul Ranjan, Farkhod Alisherov A, and Minkyu Choi, "Biometric Authentication: A Review," *International Journal of u- and e- Service, Science and Technology* ,Vol. 2, No. 3, September, 2009, pp.13-27.

[3] A Small Card Alliance Report "Smart Cards and Biometrics in Privacy-Sensitive Secure Personal Idenification Systems" Publication No. ID-02001, 2003, pp.11-23.

[4] Anil K. Jain , "An Introduction to Biometric Recognition," *IEEE Transactions on Circuits And Systems For Video Technology*, Vol. 14, NO. 1, January 2004, pp. 4-20.

[5] K. P. Tripathi, "A Comparative Study of Biometric Technologies with Reference to Human Interface," *International Journal of Computer Applications (0975 – 8887)* Volume 14 No.5, January 2011, pp.10-15.

[6] Urvashi Bakshi, Rohit Singhal, Monika Malhotra, "Biometric Technology: A Look and Survey at Face Recognition," *IJESI* , Vol. 3 Issue 6, June 2014, PP.24-30.

[7] S.Z., A.k.Jain, Y.L.,Tian et al., "Facial Expression analysis," *in Handbook of face Recognition. New York: Springer-Verlag*, 2005, Chap. 11.

[8] T.Ahonen,A.Hadid, and M.Pietikainen, "Face recognition with local binary patterns," *in Proc. Euro. Conf. Comput. Vis.,* 2004, pp. 469-481.

[9] Bo Yang & Songcan Chen, "A comparative study on local binary pattern (LBP) based face recognition: LBP histogram versus LBP image," *Elsevier, Neurocomputing*, 3 April 2013, pp. 365-379.

[10] Di Huang, Shan, Ardabilian, Wang, & Chen, "Local Binary Patterns and Its Application to Facial Image Analysis: A Survey," *IEEE Transaction on Systems, Man, & Cybernetics,* vol. 14, No. 6, Nov. 2011, pp. 765-781.

[11] Tan, and Bill Triggs, "Enhanced Local Texture Feature Sets for Face Recognition Under Difficult Lighting Conditions," *IEEE Transaction on Image Processing,* vol. 19, No. 6, June 2010, pp. 1635-1650.

[12] B. Zhang, Y. Gao, S. Zhao, and J. Liu, "Local derivative pattern versus local binary pattern: Face recognition with higher-order local pattern descriptor," *IEEE Trans. Image Process.,* vol. 19, no. 2, Feb. 2010, pp. 533–544.

[13] S. Murala, R. P. Maheshwari, and R. Balasubramanian, "Local tetra patterns: A new feature descriptor for content-based image retrieval," *IEEE Trans. Image Process.,* vol. 21, no. 5, May 2012, pp. 2874–2886.

[14] Adin Ramirez Rivera, Jorge Rojas Castillo, and Oksam Chae, "Local Directional Number Pattern for Face Analysis: Face and Expression Recognition," *IEEE Transactions on image processing,* vol.22, No.5, May 2013, pp.1740-1752.

[15] Fuzin Zhong, Jiashu Zhang, "Face Recognition with enhanced local directional pattern", *Elsevier, Nero-Computing.,* June 2013, pp. 375-384.

[16] Adin Ramirez Rivera, Jorge Rojas Castillo, and Oksam Chae, "Local Directional Texture Pattern image descriptor", *Elsevier, Pattern Recognition Letters,* September 2014, pp. 94-100.