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# Steerable pyramid transform and local binary pattern based robust face recognition for e-health secured login☆

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ABSTRACT

This paper proposes a face recognition system based on a steerable pyramid transform (SPT) and local binary pattern (LBP) for e-Health secured login. In an e-Health framework, patients are sometimes unable to identify themselves by traditional login modalities such as username and password. Automatic face recognition can replace the conventional login modalities if the recognition system is robust. In the proposed system, SPT can decompose a face image into several subbands of different scales and orientations, and LBP can encode the subbands in binary texture pattern. Therefore, SPT-LBP scheme represents a face image in a robust way that includes multiple information sources from different scales and orientations. The proposed system is evaluated on the facial recognition technology (FERET) database. According to the results, the proposed system achieves 99.28% recognition in fb set, 80.17% in dup I set, and 79.54% in dup II set.



## 1. Introduction

In an e-Health framework, patients may not be able to speak or write username and password to authenticate him; however, his face is still available and can easily be deployed as a login modality. This aspect of face recognition is less researched in the literature, though a general face recognition research is somewhat matured. Face recognition is considered as one of the noninvasive biometrics, which is widely used in many security systems.

Over the last 10 years, research about recognizing a face takes a popular area over other biometric systems. That because it's a balance between security, as it can be done efficiently without user cooperation or knowledge and social acceptances as it does not require electro-magnetic illumination generating and does not restrict user movement, so it is nowadays relatively inexpensive. Due to these reasons, face recognition is one of the popular choices in many security and law enforcement applications [1].

Hundreds of research works in this area are still published to achieve a higher recognition rate for that incompletely solved problem because of the dynamic structure of faces and different conditions that human faces' images can be varied

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on such as illumination, facial expression, makeup, eyeglasses, poses, etc. The current research involves developing a robust face recognition system against age, ethnicity, and occlusion.

Recognizing any pattern must consist of two primary steps. First is the feature extraction and the second is the pattern classification. In case of the feature extraction, there are many methods starting from the simplest one that uses pixel intensities as features. The second method is transforming subspaces of pixel intensities into a low dimensional space in the form of either principal component analysis (PCA), linear discrimination analysis (LDA) or independent component analysis (ICA). The third method uses texture information in the form of a local binary pattern (LBP), histogram of gradients (HoG), or Weber local descriptor (WLD). Nevertheless, another method utilizes multi-resolution transform techniques, such as wavelets, which extract features efficiently by analyzing images into distinct scales of resolution, which gives different sub bands from the same face. After decomposition, the components, which are less sensitive to distortion due to illumination and expressions, are taken [2].

There are two types of face features: holistic and local. The holistic features (also named as appearance or global features) are the overall face features that are extracted from each face as a single vector. In addition, it cannot deal with the variation of pose effectively such as local features because of its high sensitivity to rotation and translation. The famous holistic approaches are LDA and PCA. The local feature in contrast can be extracted out of many parts (such as noise, mouth, eyes and so on) from the face with its local statistics (such as appearances and geometric) and location as multiple vectors for each face. In another word, it measures the geometric relationship and properties such as distances, angles, areas between the important facial points. There are features that are a combination of holistic and local features. In such case, the face image is divided into blocks, and some feature extraction techniques are applied to these blocks [3].

Automatic face recognition is not a new area of research; however, the challenge is still there. The recognition performance significantly decreases with certain factors, such as, rotation, illumination, resolution, noise, etc. Especially, in an e-Health framework, patients face may not align directly to the camera; illumination may vary in different rooms; and noise can be added through transmission. To date, a good performance is achieved by using local features such as LBP or WLD, because these features are robust against some types of geometric modifications. Multi-resolution techniques such as wavelets and their variants are sometimes used to divide the face image into subbands of various scales and orientations for an improved performance. In particular, Gabor filters are fused with the LBP to produce a better descriptor than the LBP alone in the literature. Of them, Local Gabor Binary Pattern (LGBP) histogram, Histogram of Gabor Phase Patterns (HGPP), and Learned Local Gabor Patterns (LLGP) produced good results in several databases [4–6]. The main problem of using Gabor filters is its high computational cost, because each kernel needs to be convolved by the face image [7]. Similarly, the features based on wavelet decomposition are not good if the faces are captured in an uncontrolled environment.

Other variants of wavelets, such as contourlet and curvelet were also investigated in literature. Contourlet with PCA was used to extract face features in [8], and curvelet coefficients from different resolution face images were used in a classifier fusion approach of face recognition in [9]. These methods are also computationally expensive because, some of these transforms require quantized image in addition to the original image. Some recent face recognition systems can be found in [10,11], while some applications of multimedia on this topic can be found in [12,13].

In this paper, steerable pyramid transform (SPT) and LBP based face recognition system is proposed. SPT can decompose a face image into several orientations and in different resolutions. The first scale representations have the same resolution of the original image. SPT was used in several applications of image processing, for example, image denoising [14], forgery detection [15], and texture classification [7]. It has also been investigated in the face recognition system [16]; however, it was not fully explored there. The contributions of this work are (i) the development of an SPT-LBP based face recognition system, (ii) a thorough investigation of different subbands of the SPT towards the recognition of face, and (iii) a selection of subbands that achieve optimum results.

The organization of rest of the paper is as follows. Section 2 explains the proposed SPT-LBP based face recognition system for an e-Health care framework, Section 3 describes the experiments and results, and Section 4 gives the conclusion of the paper.

## 2. Proposed SPT-LBP based face recognition system

A framework of an e-Healthcare system, where face is used as a secured login for the patients is shown in Fig. 1. A mobile device in the form of a smart phone takes the face picture of the patient, and along with medical data, the face data is transferred to the cloud using the Internet. A cloud manager initiates the process of authentication by asking a resource allocation manager to distribute several tasks, including feature extraction and classification/recognition of the face. If the face is already enrolled in the system, the manager allows the medical data to be further processed, otherwise, it may ask the user for enrollment. A collaborative service manager manages the tasks of different virtual machines (VMs). The VMs are linked to a number of servers, which are responsible for distinctive executions such as feature extraction, classification, etc. The processed medical data will be made available to registered medical doctors.

Fig. 2 illustrates the process-flow of the proposed face recognition system. The input image is divided into several subbands using the SPT. The subbands are block-divided and LBP histograms are calculated from each block of the subbands. The histograms from the blocks and from the subbands are fused to construct a final feature set.

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