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Independent Component Analysis (ICA) Based Face Recognition System

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Abstract: Advancement in computing and telecommunications technologies, digital images and video are playing vital role in the present information era. Detection of a person from an image of their face is termed as face recognition. It is based on the classifiers applied for the feature extraction. It has its applications on various domains. Face recognition application without human intervention distinguish human faces in still images, or from a video frame or file. Identification of faces from the videos becomes more complex since the video frames are extensively huge in volume. Recognizing and tracking of face objects in video sequences is still an active research, which is considered in this paper. Illumination and pose is the two major problems exist with the face recognition. The video sequence is divided into frames for the purpose. The paper proposed a new method for face recognition, with the aid of Independent Component Analysis. Numerous faces with different texture, color and illuminations were considered for the detection purpose. The ICA algorithm is applied to recognize the face from the video images. The experimental results reveal that the proposed method yields better results than the existing ones.

Keywords: Face Recognition, Independent Component Analysis, Illumination, Still Images, Video Frames, Key Frames.

1. INTRODUCTION

Face recognition is defined as the classification of a person from an image of their face. Feature extraction method is applied for the researchers to perform the face recognition. A good feature extractor is claimed to select features which are not sensitive to poses and illuminations [1]. Face recognition acquires its importance in recent decades because of increasing demand over the security considerations. The last decade shows its progress at various applications such as human computer interaction, biometric analysis, Content-based image retrieval, content based coding of images as well as the videos and video surveillance etc [2]. Face Recognition on the other hand, is one of the non – intrusive due to its inefficient picture quality through images recorded by a distant camera. The problem comes in the scene is that to verify human faces from large stored databases of faces with record set of still or video images [3]. A lot of issues relies within the context of face recognition such as in their pose, illumination, expressions, ageing, occlusion, resolution of pixel arrangement etc. The main problem is with the variation of expressions and illuminations in the case of still images. The video sequence consists of moving objects with multiple of faces at a time. Hence, the detection and recognition of human faces with the video sequences becomes more complex [4]. Advancement in the computing and telecommunication field increases the security

consideration much more in the arena of images and videos. It plays vital role with huge volume of visual information that is handled by video databases. Hence, there is a requirement of effective techniques to handle the video files. In present techniques, users are allowed to search images by visual features, such as texture, color, shape, and sketch, besides traditional textual keywords. Hence, human face detection and recognition acquires its importance in the research area [5]. Among many proposed face recognition schemes image based approaches are possibly the most promising ones. Available collateral information such as race, age, gender, facial expression and speech may be used in narrowing the search enhancing recognition. But, the solution of the problem involves segmentation of faces, face detection from cluttered scene, feature extraction from the face region, recognition or verification [6]. A huge number of facial recognition techniques have been evolved, including principal component analysis, Independent Component Analysis, Heuristic approaches, probabilistic neural network approach, support vector machines etc. Independent component analysis (ICA) is a recently developed method in which the goal is to find a linear representation of non-gaussian data so that the components are statistically independent, or as independent as possible. Such a representation seems to capture the essential structure of the data in many applications, including feature extraction and signal

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separation [7]. Independent component analysis technique is applied in this paper, which appears very close to blind signal separation method for the face recognition. The ICA technique, will extract statistically independent variable from the mixture. This key idea is applied in the proposed technique to distinguish human faces from other objects [8]. The paper is organized as follows; we first describe in section 2 that shows a brief review of related work done on the topic of the face detection and recognition. The proposed technique is represented in section 3. Section 4 constitute of the experimental results obtained on the set of processed images. Section 5 comes out with the conclusion for the proposed method.

2. RELATED WORKS

Comparative Analysis of various face recognition approaches were explained by the authors on [4]. From the author's perspective, they covered almost various techniques used for the face recognition approaches. The relative analysis between all the approaches that are used for the recognition method is also discussed. Advantages and disadvantages exhibits in the techniques, with the recognition rates of all the techniques were also compared by them.

Face detection and tracking in the video sequence by using the motion estimation and fuzzy geometric model is explained by Hiremath et.al [5]. The feature extraction process is performed in the support region which is determined by the fuzzy rules to detect face in an image frame. Then, the consecutive frames from a video and their corresponding optical flow are estimated, which are used for tracking face in the video sequence. Single frontal face in the video frames with different motions, head tilts, lighting conditions, expressions and backgrounds are considered in the work. The experimental results from the method, demonstrate the efficacy of their method.

Survana Kumar et.al [3] discusses about the new technique for face recognition in controlled domains by learning additional information using heuristics. Multiple faces, with very low resolution and blurred ones are recognized by learning heuristics over time. The algorithm Heuristic Supplemented PCA (HSPCA) has been tested over several hours of different video sequences gathered from classrooms with around 30 students in each class. It has been observed that the performance improves over time, with the recognition rate using heuristics contributing significantly as time progresses.

Jawad Nagi, Syed Khaleel Ahmed and Farrukh Nagi [2] reveal their ideas with a new technique for human

face recognition. This technique uses an image-based approach towards artificial intelligence by removing redundant data from face images through image compression using the two-dimensional discrete cosine transform. Face recognition with Self Organizing Map is carried out by classifying intensity values of grayscale pixels into different groups. The main advantage of their technique is its speed and processing capability with low computations and memory utilization.

Ajit U. Ushir et.al expresses techniques on Mathematical Modeling for Face Recognition System [9]. In their explanation, they proposed the Eigen faces method for face recognition to improve its performance. Authors have introduced key-frame concept by using color histogram. Euclidean measurement is considered for the calculation. The eigen face with the least Euclidian distance is the one the person resembles the most. This technique is the first successful method in face recognition area.

3. PRELIMINARIES

3.1 Face Recognition

Face Recognition has wide variety of applications in areas such as content-based image retrieval, video coding, video conferencing, crowd surveillance, and intelligent human-computer interfaces. Face Recognition in both the still images or for the video is basically categorized into two parts namely the Face and Facial Feature detection, Face Recognition or Face Comparison. Although in the existing context face recognition on still images is ease, the complexity rise with video sequences, creates problem. The human face is a dynamic object and has a high degree of inconsistency in its appearance, which makes face recognition a complicated problem. The first step in face recognition is the Face detection is a with the purpose of localizing and extracting the face region from the background. Various classification techniques were used to separate the background and images.

Many of the current face recognition techniques assume the availability of frontal faces in similar sizes. Feature based approach is considered as better solution for face recognition in video sequences. Several challenges in face recognition include the changes in human face features at various poses, illumination, light moves, expressions, ageing, and continuous dynamic background. Hence, one of the ways to do this is by comparing selected facial features from the image and a facial database. The simplest ways to use the background information in a video sequence when compared to still images is to fuse the results obtained by a two dimensional face classifier for each frame of the sequence. A key frame is involved for further process for accurate

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results. The proposed algorithm is implemented for the video sequences face recognition with ICA model.

3.2 Independent Component Analysis

Independent Component Analysis is the generalized model of the principal component analysis that outperforms the existing PCA. It identifies the independent variables from the random mixture, for linear transformation as linear combinations. ICA works for the higher order statistics and this provide more powerful data representation than PCA. This rapidly evolving technique is currently finding applications in analysis of biomedical signals, video surveillance, Human-Machine interactions etc. The metric induced by ICA is advanced than that of the PCA, logically by providing a representation to the effect made by the noise.

Independent Component Analysis is based on the assumption that source signals are not only uncorrelated, but are also 'statistically independent'. Essentially, if two variables are independent then the value of one variable provides absolutely no information about the value of the other variable. By contrast, even though two variables are uncorrelated, the value of one variable can still provide information about the value of the other variable. ICA uses the Cluster analysis technique for finding regions in - dimensional space with large concentrations of data. These regions are called clusters. When the source models are sparse in the face detection, ICA finds directions along which significant concentrations of data points are observed. Thus, when using sparse sources of the face recognition, the ICA can be seen as a form of cluster analysis.

4. PROPOSED METHOD

The block diagram of the proposed method for face detection and recognition in a video sequence is shown in the Fig. 1. The proposed face recognition system design will accurately detect the human face in the video sequence. The video is converted into frames for further process. On every frame the algorithm is applied. To overcome the drawback of multiple face detection and to avoid duplication of faces, the key frame technique is applied. The key frames are calculated between set of frames so as to find the perfect edges of the human face. By calculating the distance between the pixels the shot is fixed. This approach contains the features extracted from the human face and represents it as the linear combination of independent variables. Recognition is achieved using the projection of the face into the space formed by the independent variables. The algorithm of the proposed method is given below:

Algorithm: Face detection and Recognition

- Input video sequence.
- Extract all the frames from the input video sequence, consider first video frame as key frame.
- Apply the searching algorithm on the face region in the key frame using important face features, namely, eyes and mouth, to detect the face.
- Apply the Independent Component Analysis algorithm to extract more accurate human face recognition, by combining independent pixels in linear combinations.
- Draw the rectangular box for the detected face in the frame.
- Repeat the Step 3, 4 and 5 till the end of the input video sequence, which results in the detection and recognition of human face in the video sequence frame.

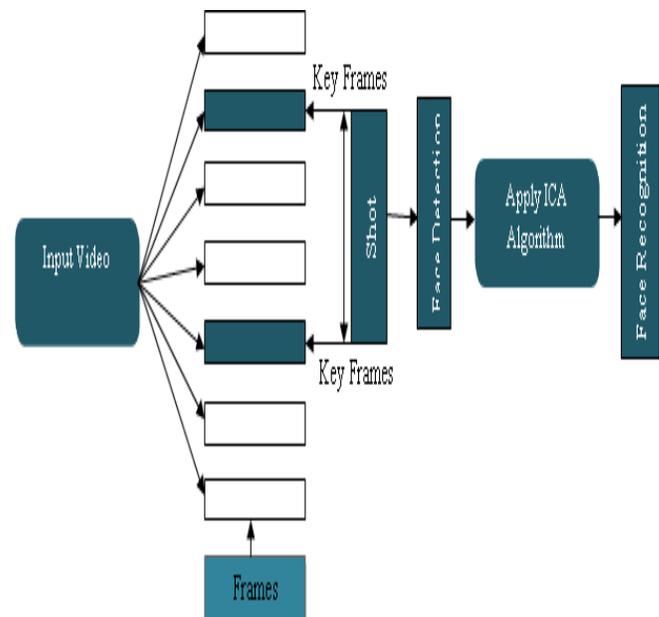


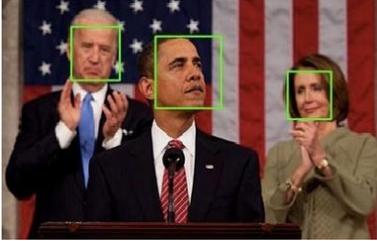
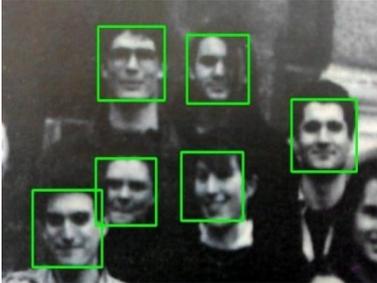
Figure 1: Block Diagram for the Proposed Face Recognition Method

5. EXPERIMENTAL RESULTS

The proposed approach experimentation is carried out on different frames of the input video sequence. Initially the frames are extracted and key frames were calculated. The shot segmentation is fixed for the extracted key frames for accuracy. The experimental result of the face recognition in video sequence using the proposed method is shown in the Fig. 2. It holds the independent variables obtained from the Independent Component Analysis technique. Thus extracted feature information is presented in the result.

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Frame Detection Face	Feature information
	<p>Face 1. 58 68 134 134 -2 10 31 43 53 45 39 86 88 91 64 103 68 83 83 48 99 52 54 70 82 72</p> <p>Face 2. 63 72 126 126 0 10 34 35 53 38 41 86 75 90 58 93 59 87 72 40 94 43 48 70 72 72</p> <p>Face 3. 67 144 144 -1 10 34 44 58 46 40 92 84 99 62 108 66 90 81 51 100 53 51 75 80 77</p>
	<p>First face. 47 62 148 148 1 10 44 65 63 55 73 102 104 88 88 99 85 90 83 47 102 41 69 83 87 71</p>
	<p>Face 1 64 72 127 127 0 10 33 43 52 41 44 82 81 82 62 92 63 79 68 42 92 43 53 70 74 70</p> <p>Face 2 57 68 139 139 -1 10 38 47 58 47 50 90 82 91 66 99 69 86 77 48 99 49 60 75 79 76</p> <p>Face 3 64 73 122 122 0 10 33 44 50 41 45 77 80 74 65 85 63 72 68 40 87 39 52 64 72 63</p> <p>Face 4 60 70 129 129 -1 10 38 43 56 43 50 89 81 91 62 100 62 83 75 43 97 46 54 71 73 74</p> <p>Face 5 41 62 163 163 1 10 51 59 70 53 79 105 107 95 95 114 91 94 93 45 115 42 77 82 99 77</p> <p>Face 6 57 68 134 134 -2 10 30 45 51 44 42 87 84 87 66 107 67 82 75 43 95 44 53 71 81 72</p>
	<p>Face 1 62 70 128 128 0 10 36 39 54 43 39 79 85 83 59 97 62 77 76 43 96 45 50 66 78 67</p> <p>Face 2 61 71 124 124 -2 10 32 41 53 40 49 85 73 85 64 95 65 82 71 40 87 42 54 68 74 66</p> <p>Face 3 57 68 135 135 -2 10 40 48 56 45 51 90 90 88 77 103 75 83 80 44 96 45 59 70 84 69</p> <p>Face 4 50 64 147 147 -2 10 47 50 63 50 60 90 90 91 79 96 80 85 87 49 104 50 66 73 87 73</p> <p>Face 5 67 75 120 120 -2 10 31 36 50 38 44 77 74 79 64 85 65 73 73 39 86 41 53 61 74 62</p> <p>Face 6 56 68 136 136 0 10 40 42 59 44 49 88 83 92 65 97 68 89 79 46 98 48 57 75 78 78</p>

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6. CONCLUSION

ICA is a very general-purpose statistical technique in which observed random data are linearly transformed into components that are maximally independent from each other. In this paper, an algorithm for face recognition using the Independent Component Analysis method is proposed. The human face is detected by feature extraction process based on ICA model. This will generate proper features to be extracted to find out the human face in the video sequences. The key frames method in the proposed work increases the algorithm speed and ends in less execution time. ICA can be found in many different applications such as audio processing, biomedical signal processing, image processing, telecommunications, and econometrics. The proposed approach yields better average face recognition using the feature extraction, which is robust and almost applicable on wide variety of applications.

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