3D Face Recognition using Hadoop

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***Abstract*—*Face Recognition is one of the biometric technique to vestige the given faces. We present a 3D face recognition method using Hadoop to recognize 3D faces under varying expressions, lighting and different poses to overcome the challenges of the 2D face recognition. In this paper, a threshold facial region of an image is detected and pre-processing is done based through the image excellence. If the selected face is frontal face with good lighting, extract the prerequisite features and do the necessary comparison steps to recognize the faces. In case, if the selected face is in bad lighting, then perform histogram equalization and normalization to increase the contrast. Different Poses and expressions are the very challenging zones which require surplus pre-processing to improve the performance of the face recognition system. Hence an enhanced normalization method called 3D Morphable Model are used as a pre- processing technique to create a frontal view from a non-frontal view and also merge images with different views in to a single frontal view. Next to diminish the number of features used for recognition process; we emulate the linear discriminant analysis method for further classification. Eventually, we used an open-source Hadoop Image Processing Interface (HIPI) to act as an interface for MapReduce technology for recognition.*

Keywords—Hadoop, Image Processing, Map Reduce, Linear Discriminant analysis

I. INTRODUCTION

Face recognition is one of the biometric methods, for identification of given face image using main features of the face. Despite significant advances in face recognition technology, it has yet to achieve levels of accuracy required for many commercial and industrial applications. Three-dimensional face recognition (3D face recognition) is a modality of facial recognition methods in which the three-dimensional geometry of the human face is used. It has been proved that 3D face recognition methods can have significantly improved accuracy than their 2D face recognition method. The main technical restriction of 3D face recognition methods is the acquirement of 3D image, which usually needs a wide range of camera. In this paper, to overcome the disadvantages of 2D face recognition systems that arise especially from significant pose, expression and illumination, we implemented 3D face recognition system that defeat the problem of changes in varying pose and different lighting conditions in three-dimensional (3D) range images. We implemented different algorithm in different levels of face recognition to improve the performance of the face recognition system.

In the earlier period, the main users of facial recognition software was an law enforcement agencies, they used the system to capture random faces in crowds. Some government agencies had also used the systems for security reason and to eliminate voter fraudulence. Recently the U.S. government started using a program called **US-VISIT** (United States Visitor and Immigrant Status Indicator Technology), intended for foreign travelers who wants to gain access to the United States. Whenever a foreign traveler gets his visa, he has to present fingerprints and his photographs for the first level of verification. The fingerprints and photograph are verified against a database of identified criminals and so-called terrorists. When the foreign traveler enters in to the United States, the stored fingerprints and photographs are verified whether the same person who has received the visa is try to gain entry. However, there are many other places where they started using this software. Other potential applications include ATM and check- cashing security.

The 3D face recognition approaches can be broadly divided into two categories:

(i) Model based approaches: the model based approaches includes Elastic bunch graph matching, active shape modeling, and 3D morphable model method. The model based face recognition approach construct the model for the faces which is able to capture the human facial variations. In this paper, we used 3D morphable model method, because this is best approach out of all and also highly suitable for face with variations in pose, expressions and illuminations.

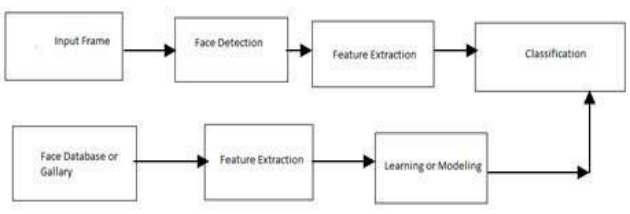
(ii) Appearance based approaches: The appearance based approach includes direct correlation method, principal compo- nent analysis and Linear discriminant analysis, out of all these, Linear discriminant analysis gives better performance and the same is used in our paper for dimensionality reduction.

Challenges:

1) automatically locate the face
2) recognize the face from a general view point under different illumination conditions, facial expressions, facial accessories and aging effects

Face Recognition Workflow:

An image or video stream is given as an input to face recognition system and the output is the verification of the user. Face recognition system has three main steps. To recognize the face image from a gallery or dataset of images, face recognition algorithm matches the face with the images in the database. In order to achieve this task, it performs the following steps: Face detection, Feature extraction, learning or modeling, classification.



to the figure, main functional modules of facial recognition system are:

1. **Acquiring Image:** Users can select existing images or just

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obtain a picture straight away by their cameras on PCs or Smartphone.

2. **Face detection:** This module is used to investigate the input image. If there is a face, it finds the location and separates the face image from the background.
3. **Image preprocessing**: this is to make the face image as standard good quality image as possible so that it can be processed easily later. Examples include: scale normalized, grey normalized, de-noising, white balance, and so on.
4. **Feature extraction and selection:** distinct features are extracted from the processed images for identification.
5. **Recognition:** produces result just by comparing the parameters of unrecognized faces acquired with the parameters of stored faces in the database.

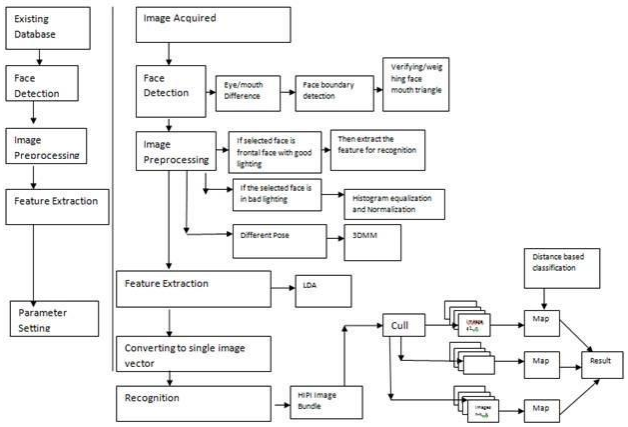
Needs for Face Recognition over other biometric traits:

1) It does not take any cooperation from the user
2) It does not require any expert to analyze the result
3) It is more accurate and secure
4) No high cost device required, we can use the camera available or any equivalent devices to capture images.

High-fidelity Pose and Expression Normalization (HPEN) method with 3D Morphable Model (3DMM) which can robotically produce a natural face image in frontal pose and neutral expression [1]. A novel face recognition approach using 3D directional corner points in which 3D surfaces by 3D DCPs derived from ridge and valley curves [2]. Then they build up a 3D DCP matching method to calculate the resemblance of two different 3D surfaces. Next, 3D Face Recognition Based on Pose Correction Using Euler Angle Method [3], in this the transformation of feature vector from posed to frontal images; this transformation is attained by the rotation matrix from Euler angle method. Next, MIPr a Framework for Distributed Image Processing Using Hadoop, the MIPr framework is able to process images in one large file, and also in many small files[4]. The main challenges in this field are the improvement of recognition accuracy, a greater robustness to facial expressions, and, the efficiency of algorithms.

There are 60 different face recognition databases available, out of which we selected ATT database (formerly 'The ORL Database of Faces'), it consists of 40 distinct subjects of 10 different images of each subject with different lighting conditions, varying facial expressions and different facial details. The size of each image is 92x112 pixels, with 256 grey levels per pixel.

Methodology



Face Detection:

There are many different face detection algorithms to locate or detect face in an image. First techniques are to convert the image into monocolor background and remove the background information from the image, which gives you the face boundaries. Next, finding faces by color: this technique uses the skin color to detect the faces, but there are some disadvantages, it will not detect all type of skin colors and accuracy is less in varying lighting conditions. Next, finding faces by motion: it is done by frame differencing, thresholding, noise removal and then add pixels on each and every line of the motion image. During frame differencing, the current frame in the video sequence and the previous

The stability has a lot to do with lighting, especially for the eyes, nose and mouth. It works much better if light is evenly distributed. In this paper, to detect face, read the image, and then using the detector object, identifies the faces. Annotate this face on the top of image and display the face.

Feature Extraction:

Feature extraction is a method of dimensionality reduction to get only discriminating or interesting part of an image in a compact feature vector.

LDA:

Linear discriminant analysis is also called Fisher's linear dis- criminant is used in our recognition system for dimensionality reduction while maintaining the class discriminatory informa- tion. The reason why this method is selected in our system is, comparatively this has produced the better performance over the other. This method mainly involved to identify the linear combinations of features to categorize two or more classes. The difference between PCA and LDA is, PCA is a unsupervised algorithm that does not consider any differences among classes but where as LDA is a supervised algorithm which calculates difference between dependent and independent variables. We have implemented the linear discriminant analysis to reduce the number of features before further classification. These reduced features are called linear combination, which form a template. These linear combinations are named as fisher faces. In this paper first we computed mean vectors of the different classes

which are there in the dataset, next within- class scatter matrix W is calculated using the following formula w = sm, where

sm is scatter matrix and estimate between class scatter matrix B= Mi(mi-m) (mi-m)T, where Mi is sample mean, m is the

overall mean and mi is the size. Calculate the eigenvectors and eigen values for the scatter matrixes. Eigen vectors are the non-zero vector which does not change the directions. Next do the sorting of eigenvectors in the decreasing order and chose n eigenvalues to get d X n dimensional matrix then finally we converted the samples into the new subspace.

There are many different face detection algorithms to

Image preprocessing techniques:

Accuracy of Face Recognition depends on how Facial images have been compensated for pose, illumination and facial expression. The significance of preprocessing techniques is to enhance the feature for processing and to eliminate the unwanted or distorted features if any. During preprocessing stage, three cases are considered:

If the selected face is frontal face with good lighting, detect the face region, extract the required feature and do comparison

to recognize the faces.

If the selected face is in bad lighting, then perform histogram equalization and normalization. The face images captured at different and bad lighting affect the performance of the recognition system very severely. In order to enhance the performance of the face recognition system, normalization is done on the target image to increase the pixel intensity value. Normalization is otherwise called as a contrast stretching.

Normalization convert an n-dimensional grayscale image I: $\{X \subseteq R\ n\} \rightarrow \{Min, \ldots, Max\}$ with intensity values in the range (Min, Max), into a new image I N: $\{X \subseteq R\ n\} \rightarrow \{newMin, \ldots, newMax\}$ with intensity values in the range (newMin, newMax).

1) If it is in different pose and expression use 3DMM techniques for correcting the pose and attain the neutral expression as well

3D Morphable Model (3DMM)

Different Pose and expression are the very challenging area, requires additional preprocessing to improve the performance of the face recognition system. Hence an improved normalization method is preferred. Morphable Model are used as a preprocessor technique to create a frontal view from a non-frontal view and also merge images with various views to a single frontal view. In this paper we implemented 3D Morphable Model (3DMM) to produce a face image in frontal pose and neutral expressions. In this model to fit the face image, the perspective projection of the face model onto the image plane is done, next association between the 3D and 2D space has been constructed by landmark marching. Next normalization is performed by retaining the identify information like shape and texture of face and finally invisible regions are filled **Hadoop Image Processing Interface (HIPI)**

In this paper, we introduced MapReduce technique to manip- ulate the large volume of data using open source Hadoop. Hadoop is an open source distributed computational frame-work, it process the large volumes of images on an infinite set of computing nodes by providing required infrastructures, This system divide the tasks based on images, or pixel and it is performed on a distributed system across one or more node, we used an open-source Hadoop Image Processing Interface (HIPI) to act as an interface for MapReduce technology. HIPI interface provides efficient and high-throughput image processing with MapReduce approach parallel programs which gets executed on a cluster. Most importantly, HIPI take away the very much technical details of Hadoop system and gives users with the well-known feel of an image library with the access to the advanced resources of a distributed system. It provides an extensible and open library for image processing; it stores the images efficiently in the MAP Reduce Technology. In Hadoop, Distributed file system (HDFS) is used for storing large collection of image files on various machines through cluster. HDFS consists of one Name Node and multiple Data Node, when an input image is given to Name Node, it distributes this image across the several Data Node to do the task of face recognition Using HIPI image Bundle data type, HIPI image bundle is distributed across all the nodes for recognition.

The input of HIPI program is a Hipi Image Bundle (HIB), where and output of mapper class is the recognized face

II EXPERIMENTS AND RESULTS

Face ID	Proposed	PCA	LDA
01	0.1145	0.2185	0.1934
05	0.2112	0.3666	0.2550
11	0.2800	0.4989	0.3450
26	0.1978	0.5980	0.3678
33	0.3124	0.5659	0.4742
45	0.2367	0.4678	0.3256
56	0.4123	0.6230	0.5189
Mean	0.2521	0.4769	0.3542

Table 1. Accuracy of the existing system compared with proposed system.

HIB is collection of images stored as a single file in the HDFS. The first step in HIPI program is culling, which filter the images based on some the conditions defined by the user. Next, individual images are assigned to each mapper class

We compared accuracy of the proposed system with PCA and LDA and shows that our proposed system outperforms the existing methods. HIPI give a simple and easy interface for rapid, distributed image processing on the MapReduce platform. Important tasks like object detection, face recognition, anomaly detection and feature extraction can be attained without difficulty using the MapReduce framework. Using this HIPI interface the accuracy of the system improved.

III. CONCLUSION

We have proposed a novel face recognition system, which is invariant to pose, expression and lighting using Hadoop Image processing interface. Various preprocessing techniques has been used for pose correction, to increase contrast and to get frontal and neutral facial images The proposed system is tested on AT T database (formerly 'The ORL Database of Faces') face database and it observed there was a better recognition rate in the case of pose, expression and lighting variation.

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