A Robust Age Estimation System For Indian Facial Image using 2D-Gabor Filter and Multilinear Principle Component Analysis

Dhiraj S.Dabi
Department of Electronics & Telecommunication
Sinhgad College Of Engineering, Vadgaon, Pune University, Pune, India

Prof. Sarika B. Patil
Department of Electronics & Telecommunication
Sinhgad College Of Engineering, Vadgaon, Pune University, Pune, India

Abstract—Age estimation from facial image is one of the challenging and crucial tasks in pattern recognition. In this paper we present an efficient age estimation system based on facial image using 2D-Gabor filter and Multi linear Principle Component Analysis (MPCA). The 2D-Gabor Filter is used to extract the feature from facial image. The extracted features from facial images are further compressed by the MPCA. The K-NN classifier is used to classify the images into one of the age group. The proposed system is applied on two different databases for performance measures. The proposed system classify the input facial image in to one of the age group from 10 different age group with margin of 5 year which gives near about accurate age estimation of the input facial image.

Keywords—2D-GaborFilter, Multi linear Principle Componont Analysis(MPCA), K-NN Classifiers

I. INTRODUCTION
Age estimation from facial image is an active area of research in several disciplines such as image processing, pattern recognition and computer vision. The estimation of age from the appearance of the human being depends on the ability of the person on his past and personal experience, it also vary from person to person, Hence developing automatic facial age estimation system that are even better and more accurate than the human ability of age estimation has become an attractive yet challenging topic in recent years.

Figure 1: The appearance of one subject at different age in the FG-NET database.

The human faces exhibit remarkable changes as age of person’s changes. As age of person changes the appearance of the face also changes, these changes are in shape of the facial parts (eyes, nose, mouth, chin), the texture of the facial parts (wrinkles). These characteristics are seems to be common at particular age level, e.g. childhood, teen age, young, adult and old age. These characteristics of the facial image can be used as feature for pattern recognition system. Further these characteristics can be taken as class label for particular age group and accordingly age can be classified in different age group. In this paper we present an efficient age estimation system based on facial feature extracted from facial image of person at different age. In the proposed system we have used 2D-Gabor filter to extract the feature from facial image. Multi linear component analysis to reduce the available facial feature, and K-NN classifier to classify the facial image in to one of the class based on class label. The proposed system has two stages 1) Training stage and 2) Testing stage. In training stage the training feature database is to be developed which contains the feature extracted from the different facial images of the person from different age group, for the proposed system we have created the 10 age group with margin of 5 years to classify the test image in to near about exact age group, e.g. 0-12, 13-17, 18-23, 24-29, 30-35, 36-41, 42-47, 48-53, 54-59, 60 and above. In testing stage feature extracted from the input facial image (test image) are compared with the features in training feature database using K-NN classifier, the feature of the matched age group is taken as result age of the test image. the proposed system is divided in to different stages as 1) Preprocessing 2) feature extraction from facial image 3) dimensionality reduction using MPCA 4) Classification of the facial image in to one of the age group using K-NN Classifier. The paper is organized in different section, section I gives introduction followed by the literature survey in section II. The implementation of the proposed system is included in section III. Details of the database used for testing are given in section IV. The paper is concluded in section V.

II. LITERATURE SURVEY
There is plentiful existing work on the facial aging progress, originating from psychological and biological studies. However, most of it aims at simulating the aging effects on human faces (i.e., simulate how the face would look like at a certain age), which is the inverse procedure of age estimation. Age estimation approaches fall into two categories: (a) classification based and (b) regression- to age estimation. Different methods and algorithm are used for the age estimation. Yun Fu, Guodong Guo [1] have proposed the four concepts about human age in there paper entitled with “Age synthesis and estimation via faces :A survey” they have proposed the definition of
Actual Age, Apparent Age, Perceived Age, & Estimated Age. In this paper they have carried out a brief survey of the different technique for the synthesis of facial image and age estimation. The paper discuss about the existing technique, & popular algorithm for the age estimation. Xin Geng, Zhi-Hua [2] have described the age estimation based on facial aging pattern, they have used the AGES method for the age estimation of human being. AGES stands for the aging pattern subspace, is the sequence of personal face images sorted in time order this gives the better result as compared to other method but it requires the 'generic training dataset' which contain face images under all possible pose and illumination, which is not available always in reality. In age estimation from facial image the extraction of the feature is important task , the different author have proposed different method for the feature extraction from facial image. Fukai H. & Takimoto H.[3] have proposed the FFT for feature extraction & Genetic Algorithm for the Feature selection, they have proposed the fitness function for selecting the extracted feature from the facial image for age estimation. That precise age estimation is vital in a variety of settings. Their present paper has been to evaluate data on the estimation of age, focusing on changes Samad R. Sawada H.[4] has proposed the algorithm for the facial expression recognition based on the Gabor filter and PCA. They have used the Gabor filter for the extraction of the facial feature to identify the different facial expression on the face. P. Ganasivam, Dr. S. Muttan [5] have proposed the feature extraction from fingerprint using wavelet transform, they have used DWT & SVD to extract the feature from fingerprint, which is further processed to estimate the age.

III. IMPLEMENTATION
The proposed facial age and gender estimation system is divided in to four steps as 1) Preprocessing 2) Feature extraction using 2D – Gabor Filter 3) Dimensionality reduction of the feature vector using MPCA 4) Age Estimation using K-NN Classifier. The following paper aims in creating a system that is used to estimate the age from an facial image. Facial images are acquired from the database sources. A Proposed age estimation system from facial images constitutes of facial image in digital form as its input which is then processed further. The algorithm is to be implemented in MATLAB. We used 2D-Gabor filter and Multi linear Principal Component Analysis (MPCA) to estimate a person's age using his/her facial image. The input facial image goes through preprocessing stage in preprocessing stage the input color image is read from the database. Then it is resized, further it is cropped for facial region and converted to grayscale. After preprocessing the facial image goes through feature extraction, using 2D-Gabor filter. The next step is to reduce the available feature vector using Multi Linear Component Analysis for dimensionality reduction. the feature vectors are then compared with the database for the minimum distance and classifies the facial image as to which class it matches. The two different database are to be used to measure the performance of the proposed algorithm. Near about 250 facial images of male and female of different age between 7-74 are supposed to be used for training. The facial image in the database goes through the same processing in the learning (training) stage and the feature vectors are stored in the training database and are used for classification of the test image in testing stage. The algorithm for the proposed system is as follows.

**Input:** Face Database, Test Face Image

**Output:** Age of Person

--

Step 1: Face image is read from database.
Step 2: Image is resized to 250*250
Step 3: Color image is converted to gray scale Image.
Step 4: The gray scale image is cropped for the face region.
Step 4: 2D-Gabor filter is applied to gray level, resized, cropped image to extract the feature from facial image.
Step 5: The extracted feature are dimensionality reduced by using MPCA.
Step 6: Test Image Features are compared with the Features available in Training Feature database using K-NN classifier for classification.
Step 7: Image with Euclidean distance less than threshold value is considered as matched image & Age of matched image is considered as the result age.

**A. Pre-processing**
The input facial image goes through preprocessing stage in preprocessing stage 1) the input color image is read from the database. 2) Then it is resized to 250*250 size, further it is cropped for facial region and 3) converted in to the gray scale. 4) further histogram equalization is applied to gray level image to highlight the different part and wrinkle on facial image.

![Figure 2: Pre-processing stage.](image)

**B. Feature Extraction Using 2D-Gabor Filter.**
The Gabor filter is a linear filter whose impulse response is defined by a harmonic function multiplied by a Gaussian function. This filter is used to detect line endings and edge borders over multiple scales and with different orientations. The Gabor wavelet can be defined as given in Eq. 1

\[
g(x,y,\theta) = \exp(-((x^2+y^2)/\sigma^2)) \cdot \exp(2\pi i(x\cos \theta + y\sin \theta))
\]
The Gabor feature representation of an image I(x, y) is the convolution of the image with the Gabor filter bank \( \hat{g}(x, y, \theta, \phi) \). The Gabor filter is used for edge detection, in this paper the Gabor filter is used for the Edge-Based Feature Extraction. The edge-based facial feature include the eyes, eyebrows, nose and mouth, these feature from facial image are extracted using the edge detection properties of the Gabor filter. Besides this the wrinkle and skin texture is also extracted which is used to classify the people at old age following figure shows how the eye, eyebrows, mouth & nose are detected using Gabor filter along with the wrinkles on from facial image.

Figure 3: Edge Detection On Facial Image Using 2D-Gabor Filter.

Figure 4: The preprocessing stage, with feature extraction using 2D-Gabor filter.

C. Dimensionality Reduction Using MPCA

MPCA stands for Multi Linear Principle Component Analysis. It is a multi linear subspace learning method that extracts features directly from multi-dimensional objects. The MPCA is the extension to the PCA, which operates linearly where as MPCA operates multilinearly. The PCA need to reshape the multidimensional object into the vector, whereas MPCA operates directly on multidimensional object through two-mode processing. In this paper the Gabor filtered image is used as input image to the MPCA. The feature extracted from the facial image using Gabor filtered are given to the MPCA for dimensionality reduction. The resultant output of the MPCA is the dimensionally reduced feature projection matrix of face Images. The pseudo-code implementation of the Multi linear Principle Component Analysis Algorithm is as follows.

**Input:** A set of facial Image  
**Output:** Dimensionally Reduced Feature Projection Matrix of Facial Image.

**Algorithm:**  
Step 1: Center the input face samples.  
Step 2: Calculate the Eigen values .  
Step 3: Calculate the mean  
Step 4: The dimensionally reduced feature  
Projection matrix of the Gabor filtered facial image.

D. Classification using K-NN Classifier

In pattern recognition, the k-nearest neighbor algorithm (K-NN) is the generally used method for classifying objects based on closest training examples in the feature space. K-NN is a type of instance-based learning where the function is only approximated locally and all computation is deferred until classification. In K-NN, an object is classified by a majority vote of its neighbors, with the object being assigned to the class most common amongst its k nearest neighbors (k is a positive integer, typically small). If k = 1, then the object is simply assigned to the class of its nearest neighbor. The neighbors are taken from a set of objects for which the correct classification is known. This can be thought of as the training set for the algorithm, though no explicit training step is required.

IV. FACIAL IMAGE DATABASE

A. Indian Facial Image Databases

The facial image database of Indian people ranging from 0-74 year has been developed for the project. This database consist of the student and staff from the S.V.C.E.T. Rajuri one of the engineering institute affiliated to Pune university, the images are taken in the campus within the period of 4 Month from June 2014 to August 2014, the facial image database are distributed in different 10 age group as Follows. The minimum age of the facial image in the database is of 7 year and maximum age of the facial image is of the 74 Year. The images are taken at different location in campus and near about the campus with same camera. The following fig shows the images from Indian facial image database and table I gives the details of the Indian facial image database.
Near about 60% images from the above database are to be selected for training stage, in training stage the feature are extracted from the facial image first, and further these feature are dimensionality reduced using MPCA. These dimensionality reduced feature Vector are used in the testing stage.

**B. Georgia–Tech Database**

The proposed algorithm is to be applied to facial Image database developed by the Georgia-tech university. This database contains the 750 facial images of 50 subject including male and female, these facial image mostly include the adult people having age more than 18 Year. There are 15 images of each subject with the different angle such as frontal, side angle etc. for the proposed age estimation system we have used the frontal facial images for training. 250 facial images from the above database can be used for training stage, Rest of the facial images can be used further for the testing stage. The example of the facial image from the Georgia-teach database is shown in following figure.

In this work, we have proposed a method of age estimation from facial images based on 2D-Gabor Filter & MPCA. The input image is first gone through the preprocessing, in preprocessing stage it is converted in to the gray level and resized. further feature is extracted from the gray scale image using 2D-Gabor filter. The proposed method uses the MPCA for the dimensionality reduction. The extracted feature is stored in the training database for different age group. The proposed System is expected to give near about 80% result for the different age group. In this paper we have proposed a method to classify the age with very less error of the estimation by having 10 age group with margin of 5 Year. Age has been grouped as 0-12, 13-17, 18-23, 24-29, 30-35, 36-41, 42-47, 48-53, 54-59, 60 and above. The facial image which has the age at boundary can be grouped in adjacent age group. In this paper we have introduced the method of age estimation which is expected to classify the facial image into near about the exact age group. In presented paper we have developed one of the largest Indian facial image database which include more than 750 images of the Indian people ranging from 0-74 year to get the exact age. The age which are present at the boundary of the age group can be grouped in to the adjacent group, this can be studied further under the future scope. It is highly impossible to get the image of the person at every age. In this paper we tried to get maximum facial image of the Indian people at different age. Further, More accuracy rate of age estimation can be achieved if more number of samples in each Group is trained. The expected result for the proposed age estimation system are tabulated in the following table.

### Table I: Details of the Indian Facial Image Database

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Distribution</th>
<th>Number Of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 -12</td>
<td>2.01%</td>
<td>16</td>
</tr>
<tr>
<td>13-17</td>
<td>2.88%</td>
<td>23</td>
</tr>
<tr>
<td>18 -23</td>
<td>55.15%</td>
<td>437</td>
</tr>
<tr>
<td>24-29</td>
<td>15.23%</td>
<td>122</td>
</tr>
<tr>
<td>30-35</td>
<td>9.04%</td>
<td>60</td>
</tr>
<tr>
<td>36-41</td>
<td>2.88%</td>
<td>23</td>
</tr>
<tr>
<td>42-47</td>
<td>3.51%</td>
<td>28</td>
</tr>
<tr>
<td>48-53</td>
<td>2.01%</td>
<td>16</td>
</tr>
<tr>
<td>54-59</td>
<td>4.27%</td>
<td>04</td>
</tr>
<tr>
<td>60 and above</td>
<td>2.88%</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>752</td>
</tr>
</tbody>
</table>

V. CONCLUSION

In this paper we have proposed a method to classify the age with very less error of the estimation by having 10 age group with margin of 5 Year. Age has been grouped as 0-12, 13-17, 18-23, 24-29, 30-35, 36-41, 42-47, 48-53, 54-59, 60 and above. The facial image which has the age at boundary can be grouped in adjacent age group. In this paper we have introduced the method of age estimation which is expected to classify the facial image into near about the exact age group. In presented paper we have developed one of the largest Indian facial image database which include more than 750 images of the Indian people ranging from 0-74 year to get the exact age. The age which are present at the boundary of the age group can be grouped in to the adjacent group, this can be studied further under the future scope. It is highly impossible to get the image of the person at every age. In this paper we tried to get maximum facial image of the Indian people at different age. Further, More accuracy rate of age estimation can be achieved if more number of samples in each Group is trained. The expected result for the proposed age estimation system are tabulated in the following table.

### Table II: Expected Result for few images from Indian facial image database with Proposed Age Estimation System
<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Facial Image</th>
<th>Actual Age</th>
<th>Estimated Age Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td><img src="image1" alt="Facial Image" /></td>
<td>10 Year</td>
<td>0-12 Year</td>
</tr>
<tr>
<td>2)</td>
<td><img src="image2" alt="Facial Image" /></td>
<td>21 Year</td>
<td>18-23 year</td>
</tr>
<tr>
<td>3)</td>
<td><img src="image3" alt="Facial Image" /></td>
<td>32 Year</td>
<td>30-35 Year</td>
</tr>
<tr>
<td>4)</td>
<td><img src="image4" alt="Facial Image" /></td>
<td>44 Year</td>
<td>42-47 Year</td>
</tr>
<tr>
<td>5)</td>
<td><img src="image5" alt="Facial Image" /></td>
<td>64 Year</td>
<td>Above 60</td>
</tr>
</tbody>
</table>

**Acknowledgment**

The authors would like to thank all the student volunteers, staff volunteers from S.V.C.E.T, Rajuri and citizen of the Rajuri village who have helped us in this research work for the development of the Indian facial image database.

**References**

4. Dhiraj S.Dabi received his B.E.degree in Electronics and Telecommunication Engineering in 2011 from Pune University, India. He is pursuing his Master in signal processing from Sinhgad College of Engineering, Pune University. He is working with S.V.C.E.T. Rajuri as an Asst.Prof. In the Department of Electronics & Telecommunication. His area of interest includes image processing, Machine learning, Pattern Recognition.
5. Prof. Sarika B. Patil received her B.E. degree in Electronics and Telecommunication Engineering in 2003 from Shivaji University, India. She has received her masters in Electronics-Digital System from Sinhgad College of Engineering, Pune University. She is working with SCOE, Vadgaon. as an Asst.Prof. In the Department of Electronics & Telecommunication. Currently she is pursuing Ph. D. from Pune University. Her area of interest includes the Biomedical Image Processing and Pattern recognition.