Human Age Prediction and Classification Using Facial Image

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***Abstract*— Human face is one of the most important sources of the information, which can be utilized for personal verification and identification. This paper discusses the method of finding the human age using the facial image of a person. It has many real world applications like human computer interaction, internet security, multimedia communication, vending machines etc. During growth, aging is affected in two main forms, one is the size and shape variation and the other is the textural variation. In this paper, we use the textural variation of the face during the growth, which appear more in the adulthood in the form of wrinkles. Areas of the face where these textural variations occur more are identified, like forehead, cheeks, regions around eyes etc. Studying these areas, the human age is identified and classified. Here we use the method of Hough Transform for feature extraction and Polynomial Regression for age classification.**

Keywords-Color ***Models; Feature Extraction; Geometrical Feature Extraction; Hough Transform; Illumination Normalization; Polynomial Regression; Textural Feature Extraction***

I. INTRODUCTION

Human face has lot many features hidden in it which can be exploited for determining the identity of the person, age of the person, gender of the person etc. The proposed system is used to determine the human age. It has so many real world applications. The first and the main is in the internet usage. There are so many sites available nowadays which should not be allowed to access by children. Likewise vending machines. There are so many vending machines which lends drug related items like cigarettes, alcohols etc which should atleast be not allowed to use by children. These systems are only examples which can make use of the proposed system. If these applications capture the image of the user and will be allowed to proceed only if the calculated age of the user is above an age limit, we could solve the problem to a limit.

The age and gender of a person is categorized by visual observation of images, where it is difficult in the computer vision. The face is recognized by considering features like eye distance, nose length, lip distance etc. The gender is classified by determining the features like mustache region, eye distance, total number of pixels of skin color etc. The age is identified using forehead region, right and left cheeks, eyelid region etc.

As our aim is to determine the age of a person, we can concentrate on the features that can be extracted for age estimation. As we all know, age of a person affect his face in two main forms. One is the Geometrical Feature Variation where the size and shape of the face changes as he grows. If we use this information of the face, we can see that this change is gradual and most of the size variation stops at certain age. Even worse condition occurs in some case where the facial size gradually decreases when he reaches the old age. So using this method of Geometrical Feature Variation is challenging. But ofcourse, this method can be used to classify the age broadly into three main classifications like baby, youth and adult.

Another method is Textural Variation method, where the human skin texture is affected as he grows. Ofcourse, as we can see, from the very birth till the death of a person, his skin texture is gradually affected, although it is visible strongly during adulthood. So for our method of human age prediction and classification, we use the textural variation method.

II. EXISTING METHODS

Age classification algorithms were first detailed and developed by Kwon and Lobo [8].They classified facial images to three age groups: babies, young adults, and senior adults. They utilized geometrical ratios to distinguish babies from two other groups after the facial features have been located. The results have shown that the performance to classify babies were less than 68%. Next, young adults were distinguished from senior adults by utilizing energy functions and so-called snakelets.

In [1], authors proposed a new framework for face-image-based automatic age estimation. A manifold learning method was introduced for learning the low-dimensional age manifold. The Support Vector Machine and Support Vector Regression methods were investigated for age prediction based on the learned manifolds. To improve the age estimation performance and robustness, a Locally Adjusted Robust Regressor (LARR) was also designed. Anil Kumar Sao and B. Yegnannarayna [6] proposed analytic phase based representation for face recognition to address the issue of illumination variation using trigonometric functions. To decide the weights to the projected coefficients in template matching, eigen values were used.

Authors in [4] combined the local and holistic facial features for determining the age. They used combined features that roughly classify a face as young (0-20) or adult (21-69). In most of the previous studies the age groups are not arranged properly. Another related work in the age estimation selects discriminative features to estimate face age. Primary studies on age estimation coarsely divided human faces into groups based on facial landmarks and wrinkles.

Most recent approaches considered the continuous and temporal property of face age and formulated age estimation as a regression problem. Researchers explored different features, including AAM coefficients, image intensities features designed heuristically, and adopted various regression methods, such as quadratic function, piecewise linear regression, multiperceptron projection, etc. differently from the above mentioned methods. Geng [7] defined an aging sequence as an aging pattern and estimated age by projecting a face instance onto appropriate position of a proper pattern [11].

In [2], the authors use the anthropometric models for determining the age of facial images. Their approach demonstrates that precise feature selection can help classifiers to categorize the images with high accuracy. They use geometrical ratios calculated based on the distance and the size of certain facial features to distinguish age groups. They evaluate the age differentiation capability of the individual features and various combinations of the features using three different classifiers, namely, neural network classifier (NNC), Support vector classifier (SVC), and normal densities-based linear classifier (LDC).

In [3], the author proposed automatic age estimation of aging effects on face image. The age group labeling was based on the training data and testing data on 720 and 580 images respectively. The facial feature was extracted based on the geometric feature based method and principal component analysis (PCA) method.

Based on the study we could conclude that there can be three methods of classifications for age determination. First method, called Geometrical Variation extraction approach, which exploited the fact that geometrical ratios of human face changes as he grows from childhood to adulthood. Second method is Textural Variation extraction method, which exploited the act that facial skin texture changes gradually from childhood to adulthood. Third method utilized a combination of the above two methods.

III. SYSTEM OVERVIEW

Our proposed system gets a jpeg image as input. The rectangular facial region is detected from the input image and it is cropped. Now the cropped image is resized into uniform assumed size. Then it is illumination normalized. Now we get a normalized facial image in which we will perform our feature extraction procedure. For our proposed methodology, we can concentrate more on the facial regions where more textural variations appear. These can be regions like forehead, cheek, chin, sides of eyes etc. Here we selected the feature cheek for estimating the age. Feature area detection is done by applying hough transform on the normalized image.

From the feature extracted, here cheeks, we can extract different properties such as contrast, correlation, homogeneity, entropy etc. Thus we have shifted our focus from a higher dimension data to lower dimension data. From the properties extracted from the cheeks, we could use any of the classification method for age prediction and classification. Here in the proposed system we use the Polynomial Regression method. A Polynomial is defined from the known age and properties, and for testing this defined polynomial is used.

Let us discuss the different steps in detail. There are four main steps for determining the human age, refer Fig. 1.

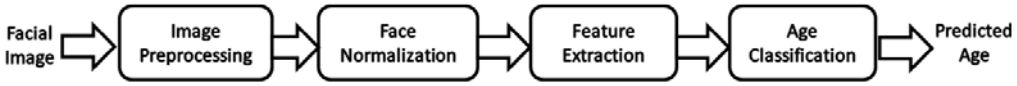

Figure 1: Steps in Age Prediction/Classification

A. Image Preprocessing

In this step, we get the jpeg image in the RGB format and it is converted to both HSV and YCbCr format. In this paper a pixel is identified as a skin pixel if it is a skin pixel in both HSV and YCbCr. It increases our confirmation that the face region we crop contains only skin pixels. Thus we crop a rectangular region which contain only skin pixels, thus we get the face region, refer Fig. 2.

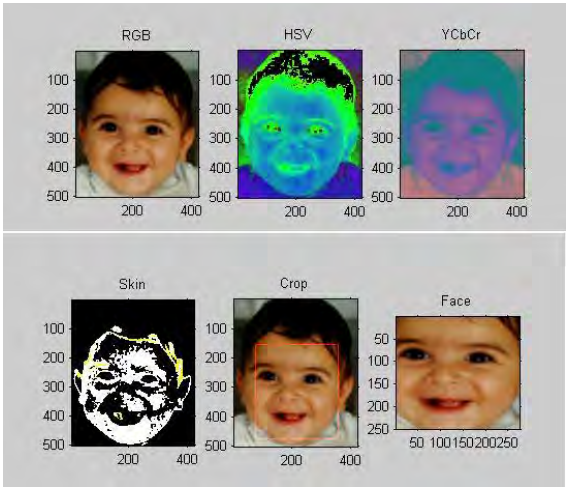

Figure 2: Image Preprocessing

B. Face Normalization

The face region we cropped may have its illumination unevenly distributed. It should be then normalized so that its illumination is uniformly distributed, refer Fig. 3. This helps us to handle all the images, taken under different lighting conditions, alike.

For this we will find the cumulative frequency distribution function of intensity levels in the range [0, G], where G is the maximum gray value in the image, and normalizing it by dividing it with total number of pixels.

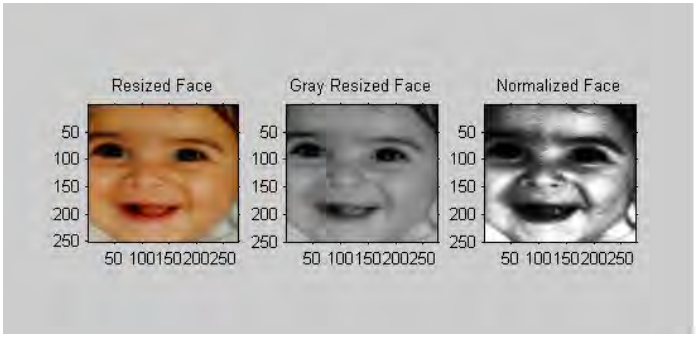

Figure 3: Face Normalization

If we verify the histograms before and after normalization, refer Fig. 4, we could very well see the difference in illumination. We can see that the illumination is uniformly distributed after normalization.

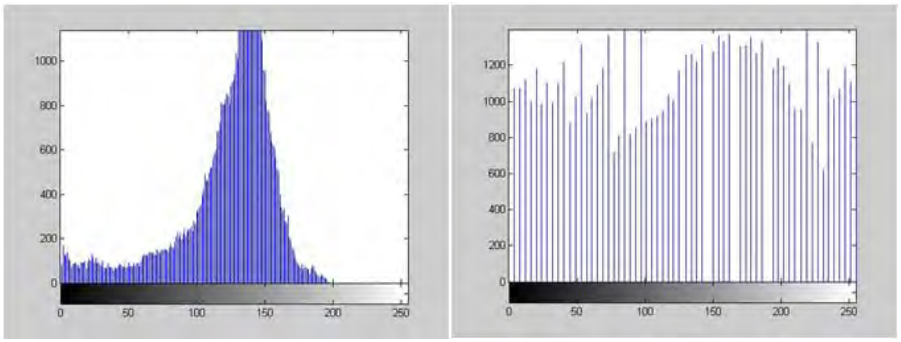

Figure 4: Histogram before and after illumination normalization

C. Feature Extraction

Now we have a face image which is illumination normalized. Upon this image, we will execute our Feature Extraction Process. Our aim is to extract cheeks. Here we use Hough Transform, to extract the cheeks, Figure 5.

The purpose of Hough Transform is to find imperfect instances of objects within a certain class of shapes by a voting procedure. This voting procedure is carried out in a parameter space, from which object candidates are obtained as local maxima in a so-called accumulator space that is explicitly constructed by the algorithm for computing the Hough transform.

Here the imperfect instance that we concentrate is the circular region; the only one is the iris. Using Hough Transform we could extract the iris and from there we could extract the cheeks, refer Fig. 5 From the cheeks we could extract the texture properties like contrast, homogeneity, energy, entropy etc. We concentrate more on property contrast for our prediction and classification.

- Contrast - It returns a measure of the intensity contrast between a pixel and its neighbour over the whole image. Contrast is 0 for a constant image.

$$\sum_{i,j} |i-j|^2 p(i,j) \qquad (1)$$

where p(i, j) in (1) is pixel intensity at position (i, j) .

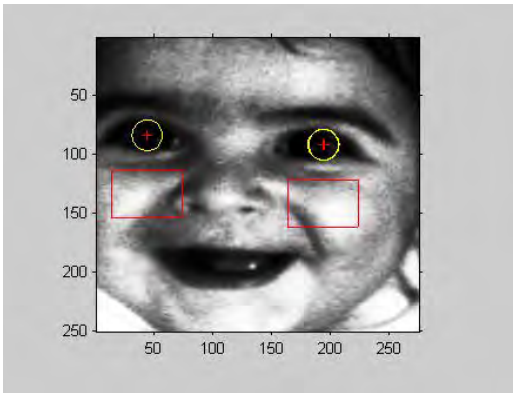

Figure 5: Feature Extraction

D. Age Prediction/Classification

Our last step is the Age Prediction/Classification. Here we find the coefficients of a polynomial p(x) , as in (2), of degree n that fits the data p(x(i)), which corresponds to contrast, to y(i), which corresponds to age, in a least squares sense. The result p(x) is stored in a row vector of length n+1 containing the polynomial coefficients in descending powers.

$$p(x) = p_1 x^n + p_2 x^{n-1} + \cdots + p_n x^1 + p_{n+1} \qquad (2)$$

IV. Results And Discussions

The paper predicts the age using Polynomial Regression method. It is a type of curve fitting method. We defined a polynomial of degree 10 and upon this polynomial we tested our system. We could also plot age against contrast, refer Fig. 6, and we could see the polynomial we defined. We could see how the graph changes as the contrast increases. We could also observe the range of contrast value usually returned from the images for different age groups.

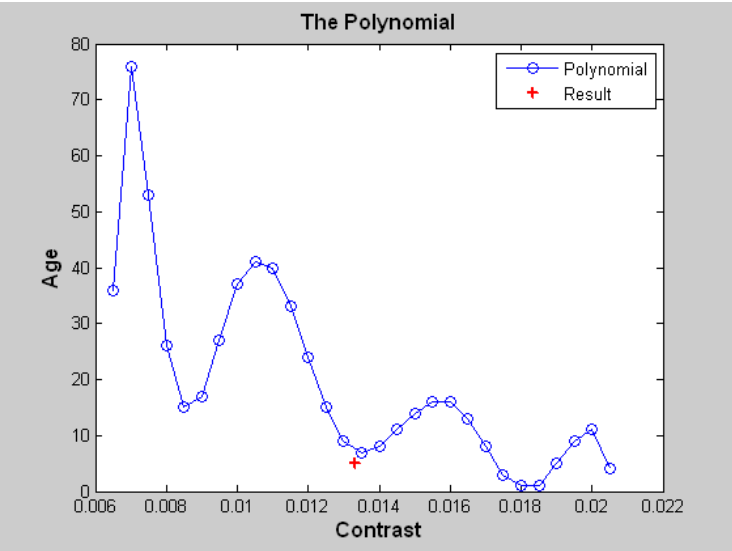

Figure 6: Polynomial Curve Calculated

V. CONCLUSION

There are so many areas where we could make use facial image analysis, like face recognition, age detection, gender detection etc. But the area which is least exploited is age detection. Because there are so many limitations for this area. Age is affected by many factors like living place, living condition, health, use of cosmetics etc. There is also variation in male and female aging. But nowadays this is a more exploited area. We made use of textural variation of facial skin to determine the age. We used the images from FG-NET database which is available in the internet, and we got the prediction accuracy of 90% and classification accuracy of 100% in all images.

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