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Age Group Estimation by Combining Texture and Fractal Analysis

N.K.Bansode
Department of Computer
College of Engineering,
Pune - 411005.

P.K. Sinha
Department of Computer
College of Engineering,
Pune - 411005.

ABSTRACT
In this paper the age group estimation is presented based on combination of texture and fractal dimension features. The age of the human is used as one of the important key parameter for computer vision applications. The fractal dimension of the face image and the texture analysis is used to classify the age of the person into the three different groups such as child(10-20), young(21-50) and old(51 and above. The proposed approach of combing the fractal and texture features shows an effective estimation of the age group. The facial age groups are estimated with 90% average accuracy.

General Terms
Image Processing, Age Group Estimation, Texture Analysis, Fractal dimensions

Keywords
Texture Features , Fractals, Age Group

1. INTRODUCTION
The human face is the key feature for the human identification. It provides information about the personality, age and gender etc. The face carries important information such as identity, expression, ethnic group gender and age. The information from the face such as gender can be easily perceived but estimating age from a facial image is an intriguing and challenging task and more difficult task for the machine vision and applications. The human age attribute is dynamic varies with the time. The human face texture undergoes several changes due to aging with time. The age based applications such as control access to the different services in the society, surveillance in the detection of the potential suspect, face recognition based on the age improves accuracy of the recognition, age synthesis, electronic customer relationship management and advertisement of the age related products to the appropriate age groups. The age group estimation has attracted research attention in the recent years. The aging is natural, irreversible process and varies from person to person. It changes both shape and texture of the face. The facial appearance of person changes due to the process of growing from childhood to the older. These changes make the face recognition more difficult task.

Texture is an important characteristic of the image object. It describes surface property of the object and used to identify the type of object. The texture describes the surface characteristics of the intensity image. The intensity can be measured at pixel level while the texture is perceived from the image region. Texture is part of the object which describes the surface characteristics of the object. The texture of the object is perceived from the surface of the object but it is difficult to describe it. The face image texture analysis includes the features analysis extracted from the image. In case of the face image there is considerable change in the neighboring pixels also the texture has homogenous property at some spatial scale. In the image and vision processing texture is visual cue due to repeated pattern present in the image which may be perceived as smooth rough ,coarse and fine or regular and irregular.

1.1 Fractal Geometry
The fractal geometry represents the mathematical model for the complex object in the nature. The fractal geometry developed due to the limitation of classical geometry for a description of the irregular natural objects such as coastal line, mountains, tree structure and the shape of the cloud. The self-similarity is the basic property of the fractals of the natural objects and may be given by fractal dimension [1]. The fractal geometry framework developed for natural object as well as regular object representation. The fractal object is self-similar objects with the structure for all levels of the resolution. The fractal dimensions are used to represent the measurement of the object surface property in terms of the repetition of the basic elements of the objects. To measure the fractal dimension of an object, the object is covered with the certain size ϵ of the box. The number of boxes required to cover the entire objects varies with the size of each block.

2. RELATED WORKS
The age group estimation is an important and difficult problem for age recognition. The different approaches based on the local feature such as local binary pattern, global approach such as principal components analysis and geometric measurement based on anthropology ratios are described in the following paragraphs.

Ruoyu Du, Hyo Jong Lee presented measurement of the human body by physical anthropometry measurement. The sixteen ratios on human face are calculated using Euclidean distances. The SVM–SMO classifier is used for the classification of the age and shown around 96 % accuracy [2]. Kung-Yu Chang, Chusong Chen, Yi Ping Hung [3] descried a ranking-based framework consisting of a set of binary queries for the classification of age the person. Rishi Gupta, Ajay Khunteta [4] presented age classification using facial feature based on the SVM classifier. The age of the person is classified into three groups such as child, adult and old. Dong Cao et al. presented a human age estimation method using the ranking SVM method. The initially rank relationship of ages is learned from various face images. Then the human age is estimated based on the rank relationship and the age information of a reference set [5]. Khoa Luu et al used a novel age estimation technique that combines AAMs and SVMs to improve the accuracy of age estimation over the current state-to- the art technique [6]. Mohamed Y. Ei Dib Hoda M.Onsi used the bio-inspired features (BIF) to analyze different facial parts. [7]. Mohammad Mahdi, Deshidi Azam and Bastanfard explored a new algorithm for age-group recognition from frontal face image [8]. Catherine M. Scandrett et al presented a statistical approach to the aging of digitized images of the face [9]. Ranjan Jana et al developed automatic age estimation based on the geometric features of facial image [10]. Wen-Bing Horng et al explored an age group classification system facial image. The identification rate achieves 90.52% for the training images and 81.58 for the test images [11]. Gayathri Mahalingam and Chandra Kambhamettu presented study of the face verification task across age by constructing local binary pattern (LBP) histograms and Adaboost learning algorithm is used for LBP feature extraction [12]. H. Kwon Young, Niels Da and Vitoria Lobo presented age classification into three groups such as babies, young, adults and senior adults [13]. Sung Eun et. al. presented a new age estimation method using hierarchical classifier methods based on both global and local facial features[14]. Dihong Gong et al used new hidden factor analysis which captures the intuition above through a probabilistic model with two latent factors: an identify factor that is age-invariant and an age factor affected by the aging process [15].

3. METHODOLOGIES

Texture is an important property of the objects. It gives information about the surface feature of an object such as smooth, uniform or rough. Many objects as similar in shape and color, but the texture property differentiates the objects from the other similar looking objects. The texture of the objects consists of texture primitives or texture elements sometimes called texels or primitives [16]. The image object consists of pixel as texture element. The fabric texture consists of different fine texture of the fabric. The study of the texture analysis consists of the texture recognition and shape analysis. The texture of the different object in the nature are described as fine for a smaller texture, coarse for the larger texture elements, rough for the random texture and smooth for the uniform texture of the object. For the image object which consists of pixels of the different intensities. Every pixel in the image is identified as position of the pixel and tone property. The texture primitive in the image is a set of the pixels with some regional property such as intensity, size and shape. The texture of the object also classified based on the spatial relation between texture elements such as weak, strong and constant texture. The texture of the objects is described using two approaches such as statistical and syntactic. The statistical properties are based on pixel intensities and properties are smaller suitable size. The syntactic properties are based on larger properties like tone, shape description etc. The research shows that the human ability to recognize texture depends upon texton which is the smaller and the basic unit of the object.

In statistical pattern recognition the texture of the object is represented by the feature vector of the texture property [17]. The objective of the texture description is to find the texture feature which is used to make the decision either deterministic or probability for the texture classification. The measure of texture based on the only histogram carries no information regarding the neighboring of pixels with respect to each other. The texture is also measured by spatial frequency. The fine texture is characterized by higher spatial frequencies and coarse texture by the lower spatial frequencies. The co-occurrence matrix is used for texture description based on the repeated occurrence of the some gray-level configuration in the texture [18]. The gray level co-occurrence matrix gives the frequency representation of the gray level present in the image. The statistical properties of the image are calculated using the following parameters.

3.1 Contrast

The contrast measures the intensity contrast between the pixel and its neighbor over the entire image.

$$Contrast = \sum_{i,j=0}^{N-1} Pi,j(i-j)^2 \quad \text{(Error! Bookmark not defined.)}$$

3.2 Correlation

The correlation measures how correlated a pixel is to its neighbor over the entire image

$$Correlation = \sum_{i,j} \frac{(i-\mu)(j-\mu)P(i,j)}{\sigma i \sigma j} \quad (2)$$

3.3 Energy

$$Energy = \sum_{i,j} P(i,j)^2 \quad (3)$$

3.4 Homogeneity

The homogeneity measure gives closeness of the distribution of the elements in the image

$$Homogeneity = \sum_{i,j} \frac{P(i,j)}{1+|i-j|} \quad (4)$$

3.5 Entropy

$$Entropy = \sum_{i,j} P(i,j) * \log\big(P(i,j)\big) \quad (5)$$

3.6 Laws Texture Energy(LE)

The laws texture energy is used to measure the texture properties of the object by measuring the average gray level gray-level, edge, ripple and waves in the texture[22]. The texture measurement is done using three vectors like L3=(1 2 1) , E3=(-1,0,1) and S3=(-1,2,-1) .

3.7 Fractal Dimensions (FD)

The object complexity is measured using fractal dimension. The fractal dimensions are used for classification of the image texture. There are object in the nature which cannot be represented by the classical geometry such as cloud, costal line, mountains etc. has the integer dimensions i.e. line has dimension of 1, square has dimension of 2 and cube has dimension of the 3 while the fractal dimension may be having fractional dimension.

The fractal dimensions are implemented using box counting method. The box counting methods involve the covering the object with smaller boxes of the size ϵ and counting the number of the boxes required to cover the objects. The size of the box and the number of boxes required is specified by the relation. N ∝ 1/s where N – total number of boxes and s – scale of the box.

The fractal dimension of the object is given by

$$d = \lim_{\epsilon \to 0} \frac{\log N(\epsilon)}{\log(\frac{1}{\epsilon})} \quad (6)$$

When we draw least square line fit curve of the different scales of the box and the different dimension d. The slope of the curve gives the fractal dimension of the object.

Algorithm : face image age group classification

Input: face image I(x, y)

Output: Age group class based on the texture and fractal dimensions

Procedure

1. Read the input image I(x,y) of the size MxN and represent in gray scale
2. Preprocessing
   a) Normalize the image I for illumination using histogram equalization and resize in the dimension of [128x 128]
   b) Convert the normalized image into the binary image using suitable threshold
   c) Calculate the texture feature using equations 1 to 5
   d) Calculate the fractal dimensions using equation 6
3. Age group classification
   a) if (correlation >=0.96 and correlation <=0.98) and (FD >1.0 and FD<=1.32) and (LE>0.08 and LE <0.09) then age group=child
   b) if (correlation >=0.94 and correlation <0.96) and(FD >1.32 and FD<=1.44) and (LE>0.05 and LE <=0.08) then age group=young
   c) if (correlation >=0.90 and correlation <0.94) and (FD >1.1 and FD<=1.5) and (LE>0.06 and LE <=0.16) then age group=old.
4. End

4. RESULTS

The age group estimation of the facial image is implemented in this paper, the age groups are classified as child (10-20), young (21-50) and old (50 and above). The texture and fractal based techniques are used for the estimation of the age group. The data set used for Caltech face dataset and Cuhk face dataset for the old and young faces. The child face images are obtained from the internet. The figure 1 shows accuracy of the age group estimation

The result of the texture features and fractal dimension for the different age groups are shown in table 1-3. The result table shows that the texture feature such as correlation and laws energy features plays important role in the estimation of the age group.

Table 1. : **Old age group texture and fractal analysis**

Sr. No	Entropy	Contrast	Correlation	Homogeneity	Energy	FD	LE
1	6.68	219.24	0.92	0.29	0.000784	1.375511	0.06
2	6.13	52.21	0.93	0.36	0.001407	1.534109	0.12
3	6.45	98.61	0.93	0.33	0.001229	1.378594	0.14
4	6.28	87.93	0.94	0.30	0.001067	1.241204	0.16
5	6.23	73.47	0.91	0.34	0.001240	1.522346	0.13
6	5.88	33.55	0.94	0.38	0.001954	1.531308	0.13
7	6.64	97.35	0.93	0.27	0.000617	1.562582	0.13
8	6.47	89.25	0.92	0.27	0.000791	1.506948	0.10
9	6.73	94.70	0.94	0.29	0.000733	1.420771	0.11
10	6.34	74.96	0.94	0.31	0.001158	1.333652	0.12

Table 2. : **Young age group texture and fractal analysis**

Sr. No	Entropy	Contrast	Correlation	Homogeneity	Energy	FD	LE
1	7.11	147.07	0.95	0.30	0.000594	1.414347	0.12
2	7.01	149.85	0.96	0.34	0.000735	1.255710	0.07
3	7.11	103.61	0.96	0.27	0.000505	1.343732	0.11
4	7.25	187.93	0.94	0.30	0.000536	1.495889	0.08
5	7.08	160.69	0.96	0.35	0.000980	1.469234	0.12
6	7.29	134.45	0.97	0.34	0.000806	1.427434	0.07
7	6.95	72.72	0.97	0.37	0.000867	1.429907	0.09
8	7.08	136.35	0.95	0.32	0.000605	1.427816	0.09
9	7.19	132.92	0.96	0.30	0.000622	1.455414	0.07
10	7.32	129.56	0.96	0.31	0.000551	1.457378	0.08

Table 3. : **Child age group texture and fractal analysis**

Sr. No	Entropy	Contrast	Correlation	Homogeneity	Energy	FD	LE
1	6.90	103.22	0.96	0.36	0.000846	1.420835	0.09
2	7.02	52.11	0.99	0.36	0.000979	1.295372	0.08
3	7.54	147.46	0.97	0.29	0.000445	1.440104	0.06
4	7.67	88.89	0.99	0.28	0.000424	1.387220	0.06
5	6.86	56.77	0.98	0.37	0.001129	1.462476	0.09
6	7.43	126.58	0.98	0.33	0.000682	1.331978	0.07
7	7.57	139.66	0.98	0.33	0.000592	1.314610	0.06
8	6.41	52.33	0.96	0.42	0.002314	1.015737	0.14
9	6.79	70.15	0.97	0.36	0.001436	1.191068	0.12
10	6.78	55.09	0.97	0.37	0.001005	1.362090	0.08

The other texture features are also important for the classification of the age groups such as energy, contrast, homogeneity and entropy. The Table 4 shows the result of the age group estimation.

Table 4 : Age group Estimation Result

Age Grope/Data Set	Child	Young	Old
Caltech	93	90	91
Chuk	90	92	88
ORL	92	95	91

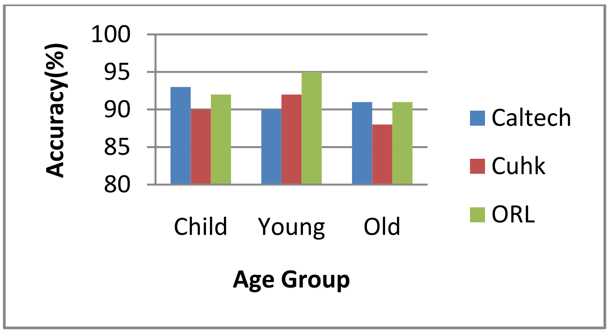

Figure 1 Age group classification

5. CONCLUSIONS

In this paper, we have presented, face image texture and fractal dimensions for the age group estimation as child, young and old. The dataset used for testing include Caltech, Orl face dataset, chuk face dataset for the young and old age group. The child images are obtained from the internet for the child age estimation. The performance parameters for the age group estimation as shown in figure 1. The graph in figure 1 shows the average accuracy for the age group estimation is 90%. The future scope for includes the use of the fuzzy logic for the classification of the age group.

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