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AGE ESTIMATION USING NEURAL NETWORKS BASED ON FACE IMAGES WITH STUDY OF DIFFERENT FEATURE EXTRACTION METHODS

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Abstract - Facial age estimation recently becomes active research topic in pattern recognition. As there are vast potential application in age specific human computer interaction security control and surveillance monitoring. Insufficient and incomplete training data, uncontrollable environment, facial expression are the most prominent challenges in facial age estimation. Degree of accuracy for age estimation is obtained by forming appropriate feature vector of a facial image. Feature vectors are constructed from facial features. Therefore comparative study of feature extraction from facial image by bio inspired feature (BIF), histogram of gradient (HOG), Gabor filter, wavelet transform and scattering transform is done. The propose approach exploits scattering transform gives more information about features of the facial images. Well organized system consist scattering transform that disperse gabber coefficients pulling with smooth gaussian process in number of layers which is used to calculate for facial feature representation. These extracted features are classified using support vector machine and artificial neural network.

Keywords - artificial neural network (ANN); bio inspired feature (BIF); discrete wavelet transform (DWT); Gabor filter; histogram of gradient (HOG); principle component analysis (PCA); scattering transform (ST); support vector machine (SVM); wavelet transform (WT).

I. INTRODUCTION

Understanding of human face images by automatic age estimation is a critical topic in which person's exact age or age group evaluation is a major task. In the estimator age group task divides labels roughly into different groups such as children, elder, teenager, adult and exact age task follows age labels densely. Our method mainly focused on the age task and is applied more generally to images while our method also outperform with age group task of estimator.

Temporal dynamic feature is used for age estimation in video based approach. In our method, we concentrate on image based approach study. Estimator learning and facial feature extractions are too important components to build age estimator effectively. For motivating the approach the estimator is discuss briefly. Most of the approaches consider problem of multiclass classification and problem of regression for learning age estimator.

A person age is obtained from classifier by only giving the age's value to the estimator as independent labels in multiclass approaches. Accurate age or age group can be predicted by using many approaches like multilayer perceptron, Support vector machine (SVM), k nearest neighbours and Adaboost. Standard approaches such as Support vector machine, Gaussian process and Quadratic regression are used for estimation of typical non-linear features.

Superior performance is obtain by learning to rank approach for age estimation as ranking algorithm is trained to adapt the labels ordering property while in conventional classifier approaches. In regression approach model age label consists relatively ordering information. But, number of parallel hyperplanes is used in a single major space, computing age estimate for bunch of labels. Therefore, performance improvement is limited. To effectively improving performance of age interference this approach consists multiple hyperplane in kernel space and the hyper plane classification aggregation results in the proper age rank.

Most popular face related feature is obtain by principle component analysis (PCA) in which both appearance and shape model are obtain which called as Active appearance model (AAM). Bio inspired feature (BIF) is a very effective appearance best feature among the all feature is obtain by using feed forward model in visual cortex. BIF consist number of layer of convolution and pooling process thus BIF is a pyramid of Gabor filters for facial images. Gabor filters are used for feature detection as they localize and extract text region from complex data of images (both colour and grey). Gabor transform is a special case of short time fourier transform. Wavelet transformation is one of the

most popular technique for time frequency transformation. Wavelet transform having inherent multi resolution representation i.e. scale (window width) and shift (window position) can be varied.

Face images are used for scattering transform to obtain the age estimation in this method. Input images are convolved with grabber filter with different orientation and scales to obtain bio inspired features. Feature vectors are obtained by pulling the pixels of image after transform. As in age estimation using face images higher efficiency obtained using bio inspired features. Texture feature of the object are reduced and local translation get invariance because of pulling of grabber wavelets coefficients that are convolved. Scattering transform recover the features such as lost texture details by retaining information related to high frequency. Thus, estimator consist discriminating capabilities. By using different pulling coefficients bio inspired features obtained are analogous to first layer of scattering transform. Therefore scattering transform can be used more effectively for face based age estimation.

II. Literature Survey

C. J. Taylor, T. F. Cootes and A. Lanitis [1] proposed features like skin aging, cranio facial growth from childhood to adult age estimated using active appearance model for age estimation.

J. B. Pittenger et al, L. S. Mark, J. T. Todd and R. E. Sha [2], different types of classifier are used for feature representation along with active appearance model. Different classifiers are neural networks quadratic function and shortest distance classifier. This approach is divided into two parts:

a. Estimation age specific – It assume that everyone exist identical aging process.

b. Estimation appearance specific – It considers that the people having similar looks exist same aging process. Similar faces are clustered before classification and aging process consist personalize age estimation.

K. Smith-Miles, Z. Zhou X. Geng in [3] and H. Dai, Z.-H. Zhou, G. Li X. Geng and Y. Zhang [4] says, active appearance model consist face images in a sequence of age ascending for same person. In this paper considered as human faces represent several unique characteristics as an aging effect which makes challenging task to obtain the proper age estimation method. Therefore propose method in this paper is (AGES) aging pattern subspace is used for automatic age estimation. Therefore aging models for different persons can be obtained. Aging pattern sub space consist personalized age estimator method which having persons long term age sub space. Aging pattern sub space estimator can reconstruct the face image by periphase and perfectly estimate the age.

W. Gao, X. Chen, J. Suo, S. Shan, [5] , to obtain long term sequence of facial images is a major problem is overcome by applying various short term patterns. As short term patterns are easily produced. A samples of short term and long term aging patterns of single person are not sufficient for estimation. Therefore major focus on approaches which are non personalize.

Z. Yang, H. Ai [6], non personalize approach such as classifier is trained by using sequence of local binary pattern histogram in which features are obtain by real Adaboost algorithm,

H. Lu, Q. Liu, C. Li, J. Liu [7], important features are obtained by masking out redundant feature and extracting local region.

B. Ni, Z. Song, S. Yan, [8] when there are face images with noise level are obtain from web source this levels are estimated by multi instant regression method to obtain age ranks.

Saeid. Fazli, Leila. Ali Heidarloo [11], feature dimensionality can be reduce with PCA and DWT with a slope orientation used for extraction of features, they shown second method discrete wavelet transform, gradient orientation, principle component analysis gives best performance for age invariant face recognition as compare with other methods.

Dr. S. Muttan and P. Gnanasivam [12], persons age is calculated using combination of Singular Value Decomposition and DWT.

Ms.Reeta Rani, Mr.Kuldeep Sharma, Mr.RakeshDhiman [13], facial features are extracted from Gabor filters and classified with K-means algorithm, adaboost method is used for age image representation.

Kuang yu chang, Chu song chen [14], Specially organized system consist scattering transform that disperse gabber coefficients pulling with smooth gaussian process in number of layers which is used to calculate for facial feature representation. Here BIF compromise the first layer of scattering transform. Feature extraction is important field in digital image processing. Most relevant feature of image is extracted and assigned to particular class. According to their content images are classified. Most crucial task is to analyze and localize the characteristics and properties of image features and organizing them to corresponding classes.

Different features of images are texture, shape, appearance and color. The group of pixels having certain characteristics is called as texture features. Texture feature extraction technique is classified into two major categories, first one is spatial texture feature extraction and another is spectral texture feature extraction.

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III. Different Feature Extraction Methods Are Used As Below

1) BIO INSPIRED FEATURES

Number of layers of this feed forward models consist convolution and pooling process. First input image is convolved with a bank of Gabor filters of multi scale and multi orientations to map it to higher dimensional feature space. Next pooling step is used to down scales the results with a non linear reduction. Results are encoded to form vector, signature by MAX or STD operations. A important property of bio inspired feature model is non linear maximum operation which is called as "MAX" is done on "S" layer to pool inputs to the "C" layer instead of simply linearly summing operation "SUM". For example, the first layer "S1" of model is created by convolving the input with Gabor filters with 4 orientation and 16 scales. To obtain 8 bands adjacent two scales are grouped from 16 scales of S1 layer for each orientation. The second layer "C1" is generated by choosing max values within a local spatial area across scales within each band. Thus, C1- layer consist values with 8 bands and 4 orientations. Scale variations and small shifts are tolerated by "MAX" operation when small range of scales is considered.

T. Serre, L. Wolf, and T. Poggio [9] extended "HMAX" model of M. Riesenhuber and T. Poggio [10] says two higher level layer S2, C2 are included for object recognition. Initially prototype patch obtained from natural images are learn then this patches are used for template matching in S2 layer. Then S2 layer units are convolved over an entire image and maximum values of S2 are assigned to C2 layer.

2) HISTOGRAM OF GRADIENTS

It consist object detection and recognition with very fast computation thus reduces computation cost. Most important property of histogram of gradient is compactness and invariance to misalignment of objects and illumination changes in the grey scale images. Therefore it requires only 5 landmarks for alignment. These fiducial landmarks corresponding to the nose tip, eye centers and mouth corners are obtained using covolutional neural networks for facial alignments.

3) GABOR FILTER

Gabor filters are linear filters mostly used for edge detection and they have been found to be very appropriate for texture representation and discrimination. Gabor filters orientation representation and frequency response are very similar to those of the human visual systems.

Image analysis with Gabor filters is very similar to perception in the human visual system. The filter having real and imaginary component are represented in orthogonal directions. The two components can be used individually or can be formed into a complex number. Gabber filters are based on gabber wavelets, number of rotations and dilations can be obtained but expansion is not possible with gabber filters as they require biorthogonal type which required more time for computation. Therefore Gabor filters with various scales and rotation is created. Gabor transform is one of the type of (STFT), that can be used to obtain frequency and phase shift of the signal changing with time. First in window the function (part of signal) to be transformed is multiplied by gaussian parameter, the resultant convolved with FT to represent the frequency-time scrutiny. The window parameter is the part of the signal which is very close to the time to be observed having more weightage. Window function width can be varied to optimize the time frequency resolution, thus simplification makes the Gabor filters practical and more realizable.

4) WAVELET TRANSFORM

Wavelet Transform having inherent capacity for multi resolution representation therefore widely used. The wavelet transform distribute the signal into small parts, every part related to separate frequency bands. To overcome the time complexity discrete wavelet transforms (DWT) are widely used. The DWT is useful in image feature extraction as it simultaneously localize signal in time and scale. The scrutiny filters bank contains a pair of high pass and low pass filter at every division level. As input image send from this pair it separates it to two lower bands. Averaging function carried out by low pass that obtains rough details of the feature of input image. Fine details of the image are obtained from impulse response of the high pass filter. First image is filtered row wise and divided by 2 followed with filtering column wise and dividing by 2. Whole process splits the image into 4 bands, as shown in figure 1; (Aj), (Hj), (Vj), (Dj) respectively.

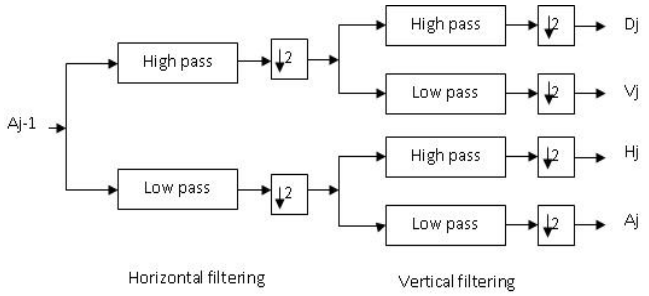

Fig.1. The one-level decomposition of wavelet transform

Every sub bands represent various image features. Maximum energy lies in lower frequency bands; therefore generally decomposition is done on the lower sub band which is also called as dyadic decomposition as shown in figure 2.

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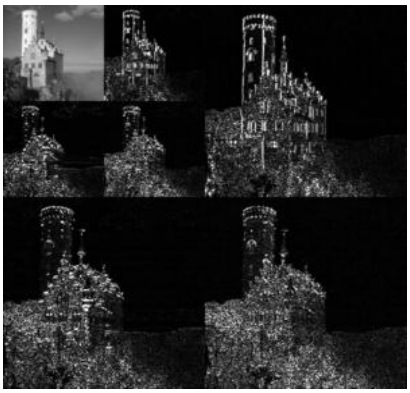

Fig.2. Example of 2D discrete wavelet transform

5) SCATTERING TRANSFORM

Scattering transform is multi layer representation of the deep covolutional networks. The scattering transform can be designed in such a way that it is invariant to different scales and a group of transformations, rotations. Scattering transform can be modeled as translation invariant version in multi layer form. A good feature extraction can be obtained by scattering transform that used to represent facial image feature vectors which are insensitive to transformation and small displacement but highly reactive to large displacement. Scattering transform is obtained with randomly distributing wavelet coefficients in number of convoluting networks, which distributes the feature characteristics in the number of the layers. Thus scattering transform consist values of different degrees that are concatenated to obtain various set of coefficients. As the concatenated coefficients are used for feature representation more accurate classification boundary is obtained.

It can be seen that scattering transform coefficients of the first layer of scattering transform are similar to the BIF. As BIF consist pyramid of Gabor filters for facial image with two layers S1 and C1. S1 layer is obtained by convolving whole image with Gabor filter and C1 layer is obtained by pooling maximum values from S1 layer. Thus BIF and first layer of scattering transform follows the same technique for feature extraction with a slight deviation in the pooling operators. The coefficient of scattering transform for each layer can be computed by cascading three operations decomposition of wavelet, local invariant module and local averaging. Consider a input signal f(x) we can obtain scattering coefficient for first layer by applying wavelet transform of various scales and orientations, taking only magnitude of wavelet coefficient and whole convolving with averaging filter Φ_j as shown

$$S_{1,j}(f(x)) = \left|f * \Psi_{j1,\lambda1}\right| * \Phi_j$$

j1 and $\lambda1$ are scale and orientation. Coefficients are made invariant to local translation because of only taking the magnitude of wavelet. Convolution with a low pass filter increases the invariant ability but the high frequency information of the signal will be lost. Lost information can be recover by convolving $\left|f * \Psi_{j1,\lambda1}\right|$ by another set of finer scales of wavelet coefficient. j2is the adjacent scale of j1 where j2<j1. The high frequency information obtained at second higher layer by taking magnitude of wavelet and averaging by Φ_j as

$$S_{2,j}(f(x)) = \left|\left|f * \Psi_{j1,\lambda1}\right| * \Psi_{j2,\lambda2}\right| * \Phi_j \qquad j1>j2$$

By iteratively convolving with averaging filter $\Phi_j$the coefficients of the k-th layer of scattering transform can be obtained as below:

$$S_{k,j}(f(x)) = \left|\left|f * \Psi_{j1,\lambda1}\right| * \ldots * \Psi_{jk,\lambda k}\right| * \Phi_j$$

jk<….<j2<j1 and $(\lambda1, \ldots \lambda k)\epsilon\mathcal{T}^k$

As shown in figure scattering the coefficients to the higher layer (m= 0,1,2) is suggested.

To represent facial image feature vectors which are insensitive to transformation and small displacement but highly reactive to large displacement we can use scattering transform. Scattering transform is used by successive layers of wavelet transform which scatter signal features details with the various layers shown in fig.3. In scattering transform, different position of scales of gabor wavelets are used to represent various facial parts. Small scales are very effective to represent minor features of different parts of the face and large scale for major features. Therefore gabor wavelets with various scales are distributed randomly in a face image to obtain higher degree of accuracy. Thus various local mask are used for feature determination from the image. We consider 8 local masks which consist both eyes (left and right), both cheeks (left and right), nose tip, chin with mouth, forehead and center of eye brows. Scattering transform with number of layers are related to face image and cropped sub images are summed to obtain feature vector.

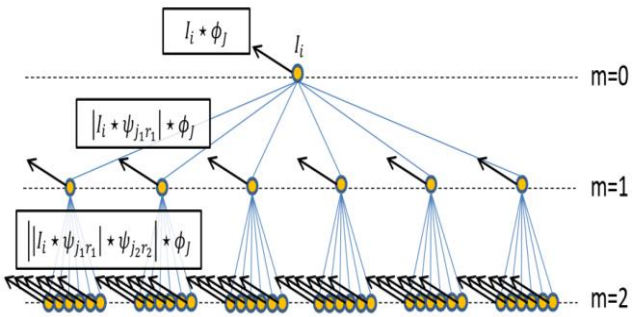

Fig.3. Architecture of scattering transforms computation

IV. Classification By Using Support Vector Machine (SVM)

The ranking approximated cost can be reduced by reducing the misclassification cost of each and every classifier. Ranking performance can be improved by accurately training binary classifier so that misclassification cost can be kept minimum. Therefore support vector machine is used as a binary classifier with rescaling method with biased penalties. If single kernel used sub problems can not be solved effectively, therefore number of kernels are used to follow the each sub problem with better accuracy and results of all sub problems are concatenated to obtain the feature space ϕ_k. Differentiating function $f_k(y)$ is obtained.

$$f_k(y) = <w_k, \phi_k(x)> + b_k$$

Depending upon the outputs generated by Support Vector Machine (SVM) the aged or younger is decided.

V. Clasification By Using Artificial Neural Network (ANN)

Artificial neural network is a best example of machine learning which consist simple mathematical or neural network. Set of learning algorithm consists evaluation function of many inputs which are unknown. Collection of interconnected neurons are called artificial neural network. It consist 3 parameter such as inter connection series between different neuron layers. Different weightage use to update interconnection learning process and finally activation process. In this process group of neurons are weighted to obtain the certain output. This function known as activation function in which weighted inputs neuron are obtained with output activation with different classes. There are many connected neurons which also gets activated simultaneously and finally activates the output neurons which represent output function belongs to specific class. Complex phenomena which can be understood via experimental data and problem formulated less or more precisely, accurately and with most robustness by ANN.

VI. Conclusion

We evaluated different feature extraction methods applicable to age classification from facial images such as bio inspired feature (BIF), histogram of gradient (HOG), Gabor filter, wavelet transform and scattering transform. Age estimation from facial images employs relative order information within age ranks and consist cost sensitivity by aggregating the rank inference. We demonstrate that replacing complex feature extraction schemes with scattering transform achieves comparable performance to other methods. A deformation stable and translation invariant descriptor such as scattering transform can be used effectively to evaluate feature extraction of facial components. By using scattering transform for age estimation can reduce mean absolute error (MAE) and increase cumulative score (CS) in facial age estimation. Features extracted by scattering transform can be supplied to support vector machine (SVM) and artificial neural network (ANN) classifier. Age estimation using classifier support vector machine (SVM) is better but performance can be improved in terms of MAE, CS indices by artificial neural network (ANN) classifier.

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