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A Survey: Face Recognition under Occlusion Condition

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Abstract: Face recognition is a pattern recognition task performed specifically on faces. It can be described as classifying a face either “known” or unknown, after comparing with stored known individuals. It is also desirable to have a system that has the ability of learning to recognize unknown faces. Computational models of face recognition must address several difficult problems. This difficulty arises from the fact that faces must be represented in a way that best utilizes the available face information to distinguish a particular face from all other faces. Faces pose a particularly difficult problem in this respect because all faces are similar to one another in that they contain the same set of features such as eyes, nose mouth arranged in roughly the same manner.

There are several types of face recognition systems discussed in the literature. Geometry and templates, Template matching, Dynamic Deformable Templates, Independent Component Analysis, Wavelets, Gabor Fisher Classifiers, Hidden Markov Models and Neural Network. This survey will be very useful for any future scholars to work in this domain using all the collected references.

Key words : Face recognition, Template matching, Dynamic Deformable Templates, Independent Component Analysis, Wavelets, Gabor Fisher Classifiers, Hidden Markov Models and Neural network

Levenburg Marquardt algorithm

Muhammad Naeem Ahmed Khan et al. (2013) have implemented the gender classification using decision tree C5.0 and J48 classifier using the tool WEKA 3.6.4. The age classification with the help of decision tree is the future work considered in this article. Saravanan A et al. (2013) have performed the implementation of Levenburg Marquardt algorithm used to find the solution for recognition even if it starts very far off the final minimum value. The BPNN neural network with the LMA was used to find the final minimum. Mark Culp et al.(2013) have identified the various types of boosting algorithms that are discussed and to find the best boosting algorithm were found. After the generation of highly accurate classification rule, the misclassification error rate for the given samples were identified. Sushma Jaiswal S et al. (2011) have compared the three algorithms PCA, LDA and morphological methods for face verification. The Back Propagation Multi-Layer Neural Network and Learning Vector Quantization, Radial Basis Function were applied for classification. Haibin Ling et al. (2010) have achieved the face verification across age progression using Gradient Orientation Pyramid with Support Vector Machine. The FGNET and Passport dataset are used for age progression and face verification where the age gap is larger. Gayathri Mahalingam et al. (2010) have explained within their work concerning the AdaBoost techniques in the face recognition application. The features are extracted using Local Binary Pattern and the face verification were performed using Local Binary Pattern Histogram techniques. The FGNET dataset was taken as the training set. The age gap was smaller compared with the existing work performed earlier stages.

Feature Extraction Based Face Recognition Gender and Age Classification

Ramesha K et al. (2010) have applied the algorithm for FEBFRGAC (Feature Extraction Based Face Recognition Gender and Age Classification) in their proposed work. The canny edge operator, posteriori probability and artificial neural network were applied in the texture and shape information. Gahyun Kim et al.(2010) have explained the occlusion verification technique in the automated teller machine. Occlusion of the face area were determined by measuring skin color area ratio. The head and shoulder detection method has 94.8% detection rate even though there are various types of severe occlusions in faces, and the proposed occlusion verifier has performed 86.7% verification rate. Duan Xiao-dong et al. (2010) have performed the feature extraction for algebra and geometry features. The LDA algorithm and Gabor Wavelet Technique were used to extract the features. The 79% of algebra features and 90.4 geometry features are captured. Mohamed Y.El Dib et al.(2010) have initialized the shape model and analyzing the more complete facial area by including the forehead details. To combined the regression based and classification based models and test them experimentally on standard datasets showing the superiority of the algorithm for Extended Bio Inspired Features (EBIF).

Adulthood classification of a mugshot facial image

M.Chandra Mohan et al.(2010) have accomplished the novel scheme for adulthood classification of a mugshot facial image into a child and adult based on the face geometric properties using 1-level linear wavelet decomposition technique. The FDF(Facial Distance Feature) evaluates various facial feature parameters (FFP). From the FFP adulthood classification parameters were evaluated. Ichikawa K et al.(2008) have classified the image from face and non-face by the usage of decision tree 4.3 with AdaBoost and LDA techniques. The



LDA can be used to integrate all features to conclude that eye and mouth have been occluded. The left and right eye, left and right nose, mouth were the features. Nutao Tan et al. (2008) have made a novel algorithm for face recognition based on a single image and a new LBP (Local Binary Pattern) descriptor. The algorithm can be divided into three steps: firstly, calculating both the horizontal and vertical edge maps from the gray image, then extracting LBP histograms from those two edge images finally, adopting elastic matching for classification.

Features using Fast Fourier Transform

Hironobu Fukai et al.(2008) have extracted the features using Fast Fourier Transform. The AIBO and ROBO were used to find the age of a human. AIBO can acquire information of users from many kinds of sensors and has many action patterns using many actuators, LED lights and sounds. The high generality face recognition system for AIBO using the radial basis function (RBF) network, which can study partially. RBF network study only skin color, to make versatile system not depending on learning data set. Xin Geng et al.(2008) have addressed the face recognition under uncontrolled conditions. The Individual Stable Space(ISS) which expressed personal characteristics. A neural network named ISNN is proposed to map a raw face image into the ISS. ISS based algorithms are designed for Face recognition under uncontrolled conditions.

Drawback of ANN

Eyal Kolman et al. (2008) have explained that the drawback of ANN is a black box character. Two knowledge base design was performed using RNN. Using special set of symbolic rules the RNN can be formed in the first design and also the second method with the help of the symbolic rules the counters and comparators are designed. Shengcai Liao et al. (2007) have applied the Multi scale block Local Binary Pattern(MBLBP) was applied in the face recognition. It was robust compared with LBP and also it encodes not only for micro structures , macro structures also. The integral images are used to compute the results. KYY Ng et al.(2007) have examined the differences in face memory between young and older adults. To learn and recognize unfamiliar faces in three recognition trials: after a single exposure, after four exposures, and after a half-hour delay. The findings indicated non-significant differences in recognition accuracy ($p>0.05$), though the performance of the young adults were superior. Compared to young adults, older adults may use a different processing route during face recognition in order to compensate for the decline in their cognitive abilities. Shu Liao et al. (2006) have explained the facial recognition approaches. There were two sets of features. First texture features and global appearance features. First set is used to find the features using LBP, the second set features are extracted using null space based linear discriminant analysis.

The JAFFE database was used for comparing the two expressions in the face image. Shu Liao et al.(2006) have implemented the Advanced Local Binary Pattern method and it was used for feature extraction. It can capture the local characteristics of the texture image, ie(edge and corner). The proposed approach has been compared with other widely used texture classification techniques and evaluated by applying classification tests to randomly rotated and histogram equalized images in two different texture databases: Brodatz and CURET.

Morphable model based on synthesis and analysis strategy

V.Blanz et al. (2003) in Ref [31] and in Ref [36],(1999) have performed new morphable model. Morphable model based on synthesis and analysis strategy. The model was able to handle both illumination and pose variations. The complex fitting algorithm and images with long size also considered in this model. The Morphable model transformed the shape and texture models into a vector space representation. Kazuya Ueki et al.(2006) have presented the classification of age group using facial images under various lighting conditions.

Guillaume Hesuch et al.(2006) have proposed LDA and HMM (Hidden Markov Model) techniques for face authentication. LBP was used for preprocessing the facial image under illumination conditions. S.K.Zhou et al.(2005) in Ref [31], R.Gross et al.(2004) in Ref [32] have demonstrated the illumination and pose variations in the facial image. The morph dataset and FG-NET (Face and Gesture Recognition) dataset were used for this purpose. A.Lanitis et al.(2002) in Ref [33], Lanitis et al.(2004) in Reg[28] have proposed methods for aging effects on face images. Face recognition and age estimation , the parametric model were performed. The database have under the age of 30. The performance were evaluated using different classifiers. The classifiers have been evaluated using supervised and unsupervised neural network. G.H.Givens et al.(2004) have analyzed the various co-variables such as gender, expression, hair and age etc. The performance have been tested with various face recognition algorithm. The older faces were often easier to recognize than the younger faces.

Machine based age prediction function.

Y.Zhan et al.(2001) have designed a Support Vector Machine based age prediction function. The image based surface detail transfer method applied towards emphasizing or de-emphasizing wrinkles as face images. P.J.Philips et al.(2000) have implemented to the advent of standardized performance evaluation protocols with the use of FERET dataset which is applied to the commercial significance of face recognition systems . Y.H.Kwon et al.(1999) have classify the face image into three groups such as infant, young adult and senior adult. The proposed method was to detect the wrinkles and to classify the wrinkle regions in the face images



belonging into young adult or senior adult age group. Y.Wu.N.Thalmann et al.(1995) have represented skin deformations as a plastic visco-elastic process and generate a permanent wrinkles through a simulation of elastic skin deformations technique. A.J.O.Toole et al.(1997) have performed the standard facial caricaturing algorithm to 3D models of faces and reported an increase in the perceived ages of faces. The decrease in the perceived age when such creases were de emphasized.

Eigen face and eigen features corresponding to face components

Pentlant A et al.(1994) have extended their early work of eigen face and eigen features corresponding to face components. They proposed the modular eigneface which was composed of the above eignefaces. Less sensitive to appearance changes then the standard eigenface method. The proposed method have fast and simple. After applied the proposed work, the FERET database with in the 7562 images with 3000 subjects have the recognition rate of 95%. Y.Zana et al.(2006) in Ref [65], J.Shi et al.(2006) in Ref [23] have proposed the algorithm for polar frequency domain which is effectitive compared with the aging variation. Based on the algorithm the landmarks, the geometry based approach for face recogniton across ages are identified. In the References Belhumeur, P.N et al. (1997), in Ref [38], L.Sirovitch et al. (1987) in Ref. [43], M.Turk et al. (1991) in Ref [44] and M.Fleming et al. (1990) in Ref [45] have extracted the Eigen space, Fishers Discriminant analysis for the frontal views of the faces. The global features are sensitive to translation and rotation. The alignment tag can be performed before classification. The alignment of an input image requires the computing correspondence between the two face images. Based on these correspondence input face image wrapped into the reference face image. Boualleg et al. (2006) have compared the neural classifier and the principal component analysis. The geometric approach were performed for the preliminary classification of the faces . The hybrid method for combined the neural network with PCA were used for the proposed work. X.Tan et al. (2005) have extended the existing work of local probablistic approach using Self Organizing Map(SOM). The mixture of gaussians to learn the subspace that were used identify each individual in the dataset. The k nearest neighbor ensemble method applied to identify the unlabeled subjects for face image. The proposed method have highest performance with partial occlusions and expression variations. R.Gross et al.(2004) have proposed the research work for face recognition across pose and illumination variation. For Frontal face recognition there is a pose invariant face recognition and illumination invariant face recognition were considered for their proposed work. M.Gandhi et al.(2004) has proposed a new automatic aging scheme in his thesis. Variations due to lightining conditions and pose variations were considered. Geometric details have captured

from the input image. From the internet 800 high quality images were captured and to find the relationship among all the images. The wrapping up of all the images and fed into the learing process using support vector machine. Finally the age prediction function found the exact age of a human image which was derived from the internet images. M.J.Jones et al.(2002) have constructed a model of skin and non-skin classes from a dataset of nearly 1 billion labelled pixels. The proposed method was used to detect the skin pixels. The false acceptance rate is 8.2% and 80% of recognition rate. From the result they observed that the color was a powerful for detecting in unconstrained imagery. Henry A.Rowley et al. (1998) have developed a neural network based upright frontal face detection system. The window contains the face image. The Bootstrap algorithm adds the false detection into a training set to train the new progresses. The proposed work carried out for the false detection examples as well as the positive face examples for training. Rama chellappa et al. (1995) have reviewed 20 years of literature survey papers and summarize the various techniques available for face segmentation , to find the location of the face, face recognition. They explained the applications of face recognition in commercial and law enforcement sectores.

Review on Age Estimation with respect to face verification

Nabil Hewahi et al. (2010) have captured the four categories of facial features like child, young, youth and old. Easy Neural Network tool was used to classify the different age groups. The FGNET and Morph dataset were used as a training set. The four stage neural network operations were performed in this literature. Yun Fu et al. (2008) have implemented for face recognition with the discriminative approach. The features were extracted using local binary pattern method and the face verification was performed using the elastic matching pattern and the age can be classified using the discriminative approach. Xin Geng et al. (2007) have developed the AGES(Automatic Aging Pattern Subspace) model, which is defined as the sequence of particular individual face image sorted in time order, by constructing a representative subspace. The proper aging pattern for the unknown face is determined by the projection in the subspace in the reconstructed the face image with minimum reconstruction error, while the position of the face image in the pattern was indicates the age.

Gradient Orientation pyramid and hierarchical techniques

Haibin Ling et al. (2007) have used the Gradient Orientation pyramid and hierarchical techniques to find the age of a human. The descriptor having two class problem for the face image with the help of SVM (support Vector Machine). This approach was applied to two passport data sets containing more than 1,800 image pairs from each person with large age differences. Aging process adds difficulty to the recognition task, it does not surpass illumination or expression as a



confounding factor. Narayanan Ramanathan (human faces) et al. (2006) have explained the Age Invariant Signature, facial growth event and recognition. They compared the various approaches and proposed the problem. The age estimation, appearance prediction and face verification were the stages of the problem. The FERET, Morph and FG-NET dataset were used for the purpose of age estimation. David Masip et al. (2009) have identified the drawbacks in Face Recognition. Information in high dimensional subspace and the reduced training set have a problem to identify the new people to recognize. The new approach for boosting based classifier with the existing PCA and LDA technique were proposed for recognize the new people. Andres Lanitis et al. (2004) have designed classifiers that can accept the model based representation of unseen images and produce an age estimation of their person. The training set contains the Age estimation classifier for each age group and classifiers for different clusters of each subjects. The results indicates that the machines can estimate the age of a human as reliably as humans. The training set contains the Age estimation classifier for each age group and classifiers for different clusters of each subjects. Karl Ricanek Jr et al.(2006) have investigated all directions of adult age progression. The proposed morph database contributes to various active research areas, face recognition with longitutation images and longitudinal spans and that is publically available. Xiaodan Zhuang et al. (2008) have proposed using Hidden Markov Model supervector to represent face image patches to improve from previous GMM(Gaussian Mixture Model) super vector approach. In the proposed method the HMM with Euclidean distance supervector approach were applied for large face dataset.

Multi layer And-Or graph

Jinli Suo et al.(2007) have represented multi layer And-Or graph and it combined the global appearance changes in shape, deformations and aging effects of facial components and wrinkle appearances. There are two stages in this approach. Aging model learned from dataset, the uncertainty in face aging. To verify the results the simple human experiment and the simulated aging process are compared. Shaohua Kevin Zhou et al.(2008) they proposed Face Recognition technique in biometric perspective, experimental perspective and theoretical perspective. To recognize the new objects with new lightning conditions were considered in their proposed work. Sucharitha et al. (2011) have identified the graph based method that contains information on the appearance and geometry of fluid feature points. The age model learned from individual graph space and built with feature descriptors extracted from the face image. Udeni et al.(2009) have implemented the way of synthesizing a facial image with the effects of age. There may be changed with the person and his face image. The mechanism was proposed in their approach to identify the person's face image. Y.H. Kwon et al.(1999) have proposed the model for age classification.

The facial feature ratios were calculated. After the wrinkle analysed the energy equation performed. The potential fields was used to find the solution for the energy equation. The geometric ratios with wrinkles on the forehead, near to eyes, cheeks are identified. Based on these techniques the wrinkles were analyzed. I. Pitanguy et al.(1996) have measured the aging parameters across the age. The aging curve for all facial features are identified. The exact age group of the particular features are captured. The aging curve captured for the exact age of a particular man with the particular features.

D.Pissarenko et al.(2002) have analysed an algorithm for face recognition using eigenfaces. There are many other face recognition techniques were analysed. Compared to other techniques the eigenface based face recognition techniques performed better result.

Facial appearance changes in a coherent manner as people age.

Soma Biswas et al.(2008) have observed that facial appearance changes in a coherent manner as people age. The coherency of face features were calculated. The results shows the effectiveness of such non-generative approach even with simple measures of capturing coherency in aging. Walid Moudani et al.(2011) have presented a method for skin detection based face verification. The color images were considered with complex background and the comparative study done for applying the several algorithms with good accuracy were achieved. S.M. Valiollahzadeh et.al (2008) have implemented an algorithm for Support Vector Machine with adaptive Boosting (AdaBoost) classifier. The 2D non-standard haar features were used to represent a face. The MIT-CMU test set used for face detection with 98.2% accuracy.

Robustness in the occlusion conditions in face detection

T. Kurita et.al (2003) have explained how to improve the robustness in the occlusion conditions in face detection. New architecture of neural network has been designed for the partially occluded face image. The original face image can be reconstructed and this process have been done recursively. Anuja Priyama et.al. (2013) have performed the comparative analysis of decision tree classification algorithms ID3, C4.5 and CART for student application to predict their performance. The large databases are having limitations when using the above algorithms. To solve the problem SPRINT and SLIQ decision tree algorithms were used. Performance and results are compared of all algorithms with existing datasets. The accuracy were more witnessed when using the SPRINT algorithm approach. Ranjita kumari Dash et al (2013) have done the comparative analysis for different classifiers in WEKA tool. The fundamental concept of data mining techniques and classification were discussed in their research. The Naïve Bays functions, Lazy, Meta, Nested dichotomies,



Rules and tree classifiers are used for the classification of data set. In statistical wise, time wise and the accuracy wise the correctly classified instances and incorrectly classified instances were identified using WEKA tool. The dataset is in ARFF format. 10 fold cross validation was used to provide better accuracy. G. Nirmala Priya et al.(2011) have implemented the algorithm which automatically detects the presence of occlusions in the facial image. The experiments balances both illumination and facial expression changes. The Mean Based Weight Matrix (MBWM) algorithm has been proposed and the performance compared with LBP method. The MIT face dataset used and the result have 4.25% accuracy compared with the LBP method.

CONCLUSIONS

Face recognition is a pattern recognition task performed specifically on faces. It can be described as classifying a face either “known” or unknown, after comparing with stored known individuals. It is also desirable to have a system that has the ability of learning to recognize unknown faces. Computational models of face recognition must address several difficult problems. This difficulty arises from the fact that faces must be represented in a way that best utilizes the available face information to distinguish a particular face from all other faces. Faces pose a particularly difficult problem in this respect because all faces are similar to one another in that they contain the same set of features such as eyes, nose mouth arranged in roughly the same manner. There are several types of face recognition systems discussed in the literature. Geometry and templates, Template matching, Dynamic Deformable Templates, Independent Component Analysis, Wavelets, Gabor Fisher Classifiers, Hidden Markov Models and Neural Network. This survey will be very useful for any future scholars to work in this domain using all the collected references.

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