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THE EXTRACTION OF SELECTED FACIAL FEATURES FROM THE STATIC IMAGE IN THE ESTIMATION OF AGE

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ABSTRACT

In this paper the combination of techniques for the extraction of selected features of human face is presented. Principal focus of these approaches is to enhance the process of the age estimation. The advantages and disadvantages of specific methods are presented following the prior researches. The main goal presented throughout the paper is the extraction of selected features via experimental testing of various techniques used in the field of the age estimation. Paper presents the combination of such techniques that enhance the estimation process and further this combination is to serve as a basis for the development of overall complex system for the age estimation and subsequent identification of a person in the image.

KEYWORDS: age estimation, face detection, facial features, feature extraction.

INTRODUCTION

Detection of face is a very common and widely utilized process, once face is detected several techniques may be employed – one of these being the estimation of age, this estimation rather rare. There are several factors that may affect such estimation: environment, provided health care or heredity. Many other factors influence the overall look of human being.

Age detection may be used in various types of applications. First of these is gaining the access to a system based on the age, e.g. to forbid underage persons from viewing some website. The other type is human-machine interaction, where the system automatically adjusts the interface based on the estimated age. Useful utilization might be specifically for children or elderly people. Data collection and person identification based on the age might be of vital for security purposes.

Age estimation faces many critical factors that are related to the processing of images, e.g. face detection, image resolution or sex estimation. We already noted that the aging process might be determined by several factors, this forms other kinds of issues – limited number of age groups, sometimes the difference between neighboring age group is insignificant, mainly in the case of the adults. Variety of aging process – number of facial wrinkles may vary in the same age group and thus the age estimation may produce different outputs. The last are external factors – sanitary conditions, life style, psychological condition of individual and also intentional factors that interfere to the aging process by means of cosmetic surgeries or in the form of makeup.

STATE OF THE ART: THE AGE ESTIMATION

In this section are presented approaches and specific algorithms that enable the age estimation process based on the facial features. There are basically two main ways on how to achieve it: standard classificators are being employed, where the specific age group is assigned a set of facial features following the basic face structure or specific features such as wrinkles. Another way is represented by alternative methods based on the modeling of the aging process.

One of the first algorithms for the age estimation was introduced in 1999, it included two fundamental functions: geometric dimensions calculated following the distance and measurements of selected facial features and estimation of the number of wrinkles detected as deformed contours in the area of face. Three age groups were introduced by the authors – Kwon and Lobo [1]: children, adult and elderly people. Authors carried out the testing only on the 47 high resolution images and claimed accuracy of testing to be 100 percent.

Lanitis et al. [2][3] utilized Active Appearance Model (AAM), the algorithm that statistically compares faces with the aim of the age estimation. Functions are in the form of quadratic equations and are used to form a relationships representing faces in relation to the actual age, i.e. age estimation.

Deployment of age patterns of individual person in the data structure containing faces of various ages was introduced by Geng et al. [4]. Each set of such time-dependent group of faces is considered as one sample and may be translated to a reduced space. Tested face is placed to various positions in the pattern and the position, which minimalizes the number of errors in the reconstruction, is indicating the age of a subject. Experimental testing, based on publicly available datasets proved this method to give enhanced outputs when compared to prior methods. Another outcome of this research proved methods that work with unique facial features to achieve better results when compared to standard classification outputs.

Fu and Huang [5] represent age patterns by manifold learning, selective subspace learning based on diversity criteria is developed on low-dimensional presentation of age diversity. Relation between age and face representation introduced by Guo et al. [6] is utilizing Support Vector Machine Regressor (SVR). The key idea is the extraction of rough age estimate using global SVR with subsequent enhanced estimation using the local SVR learnt on small age interval.

Majority of methods for estimation of age utilize information from the face as a whole. Alternative to this is presented by Suo et al. [7], where the three-layered hierarchical model of face is being used as a basis for the estimation of age. The first layer is global representation of face, second is related to specific parts of face that are responding to various functions and third layer is covering details such as wrinkles or hair characteristics. Experimental results prove utilization of such details to be substantial for the effectiveness of the age estimation.

Hayashi [8] focused his research of facial wrinkles to estimate the age and sex. Skin areas were extracted first from the facial images and subsequently followed the histogram equalization to enrich the wrinkles. Hough transformation was then used to extract shorter and longer facial wrinkles. Outputs of research was rather unsuccessful and achieved only success rate of 27 person in the age estimation, however rate of assigning the sex was 83 percent. Note that no size of input set was provided. Hayashi highlighted difficulty of wrinkle extraction for women of 20 to 30 years old due to make-up coverage. In the recent publications the author has claimed improvement of methods for the age estimation that are comparable to real life man-to-man estimation. However one of the reasons for automatic estimation of age is the inability of a man to estimate the age with certainty. This automatic estimation should be efficient enough with regards to face diversity and image quality.

EXTRACTION OF FACIAL FEATURES

Selected method for extraction of facial features combines the facial information and information of the pattern. Basic idea of this approach is selection of facial features candidates based on the information of shape and its verification by sample comparison. The filter, specifically aimed on areas, is being utilized to achieve partial shapes from features that correspond to areas or marginal points and is then verified by subspace methods. This method may be used to achieve the best position, providing the position is based on the information of shape.

Once we compare samples based on subspace method, the selection of appropriate facial features (see Fig. 1) from the group of candidates is carried out. Method is invariant towards variation of facial features and changes in illumination.

The processing rate for comparison of samples will be done only from the candidates selected by filter with low processing value, this will result in significant reduction in processing time when compared to other methods that utilize comparison of the whole samples.

Sample comparison is used to correctly estimate the facial features from candidates. This technique is however not resistant towards illumination changes or face rotation. High processing rate and detection of initial parameters pose other disadvantages of this method.

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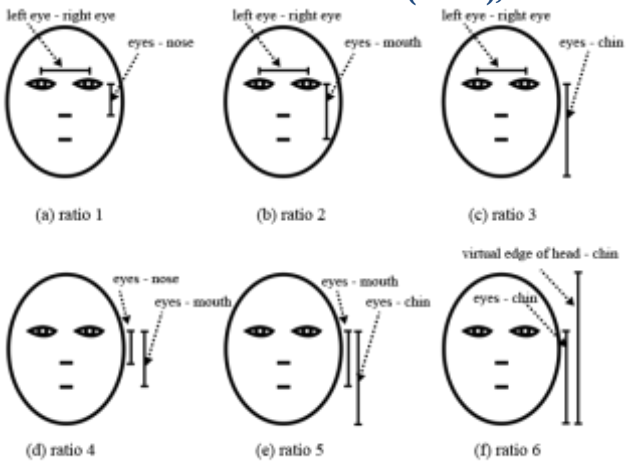

Fig. 1. Ratios of facial features

In this paper we describe sample comparison following the subspace method to identify fitting facial parts. In comparing the samples the extraction of edges is not necessary, this method is also tolerant to noise, since the overall information about pattern is being processed. Besides, subspace techniques should allow higher tolerance in sample deformations. Our approach, based on [9], allows to extract edges independently, i.e. edges of nose, mouth (Fig. 2).

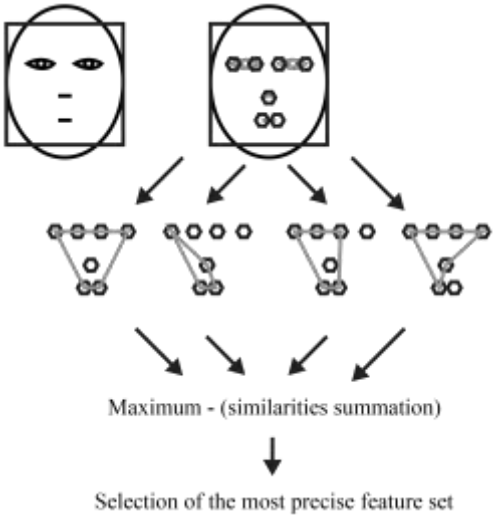

Fig. 2. Extraction of facial features

As a part of the research selected techniques for the extraction of features that are to improve the age estimation were tested.

Canny edge detector [10] uses linear filtering to calculate the gradient of distribution function and continues with lining and thresholding to extract the binary map of edges. Tests with several images proved individual edges and facial wrinkles to be insufficiently highlighted and thus not suitable for correct age detection.

Difference of Gaussians (DoG) was another selected technique tested on the same number of inputs are for the above stated method. This method proved to be less exact in the features extraction, since the distances of individual features are too distorted.

Next technique, the grating cell operator [11] based on Gabor filter is utilizing non-linear processing. However apart from Gabor filter the non-textured characteristics, e.g. isolated lines or edges are not considered. Technique is proper for utilization of lines with specific orientation. Based on tests this operator is efficient to handle faces that are being rotated, however not for feature extraction.

Gabor filter utilizes Gabor function and has the maximal response at the edge. Both symmetric and asymmetric filters proved to be efficient line detectors however are not suited for extraction of facial features when considering age estimation. Gabor energy filter was the last used for testing and showed strong responses on the presence of edges (see Fig. 3). Filter proved to be useful for age estimation, providing the facial features are more concerned on facial wrinkles. This very filter may be used for the facial features extraction, providing that the face is the only object of the interest.

Fig. 3. Extraction of facial features: Gabor energy filter

CONCLUSION

Recognition algorithms have as the input the very extracted metadata from the images. The most precise and effective processing of these images with filters is thus essential. Multiple filters should be used for age detection due to the illumination changes, possible rotation of the objects etc. The experimental analysis proved the most efficient filter for estimating the position of eyes and mouth to be granting cell operator. Using this filter the face rotation may be determined providing the matching function with pre-learnt data is used. The detection of the age presumes utilization of Gabor energy filter which demonstrates to be the most efficient in the age estimation process.

This research conducted a wide analysis in the field of image filters and it to serve as an input for the implementation of system for the age detection. Based on testing we achieved promising results that may improve the overall estimation of the age. However we have to bear in mind the each individual's health condition is subjective to many influences that may shape the overall appearance and thus the age estimation and for this reason several biometric technologies should be implemented along this approach, e.g. voice input.

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