Computers and Electrical Engineering 68 (2018) 337–347

Contents lists available at ScienceDirect

Computers and Electrical Engineering

journal homepage: www.elsevier.com/locate/compeleceng

Age estimation using deep learning☆

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ARTICLE INFO

Keywsords:
Age estimation
Deep learning
Supervised autoencoder
Softmax classifier
Features extraction

ABSTRACT

Age has always been an important attribute of identity. It also has been an important factor in social interaction. The posture, vocabulary, facial wrinkles and the intonation are all elements that facilitate the prediction of the user's age. Age estimation from the face by numerical analysis finds many potential applications such as the development of intelligent human-machine interfaces and improvement of safety and protection in various sectors such as transport, security and medicine. In many works, researchers are particularly interested in the face's features to regress the age. Recent advances in Artificial Intelligence (AI) and particulary Deep Learning (DL) techniques increase motivations to use this methods to estimate age. In this work, we present a novel method for age estimation from a facial images based on autoencoders. Autoencoder is an artificial neural network used for unsupervised learning of efficient coding. Its aim is to learn a representation for a set of data. The purpose of this work is to exploit the performance of autoencoders to learn features in a supervised manner to estimate user's age. We use MORPH, FG-NET datasets to test the performance of our proposed method. Experimental results show the robustness and effectiveness of the proposed method through the MAE (Men Average Error) rate showing a value of 3.34% for MORPH dataset and 3.75% for FG-NET.

1. Introduction

In recent decades, with the growing need to automate recognition and surveillance systems, analysing human faces become the most topics of interest in computer vision field such as face detection, gender classification, and facial expression recognition. In this framework, researches in age estimation techniques have been progressed [1]. Recently, human age presents an important indication on the target user in many application such as age-based access control, age estimation in crime investigation, age adaptive targeted marketing, electronic customer, relationship management, entertainment for recommended systems, security access control, biometrics, precision advertising, intelligent surveillance, internet access control, ethnicity classification, social media analysis, medicine, psychology, and Human Computer Interaction (HCI) [2,3]. In fact, the challenge of novel HCI now is not only to provide natural and simple interaction with the interfaces but also to adapt itself to the user's cognition, sensory and cultural abilities. For the purpose to improve reliability and easiness, these new interactive interfaces search to automatically learn and adapt itself to the user's natural abilities and features [4]. As a result, the interface needs to gather the maximum information about the user to improve the quality of experience. In this framework, age estimation is deemed to be an important indicator of user identity. Indeed, age present a principal channel of nonverbal information which could help researchers in this domain to improve the performance and the efficiency of novel

☆ Reviews processed and recommended for publication to the editor-in-chief by guest editor Dr. Y. Zhang.

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https://doi.org/10.1016/j.compeleceng.2018.04.012
Received 29 October 2017; Received in revised form 17 April 2018; Accepted 18 April 2018
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interfaces [4]. In general, the automatic estimation of age by a machine is useful in applications where the objective is to determine the age of an individual without previously identifying it [5]. Estimating age from facial images is a complex task: firstly, an age label can be considered as an individual class, so we talk about an important number of classes. Secondly, on the learning side, this problem is much more difficult than those of face detection and gender estimation, and binary classifiers, well studied, may not be applied directly. Also, two different people can grow differently, since the aging process is determined not only by the genes of the person, but also by many external factors such as health, lifestyle, environment and conditions. Another problem is that from adulthood to old age, the most noticeable change is the aging of the skin (change in texture) and changes in the form of continues wrinkles [6]. Finally, men and women can age differently. In general, age estimation can be seen as a classification or a regression problem depending on whether the age groups are considered to be classes or age as a continuous variable [7].

Since the 1970s, AI researchers have been trying to unravel the secrets of how the human brain works in the hope that one day it will be possible to replicate it virtually and transfer it to machines that would become as intelligent and autonomous as humans. This scenario allowed researchers to start designing more intelligent machines [19]. In fact, before 2006, we did not know how to train a deep architecture: the iterative optimization converged towards local minima of poor quality. Neural networks with more than two hidden layers randomly initiated therefore give worse results than ordinary networks. Deep Neural Networks (DNN) are no more than multilayered networks with classical architecture, they have several hidden layers. Indeed, even if the approximation theorems of the late 1980s assert that a single hidden layer is sufficient for the approximation of any sufficiently regular function, there is nothing to prevent a prioritize the implementation of learning by propagation in networks with several hidden layers. In this context, we present in this work an age regression system witch exploit the robustness and effectiveness of DNN to estimate the user's age with high accuracy by learning robust and discriminative features from the data [8]. The work consists of two modules. The first one is to extract from the image the facial area and adjust the user's head position to improve the classification task. The second module provides an estimation of age based on the facial features as well as an off-line learned model. It is obvious that the overall performance of the system depends on the performance of the two modules. This paper is organized as follows: in the next section, related works are described. In Section 3, we present the autoencoders models existing in literature. In Section 4, proposed method is described. In Section 5 results are reported. Finally, conclusions are drawn in Section 6.

2. Related works

Several methods have been reported in the literature to automatically estimate the user's age. A typical schema of the existing methods for age estimation usually consists of two phases [7]: the first one is extracting image features and representations for age, and the second one is learning an age estimator with these image features. The procedure of age estimation focus to label a facial image automatically with the exact age or the age group of the individual face and extracting significant features from facial faces improve the accuracy of age recognition. In 1998 Kwon and all [9] used a small dataset with 47 images to estimate ages using the anthropometric models and wrinkle pattern. In 2002 Lanitis [10] used Active Appearance Models (AAM) for an age representation, according to the experiment results some part of the face and in particular the area around the eyes present a significant source of information for the task of automatic age estimation. In 2007 Geng and al [11], used the MORPH and FG-Net dataset for Linear Discriminant Analysis (LDA) and KNN (k-Nearest Neighbors) age classification. The method named AGES presented in this work uses the representative subspace to model the aging pattern. In 2015 Jhony K. and al [12] use also the AAM, the MORPH and FG-Net datasets to predict ages of four groups between 1 and 77 years. They proposed a framework of AAM, Local Binary Patterns (LBP) and Gabor wavelet to extract highly discriminating features. One year later Dat Tien and al [3] used Weighted Multi-level Local Binary Pattern (WMLBP) based on a fuzzy logic system for features extraction and Support Vector Machine (SVM) to classify ages of 637 participants, ranging from 18 to 93 years old. The most disadvantage of AAM in previous works was the influence of eliminating nose in areas of hair, background and non-uniform on their performance. They proposed in their article a novel method based on WMLBP to avoid these disadvantages cited previously (such us illumination background). Since 2005 the expression DL was introduced to the Machine Learning. DL is a set of automatic learning of methods, attempting to model with a high level of abstraction of data. Many researchers exploited the performance of DL in facial analysis to regress and estimate the user's age [15]. Ivan Huerta and al [13] presented in their work a framework based on two phases: in the first one they used (Histogram of Oriented Gradients) HOG, LBP and Speeded Up Robust Features (SURF) for features extraction and in the second one they used the Convolutional Neural Network (CNN) to incorporate types of layers (convolutional and pooling layers) to extract important features and other layer (locally and fully connected neural) to relate globally information and learn data. In [14] Yuan Dong and all used the Deep Convolutional Neural Network (DCNN) for features extraction to predict age of the facial image. They used the transfer learning strategy to label face image. In [15] Paul Rodrõguez, and al presented a novel method for age and gender recognition. The purpose was to increase the CNN's performance and robustness to image deformation. They presented a pipeline of an attention network which estimates the most informative patches in the low-resolution image. Experiment results had shown the robustness of this method to clutter and deformation. In [16] Hao Liu and al used Ordinal Deep Features Learning (ODFL) architecture to estimate the user's age. They used the DCNN to learn features directly from the image pixels. Experiment results showed the effectiveness of this method. Xiao long Wang and al [17] proposed a new framework for image-based age estimation, they used an unsupervised learned aging feature via convolutional sparse coding .To improve the robustness of this method, standard derivation pooling was applied to the features maps generated by convolutional sparse coding. Experimental results showed better results than traditional Max pooling schemes. Zakariya Qawaqneh and al proposed [18] a new algorithm for the classification of human's age and gender throw the speech and face images using CNN for feature extracting and classification. Some related works, methods, age ranges and the most used dataset in age estimation could be summarized by the Table 1.

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