

A Study on Physiological and Biological Feature Descriptors of Human Aging

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Abstract: Human aging research now crosses all areas of physiology and biology. Human age prediction is applied in many real-world areas like forensic art, passport renewal, border security, finding a missing person or criminal, preventing vending machines from selling products, e.g., alcohol, tobacco, to under-aged individuals etc. Incredible changes found in human body during the craniofacial growth and behavioral pattern. This paper presents a study on various physiological and biological approaches used to predict human age. In this paper we discussed many interesting studies of these approaches and given a thorough analysis of problems in human age prediction.

Keywords: Age Estimation, Face aging, Survey.

I. INTRODUCTION

Forensic Sciences is the recent area of applied research. Its value and importance as an assessment tool have risen exponentially as the needs for an informed opinion on the human age for the most judicial system. Human age is an important classifier in the most such systems, criminals and their victims, human trafficking, passport renewal, border security, finding a missing person, preventing vending machines from selling products, e.g., alcohol, tobacco, to under-aged individuals and many more human-computer interfaces [1-4]. We studied physiological and biological feature descriptors for human age prediction. In analyzing the aging system, it is necessary to predict the changes accurately in appearance resulting from the effects of aging. It must retain the identity of the person that is the viewer of an image must be able to see that it is the original person aged by a set amount. In this paper, we categorized age estimation features into two, physiological and biological. Physiological features include shape changes in overall appearance resulting from bone, cartilage, teeth, sagging, color changes resulting from aging and textural changes resulting from voice, gait, wrinkling, skin elasticity. Biological features include Deoxyribonucleic Acid (DNA), fingerprint, iris, face, palmprint, hand vein, palm vein, finger vein, periocular, ear, hand geometry, retina, sclera, Electrocardiograph (ECG), Electroencephalograph (EEG), whole blood and odor/scent. This study considers some of the above mentioned and more common circumstances that result in individuals.

II. PHYSIOLOGICAL FEATURE DESCRIPTORS

Teeth:

Forensic odontology which is direct or indirect application of age estimation [5]. Various tooth dimensions are measured to estimate the age with ± 2 weeks by both methods. Best

estimation can be done with vertical dimension of tooth i. e. the height of tooth. It is found that upper tooth dimensions called crown measurements such as Labio-lingual (LL), Masio-Distal (MD), and Tooth Height (TH) gives more accurate results by direct method. Indirect method can be a computerised tomography (CT) digital image [6].

This type of estimation mostly done in non-adult, infants and juvenile remains in forensic laboratory. In addition with dental development and eruption, bone fusion (ossification) or skeletal maturation and size features also considered for estimating the age.

Speech/voice:

Many physiological changes results from the childhood to adult growth of larynx and vocal folds [7-10]. Acoustic and prosodic features, specific combinations of plosives and vowels, these are relatable to the physical age of the speaker. In a speech signal, Voice Onset Time (VOT) is the period between the release of a plosive and the onset of vocal cord vibrations in the production of the following sound. Voice Offset Time (VOFT), on the other hand, is the period between the end of a voiced sound and the release of the following plosive. Factors affect the voice such as surrounding environment, jitter differences, Age, height, weight, physical and psychological health status of the speaker affect a variety of physical characteristics such as the size, tension and agility of the vocal cords, the length of the vocal tract, the power and resonance of the voice source, i.e. the lungs, the size and shape of the resonant cavities, muscle response in the vocal apparatus, and many other such factors. Due to this it is less possible to identify age from only voice of speaker.

Handwriting/Signature:

Most of the Handwriting based proposed system [11,12] used to predict the gender and handedness of human being. Features such as Directions, curvatures, tortuosities, chain codes, and edge-based directional features can predict the age ranges. Handwritten text images segmented into the number of cells. Gradient Local Binary Patterns (GLBP) and Gradient feature are computed and concatenated to constitute the image feature factor. With the help of SVM classifier age ranges can be predicted.

Language dependency is the most important factor which affects to age estimation. Other factors are gender, left handed or right handed; databases IAM dataset and KHATT corpus, QUWI dataset 14% handwritings were predicted age for seven different age groups [13, 14].

Gait:

Human gait means a person's manner of walking. Very few in literature [15-18] have worked on Gait based features to estimate the human age. Gait pattern significantly changes with the advancing age. It is observed that Gait speed decreases the increased human age. Stride based properties, reduced velocity, shorter step length and variable increased step timings are the characteristics considered for identifying the age. Walking surface is mattered in this type of approach [19, 20].

Facial image:

Among all approaches [21-36] face images are easily available evidences for the age estimation. Social networking websites, criminal database images provides many related images. For children, main appearance change is the shape change caused by craniofacial growth, For adults facial aging due to skin wrinkles and anthropometry/shape and texture, color, ethnicity are considered. Craniofacial growth helps in identifying young adults whereas loss in facial muscle elasticity, wrinkles on forehead, near cheek bones and next to eyes identify old age person. Problem arises with the face alignment; sideways face, blurred face, motion face and rotation of the image, illumination variations, pose variations, facial expressions etc. Other obstacles are change in hairstyle changes the face appearance, beard, and goggles/glasses. Simple method to tackle this problem is age synthesis i. e. generating the faces like in age progression. Sometimes it may not work due to limited training sample size data. MORPH Database, FGNET, FERRET database are most commonly used databases in recent studies. These databases directly consider age ranges/groups for age estimation.

III. BIOLOGICAL FEATURE DESCRIPTORS**MRI:**

In Magnetic Resonance Imaging (MRI), human brain, the image can be segmented into gray matter (GM), white matter (WM), and cerebrospinal fluid (CSF) regions [37, 38]. Number of streamlines calculated as a proxy of connection strength between two regions using Diffusion Tensor Imaging (DTI). Structural connectivity networks based on DTI a weighted sum of the structural connectivity matrix for each subject as a raw score, where the weight of each connection was predefined as a correlation coefficient between edge weights and age over all subjects in the training group. Then, the raw score is converted to a predicted age with either linear or non-linear regression. It is useful for early detection of Alzheimer's disease.

Whole blood:

Blood is one of the most often encountered and valuable traces found at a crime scene. Raman spectroscopy [39] was successful in species identification and blood ageing under laboratory conditions. The proposed spectral processing model [40,41] assumes a homogeneous blood stain with a constant thickness. These assumptions cause some deviations when compared to the reflectance spectrum measured in reality because of non homogeneity of thickness. Hemoglobin derivatives such as HbO₂, MetHb and HC fraction measurements in blood stains considered as a function of time to estimate the age. Color of blood changes from red to dark brown factors that affects in whole blood age estimation. The accuracy of age estimates decreases with the age of the blood stain. Thus, to determine small differences in age, spectroscopic measurements should be performed as soon as possible after the crime. Environmental circumstances, humidity and temperature influence the speed of the chemical reactions within blood stains.

Skeletal Information:

Skeleton, hand-wrist bones, medial clavicle bones are used in such approaches to estimate the age. Tanner Whitehouse (TW) method is scoring method [42,43] developed in 1962 based on hand-wrist of an individual between 1 to 21 years of age. Maximum 20 individual bones are studied in hand-wrist and their different combinations of radius, ulna, and selected metacarpal. This method cannot be applied for every individual because of variety of population like Japanese, Chinese, and German etc.

The study of medial clavicle [44-46] concentrates on radiographic data and Computed Tomography (CT) scans. In application of Schemeling method anterior and posterior radiographic imaging of medial clavicle is carried out at

fusion stage. With the help of CT, it is concluded that medial clavicle is valid means of determining the minimum age in legal cases.

This type of approach mostly used in adults upto 40 Years age. It is very difficult in senior or older age adults age between 60-80 years by traditional method because of missing or decaying the bone information.

Fingerprint:

Morphological features such as ridges thickness, size or amount of pores, curvelet domain are the main area in fingerprint based estimation. Very less papers [47-49] are observed on fingerprint and study done for finding mostly the age groups of children, young and adults. Latent fingerprint features extracted are binary pixels, mean pixel, standard deviation. Problems faced in healing stages of wounds on fingers, luminescence behavior, degradation using chemical methods, chromatography, mass spectrometry and various surface types. Smooth, plain, non-porous and well reflecting surfaces like mirrors, glass, displays could give nearly accurate results.

Methodology Used:

Various classification and regression techniques [50-58] are used in both physiological and biological approaches. Multiple linear regressions (MLA), Principal component analysis (PCA), Klemers and Doubal's method (KDM) are commonly used methods.

Age estimation evaluation parameters; Mean Absolute Error (MAE), Cumulative Score (CS) and Accuracy is calculated after the training phase in mapping of testing feature vector.

Recurrent Neural Networks (RNN) [59] and Convolutional Neural Networks (CNN) [60-69] architectures are used in age estimation. RNN focuses on face aging pattern whereas CNN deals with our multiclass classification problems like demographic estimation such as age, gender, and ethnicity, face alignment via landmark detection, face rotation, and face verification, in face recognition and age estimation. CNN has gained great success in the past few years.

IV. CONCLUSION:

In this paper, we studied many physiological and biological feature descriptors for human age estimation. These approaches have their own advantages and disadvantages and various applications. We discussed factors that affects to these approaches. Most of literature defines facial images are good and easily available source for age estimation. We studied that every approach is not suitable and doesn't provide accurate age estimation. Facial images using CNN

attracts attention towards image recognition and can give more accurate results regarding age estimation. For accurate results we can use various combinations of above discussed approaches.

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