Age Estimation and its Progression from Face Images

Neha Sharma, Reecha Sharma, Neeru Jindal

Abstract: Face model improves the performance of evaluating the accurate age estimation with facial images and has enormous real-world applications. Human aging is a process of growing gradually old and mature. However, it is slow, depends upon person to person and most important it is irreversible. This paper mainly focuses on the various face model techniques, their performance metrics, databases, age estimation challenges to provide the researcher a great knowledge with recent journals in this field. Age estimation process progress with two modules: first part is feature extraction from the image and second module is age estimation. The accuracy or the desired output from age estimation model largely depends upon the features extraction, which if selected appropriately helps to achieve better results for research work.

Keywords: Age Estimation, Feature Extraction, Performance Metrics.

I. INTRODUCTION

The face of every person is unique. That is true, because facial appearance dynamically depends on various factors such as facial muscles, beard, skin color, hairs, head profile, facial expression, make up, illumination and effect of UV rays on skin of human, internal tissues [14]. There are several reasons that affects the noteworthy changes in face aging of humans, approximately it is bifurcated into two parts one is early growth means birth to childhood, in which variations in the face contour, features of the face (eye, nose, mouth, chin etc.) and organization of facial features are included mainly. It is called craniofacial growth or shape change; minor effect is on skin color alteration in this stage. Furthermore, adult aging is the second stage means adulthood to old age. In this stage, major modification occurs in texture of skin and skin color such as appearance of wrinkles, lines on the face are neatly visible and very minor craniofacial changes or it fundamentally decrease the elasticity and muscle strength of the face [15]. Moreover, age of the human is characterized with four ideas.

First is actual age which is real age of person, second is appearance age defined as visual appearance, third is perceived age that uses the human subject for the measurement and measure from visual aspect and fourth is estimated age in which age of each person is computed from visual appearance with the aid of machine [1], [3].

The objective of this paper is to acquire the knowledge about the techniques, challenges presented in the age estimation recent journals, In the next section, some related work for age estimation using face model is given.

II. RELATED WORK

Authors have done massive research in this field. It has many real time applications such as in the security control, entertainment, surveillance, forensic art, electronic customer relationship management (ECRM), biometric and cosmetology etc. The fine output of age estimation depends on the accuracy of facial model that further rely on the type of database chosen for task achievement, variations in the data sets like gender, race, light, expression, image quality, illumination, labeling, amount of images, missing images etc. are all different in every data set. Moreover, age estimation process is neither strictly classification nor regression process, few of the research work is completed on the combination of classification and regression that improves the accuracy and vast amount of work can be done in this field. The face aging with wrinkles oriented active appearance model (WOAAM) that outperforms the basic active appearance model. The shape, appearance and wrinkles are taken in to account. Further, it has shown the improved factor work by 2.0 than the prior and work on the dark spots is now the future work [24]. The AAM fusion with HOG is reliable feature extraction technique for the shape and texture analysis. By using the strength of two it has shown the performance by MAE which is 4.95 yrs on FGNET and MORPH data set [25]. The age estimation with deep metrics label sensitive learning, deep SRC with HSVR achieving the MAE by 3.83 [28]. The head pose estimation is significant in developing Human- Computer Interface, a novel method is used SSE (synchronized sub manifold embedding) for 3D pose estimation [18]. The young male age classification from facial images using neural network is performed. In this mosaic feature and KL features are used and mosaic feature shows the better result than KL features [19]. Further, the author uses DLDL with KL testing the work on Chaleran and MORPH data set. The output gained on MAE is 5.75 [35]

The backward face aging model digitally, means taking adult face and estimating the corresponding childhood face by considering face contour and its different components, face texture with the help of geometrical model. Consider the fact that face aging is non-linear process,

to calculate the fast and accurate facial landmarks active appearance model (AAM) is used and for texture good results the main face image and templates undergo weighted mean calculations [2].

The recent technologies and applications of age progression such as PCA based method, prototype based methods, learning based, reconstruction based and concluded that learning based method estimate the facial features displacement of images but miss texture color, skin color and prototype method is effective for age progression but no single particular attribute is retained and rest of methods have number of intra-person images of face which covers the different range of age, collecting the large database for real world face aging is very hard [13]. Dealing with an individual image and manage it in unconstrained environment with variation in illumination, expression, posture etc. The database is taken from internet and shown the age progression for age group 1to 80 automatically. Moreover, next work focus is on modeling wrinkles and hair whitening for approaching towards realism [17]. The use active shape model for the extraction of shape, facial features and local profile model and represented that algorithm extracts the facial feature effectively with high accuracy. But, on the other side, ASM mostly dependent on initial shape and prior knowledge, if the divergence of actual position of object image broadly varies, a large error occurs and fall into local minimum problem and the author emphasize on this aspect for further studies [7]. The performance on human age estimation with kernal partial least square method and dimensionality reduction has shown remarkable results. This is first time KPLS is used with regression problem in computer vision to achieve high accuracy. It shows that KPLS outperforms SVM method and state of art approach in age estimation [12]. Based on the literature study, some research gaps are observed.

A) Research gaps

The literature studied pointed out, several observations heeding the challenges of facial age estimation and age progression have been drawn. It has been ascertained that there is a requirement to investigate this emerging field and various research gaps have gained the attention to continue the research work which are listed below.

The primary trouble regarding accessibility of large data set that cover satisfactory range with chronological facial aging images makes the age estimation incomplete. So, the collection of web image becomes the productive solution for unconstrained environment [3,34]. It is hard to carry off the uncontrollable facial characteristics of face images, tensor representation (multi-linear analysis) is considered

to suits best, because it is much flexible to age synthesis and age estimation. The practical application for age progression is not development sufficient, as present- day methods work well with only images which are taken under experimental environment. Real time images can be possible solution to this age progression problem. To find out general critical features in age progression and age estimation, they share few similar ideas, merging the various modules could be beneficial which can evolve a robust facial model in real world conditions. To modify the accuracy with betterment in age estimation [21,22], the evolution of advance scheme for combined classification and regression method is needed. Regression method is applied to large web collected data set, can achieve the age estimation accuracy with the aid of automatic online training. As there is issue of labeled input for real time images. There is demand to create a model which estimate the accurate age of input images [20] and continue for age synthesis process may improve the accuracy. Age progression requires higher accuracy [4]. Moreover, human aging is natural temporal sequence, which recurrent neural network (RNN) can handle it well. Keeping in mind the value of accurate estimation of age, it is intended to create a prediction facial model, for real time conditions. However, a general block diagram is discussed in the following section

III. GENERAL BLOCK DIAGRAM

The two basic aspects in the facial aging of human are age estimation and its synthesis that has shown the enormous research work done in present era. The age estimation is a process of marking the face image of human with the accurate age in years or it can be classified as the age group also. Further, the age progression is a process of transforming a facial visual image of input to model it across the various ages with aged or younger personal effects on the face input image. Our daily life usability for gizmos increasing tremendously and acute security premises utilize the face recognition system as person face is unique. The growth in this research field is increasing vastly. In the figure1, the input image could be real time image or any image from the data base. The pre-processing part includes not only filtering but it can be normalization, scaling, rotating, cropping the image as required. Feature extraction prior step is feature detection from face images then extraction technique is applied which further moves to classification or regression process or it can be hybrid process also. The figure 2 shows that the age and appearance of input image and target image or desired output image is known already, the further process of facial age synthesis algorithm applied to the images that produces the synthesized output or required age and appearance of person with rejuvenating or older effects. The general block diagram of age estimation and age progression is shown in figure1 and figure 2 below:
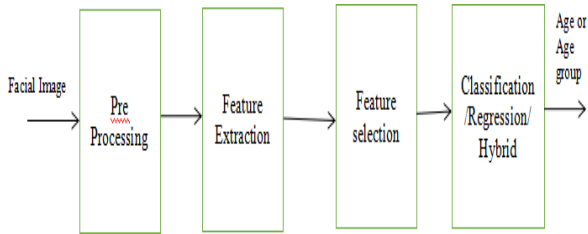
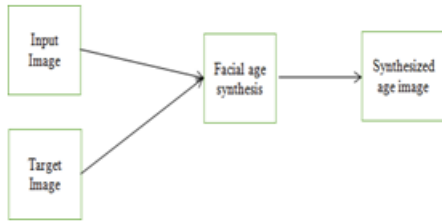**Fig1: General diagram of age estimation [3]**

Fig2: The age progression general diagram [17]

IV. COMPARISON OF TECHNIQUES

Face model or facial representation can be done in 2D and 3D and it can generate photo realistic or non-photo realistic results. For face modeling, appearance-based model is advised to be best of both geometry-based and image-based model that provides the photo realistic results for age. The only trouble is large collection of database and automatic face correspondence [1], [3]. Various techniques are listed below in table I. All the papers are using different techniques in their respective work to outperform the existing results. In summarizing for age estimation and its progression, each human has its own growth and development [5,6], the accurate output image of age estimation depends on accuracy of facial representation which further rely on the type of database selected for research work [4], some work is done on combination of regression and classification   which improves the accuracy. Several
methods are discussed in paper for facial representation

V. PEFORMANCE METRICS

The performance parameters are important in evaluation of the facial age estimation algorithms [8,9]. Depending upon the requirement of work the parameters are taken under consideration. Some of the commonly used parameters are listed below in figure 3 and elaborated definition of these parameters are as the first parameter is (MAE) mean average error expressed as mean error between average and rough age for the input or test set. Second cumulative score (CS) that signify the number of test cases that have an absolute error less than the presented minimum value. Accuracy is defined as with what precision the output is achieved and expressed in percentage.

A) MAE

^

such as geometry based, image based, appearance based

[7,10,11]. Research for real time applications are required as most of the research work is implemented

$$MAE = \sum_{i=1}^{n} \frac{|x_i - x_i|}{N_i}$$

……………...(1)

quite well with images taken under environmental conditions.[23,16,38]

Table I. Comparison of various published journals for face model in age estimation

Publications	Feature Extraction	Algorithm	Database	Performance
Khemchandra patel et al [40] 2019	Neural network	Stack deep autoenco der classifier	FGNET	MAE (0-14) 5.5
Victor martin et al [24] 2018	AAM	PCA	Caussian women database	MAE 17.1 Error 5.5
Quan Yan Chang et al [25] 2018	AAM+ HOG	SVM	FGNE T MORPH	MAE 4.9 Error 4.43
Wei Lui et al [34] 2018	Deep learning	CNN	Adience	Acc 53
Hao Liu et al [27] 2018	Deep SRC	HSVR	FGNE T MORPH	MAE 3.83 Acc 98.4%
Binbin Gao et al [35] 2017	DLDL	KL	Chalera n MORPH	MAE 5.75 Acc 95.41%
Junliang Xing et al [36] 2017	Deep learning	Net VGG hybrid	Web face	MAE5.7 Acc 92.3
Shixing Chen et al [30] 2017	Convolutional neural network	Ranking CNN	MORP H FGNET	MAE2.96(MOR PH) MAE4.13(FGN ET)
Heng Wang et	AAM	Tensor	FGNET	MAE 37.03

Where xi = Approximate age of person.

x = real age of person.

B) Cumulative Score (CS)

$$N$$

$$CS = \frac{\square_{e \leq \theta}}{}$$

$$N_i$$

$$\times 100$$

…………(2)

N is number of images which shows an absolute error which is not greater than j years.

Accuracy

$$Accuracy = \frac{TP + TN}{P + N}$$

…………*(3)*

TP = positively classified face, TN= negatively classified faces. P and N are the real positive and negative images.
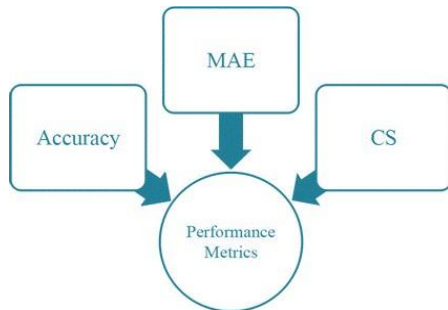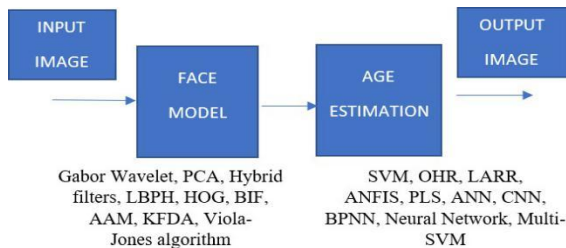

Fig 3: Various performance metrics for evaluation of age estimation

VI.   CONCLUSION AND FUTURE SCOPE

A survey of various facial age estimation techniques is presented in this paper. The neural network approach is gaining the attention in fast manner because of its better results and it handles the complexity of large dataset. The graphs in figure 5 shows the number of publications from 2010 to 2019 in neural network and appearance model that shows deep learning has attained its space in research very strongly. A lot of research work is to be done in future with these methods. Further the many problems solution with the help of neural network from past few years are achieving the results extremely precisely.

Fig 4: Some useful techniques for face model and age

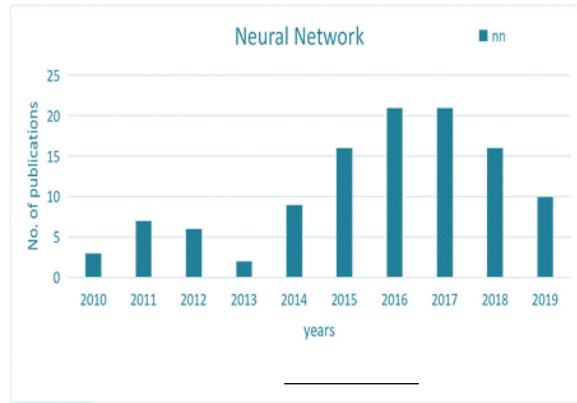**estimation from literature survey**

Fig5(a), (b): Neural network and Appearance model graphs respectively

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