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A Survey on Face Beautification Techniques without Cosmetic Surgery

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ABSTRACT

Human Face plays an important role in identity. Therefore people like to look pleasant and gorgeous. One of the way for face beautification is plastic surgery. However, this type of cosmetic surgeries are more expensive leading only rich and media people afford it. Moreover User can visualize their face modification after undergoing this cosmetic surgery and this modification is permanent. If user dislike their face modification than they can go in depression and also it is difficult for further desired beautification. In current digital era, computer vision applications provide the dynamic virtual mirror that allows us to change face feature and improve the beauty of face instantly in an image and video. There are many face beautification techniques available that allow the user to visualize the face texture, appearance and face color prior to any cosmetic surgery. In this paper, we have studied various face beautification techniques that increase the attractiveness of face for any common man. We categorized them into three groups, based on their corresponding fields of work as Face Texture Beautification, Face Feature Beautification and Face Shape Beautification.

1. Introduction

It has always been a special interest of human to improve beauty and attractiveness of face. Recently we came across an image of one of the bollywood actress Rekha which has become viral. She had undergone the plastic surgery and after this surgery she looks so young like 25 year old actress. One of the way to improve the face attractiveness is through various types of innovative cosmetic surgeries that change the human look and attractiveness but this type of cosmetic surgery is very expensive and painful. If the surgery performance is not as per our liking then it is difficult to change it [34With the development of computer vision applications, more and more scholars studying facial aesthetics have proposed techniques for facial shape beautification[26-30], and facial skin beautification, face feature modification (morph), Face Color beautification [8-10],[1-2],[38]. Face makeup can be defined a method to change human face appearance and looks by using special cosmetics such as lipstick, foundation, powders, creams, concealer, primer etc. These face beautification techniques can improve face attractiveness by removing wrinkles , smoothing skin,removing dark spot from the face [22],[37].If the user have problem with their face feature then they can modify and visualize them selves with different face feature in dynamic virtual mirror before any type of cosmetic surgery. This can be considerd as gods boon for users. As it testout power to the users to visualize the facial beautification with the minimum number of operations to avoid tedious manipulations [22],[35]. The face Beautification applications widely used in Movies, Animation [1],[9], Mobile application [2][9][36], Plastic beauty surgery [2], Games [2], in motion picture [1],[9]. Faces can vary widely due to age, rationality and makeup etc. Based on our study we categorize face Beautification techniques into three major groups as shown in figure 1. From the study we found that the preprocessing steps of any beautification techniques include face detection, identification of face region for beautification and facial landmark localization.

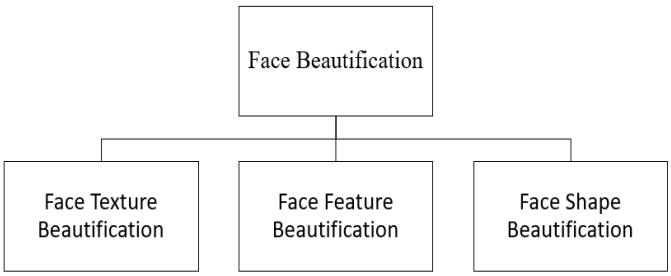

Fig 1. Types of Face Beautification

The rest of the paper organized as follows: In section II we discussed about texture based face beautification technique and parametric comparison. Face Feature Beautification Technique and parametric comparison is discussed in section III. The face Shape beautification and these technique parametric comparison is discussed in section IV. Concludes the Result in section V.

2. Face Texture Beautification

Skin surface condition is defined as skin texture. Good skin texture is soft and smooth, well hydrated with firm collagen and elastin support. Uneven skin texture is coarse, rough, dull, dry and often found damage due to sunrays [31].D. Zhang et. al. [21] proposed a method for access the beauty index. Face beauty system based on the Geo and PCANet method that can quickly and accurately estimate beauty indexes for test images. The original face image warp by virtue of the new landmark position using Moving Least Square method and obtain the beautification result. Face skin beautification method allows to remove face speckle, wrinkle removal, and skin whitening. Face beauty improved using multi-level median filtering for face skin beautification and for improve face beauty result they apply seven times median filtering. X. lu. et. al. [22] proposed a facial skin beautification framework to remove facial spots based on layer dictionary learning and sparse representation. First face

image decompose into three layers: lighting layer, detail layer and color layer. The detail layer dictionary are learned by using 60 thousands beauty images that are collected from the Internet and sparce representation used in reconstruction of detail layer of image. A binary mask obtained from the learned layer that is used to transform detail information from original detail layer. Face beautification method is more effective in eliminating moles, flaws and wrinkles and improve the face texture beauty. Nowadays, golden ratio is applied in facial beauty H. Roy. et. al. [23], tried to establish the relation between face beauty and the golden ratio. The golden ratio-based geometric transformation and filtering operations are used improve the face beauty. The face beauty framework is divided into two parts: 1. Establish and verification of the relation between face beauty and golden ratio, 2. Golden Ration apply for face beautification. First, perform verification of a nonclassical theorem of beauty and the golden ratio based on the symmetry of the face, using various machine learning tools. Verification of the ratings is done using SCUT-FBP dataset. The second part of the work is to beautify a face based on mathematical calculations for golden ratio. The various filtering techniques are used to improve the skin texture, remove blemishes and change the facial feature according to the golden ratio.

Table-1
Comparison of Existing Face Texture based Beautification Techniques

Reference Number	Method used	Model used	Face orientation	Filtering technique used for skin beautification	Approach used for facial beauty index
A Facial Beauty Analysis Simulation System [7]	Geo, PCANet ,Moving least square, Ada boost	Active Shape Model (ASM), face region segmentation model (FRSM), Average face beautification model	Frontal	Multi-level median filtering, apply 7 times for better result	KNN
Facial Skin Beautification Via Sparse Representation Over Learned Layer Dictionary [6]	Sparse reconstruction	NIL	Frontal and nearly frontal face image	weighted-least-squares(WLS) operator	NIL
An Automatic Face Attractiveness Improvement Using The Golden Ratio [1]	Golden ratio-based geometric transformation and some filtering operations	Regression model	Frontal face	Bilateral filter	Random forest
Replacement of Facial Parts in Images [10]	Tailored algorithm	3D face model	Any angle of face	NIL	NIL
Deep Face Beautification [4]	Deep Beauty Predictor , BeAuty SHaper (BASH)	Probabilistic Principal Component Analysis (PPCA)	Frontal face	NIL	NIL

A novel method J. Du. et.al. [24] Proposed that modify facial appearance by replacing facial parts between arbitrarily paired images. Method divided into different task such as face segmentation, face reconstruction, deformation and image editing. In first step of face segmentation, the target image is first segmented into the front facial region and background image. Secondly, 3D facial models and relevant scene parameters are estimated from source and target images. Thirdly, the target facial part is replaced with the selected source part on the 3D mesh. Then, the new replaced 3D face is rendered into a facial image. Finally, the new facial image is generated by seamlessly blending the rendered image and background image. The important key feature of face beautification method is that we transfer facial geometric information between images using 3D model, which can deal with arbitrarily paired images with the different facial viewpoint. J. Li. et. al. [25] proposed an automatic face beautification framework that is able to automatically modify the geometrical structure of a face so as instantly improve the attractiveness of face. The relation between facial shape and attractiveness is capture using learning based approach via training the Deep Beauty Predictor (DBP). In this method, construct the BeAuty SHaper (BASH) to infer the “flows” of landmarks towards the maximal aesthetic level instead of used the pre-trained DBP. BASH modifies the facial landmarks with the direct guidance of the beauty score estimated by DBP. There are many texture based face beautification technique are available that compare in given Table 1 provides a brief comparting summary of texture based face beautification techniques. The parameter consider for comparison includes: method and model used, face orientation, filtering technique used for skin beautification, and approach used for finding face beauty index**.**

3. Face Feature Beautification

Face feature is define as a distinguishing element of a face, such as an eye, nose, or lips, chin, mouth [32]. Image warping process is able to digitally manipulating an image such that any shape in image have been distored. Image warping techniques are used in creative purpose such as in morphing, animation [1] [13]. S. Seitz et. al. [8] proposed an interpolation based view morphing technique that is shape-preserving. It handle image morphing, handle 3D projective camera and scene transformation. It is based on interpolation of images that pre-warp and post-warp the images prior to calculating a Morphs generated by this technique create the illusion that the object moves between its positions in the two images. It preserves the 3D shape during morphing without the use of

various 3D models. Provide robust result for rigid objects. However, it degrade the performance of projection parameters for a deformable object like a various expression change in face. Furthermore, it requires manual correction [1]. F. Yang et.al. [1] provide the better solution of view morphing. This method works well in condition of two faces of different pose and expression. Warping methods used for face morphing that require accurate mapping between the two input images, they warp the two faces independently using a 3D model. J. Areeyapinan et. al. [2] proposed a morphing method that is fully automatic and generate a morph image. It provide accurate morph face when two images having equal face properties. The result is depend on similarity of input face images. The warping method used to decrease the overlapping of the result image. It is used critical point fillter and energy function to map facial feature between source image and target image. It required more computation time for mapping and refinement of facial features. Most of the morphing techniques may not provide accurate result when the two input images have large displacements. J Chen. et. al. [9] proposed a system that solve this challenging task. Firstly, a series of deformed images is generated through optimizing an adaptation of deformation. Then they deform the input images before estimating their relationship. The deformation is computed by minimizing an improved Adapting the as-rigid as-possible (ARAP) deformation model energy function with group lasso and smoothness penalty terms for local control. J. Liao et. al. [10] proposed a semi-automated video morphing technique that create smooth transitions between videos of different objects. First goal is to solve for a smooth temporal mapping between the two videos, using only a crude spatial alignment guided by the sparse user define points. In the second step, solve an optimization problem over the 3D domain. GPU-accelerated algorithms used for efficiently morph between challenging input videos. The result is degrade when disorder between foreground and background motions of object. A. Jain et. al [20] present a system that reshape of the actor body in the video sequence. It used a morphable model of 3D human shape to morph the human shape. Marker-less motion capture approach is used for fit the pose and shape of the body model to a human actor in each frame of a single or multi-view video sequence. Principal Component Analysis (PCA) model is used for deformation of human face. PCA model contains for each test subject a set of semantically meaningful human body attributes such as height, weight, breast girth, waist girth, hips girth, and leg length, . In current digital era, they have enabled the captured human models through a variety of photogrammetry methods using RGB cameras, as well as through the use of commodity RGB-D sensors, such as the Microsoft Kinect and sony camera [14] [17]. Y.Liu et. al. [14] proposed a real-time facial tracking and animation system that used of microsoft kinect sensor for capturing audio and vidio as input. It is based on facial tracking and animation system for capturing 3D facial performance in real time. Based on a data driven lip motion regressor, it can reconstruct more accurate 3D mouth motions from combined video and speech audio. It unable to handle video-based realtime facial tracking application. D.Kasat et. al. [16] presents a system which provides a real-time deformation of face feature shape and visualize themselves in digital virtual mirror. The kinect sensor is used for input video and modify and face feature instantly without standing in front of the mirror. It produce delay in illumination condition. It allows the users to pose in front of a digital 'virtual mirror' and visualize themselves in different face features such as jaw, chin, mouth, lips etc. using RGB-D camera such as Microsoft Kinect. A.Feng et. al. [17] present a system that is based on Avatar Reshaping and Automatic Rigging Using a Deformable Model. First of all the 3D shape reconstructionusing low-cost 3D cameras such as ,Kinect, RealSense,and Structure Sensor.They use morphable model that allows us to reshape and resize the 3D scan according to approximate human requirement.so, a human 3D scan can be modified to be taller, shorter, fatter or skinnier. This system help in social science research, as well as for visualization for applications such as fitness, body image, plastic surgery etc.

Table-2
Comparison of Existing Face Feature based Beautification Techniques

Reference Number	Method used	Model used	External device requirement	Nature of input	Handling 180^0 rotation	Warping process used	User interaction required
View Morphing [8]	scanline methods, reprojection	NIL	Virtual camera	Two same face images	No	No	Yes
Face Morphing Using Critical Point Filters [2]	Critical point filter (CPF)	NIL	No	Two face images	No	Yes	No
Image Morphing Using Deformation and Patch-based Synthesis [9]	Iterative Expectation Maximization (EM) algorithm, Alternating Direction Method of Multipliers (ADMM) algorithm	Adapting the as-rigid as-possible (ARAP) deformation model	No	Two different face images	No	No	No
Semi-Automated Video Morphing [10]	GPU-accelerated algorithms	NIL	No	Two video	No	No	Yes
Face Morphing using 3D-Aware Appearance Optimization [1]	Levenberg-Marquardt algorithm	ASM	No	Two images	Yes	Yes	No
Real Time Face Morphing [16]	Moving Least Square (MLS)	AAM	Kinect Sensor	Video	Yes	No	No

Table 2 depicts the comparative study of the techniques providing face feature beautification in image and video for parameters such a Method and Model used, External device requirement, Nature of input, handling rotation, Warping process used and user interaction required.

4. Face Shape Beautification

Face Shape is define as a geometric structure of your face. Face shape are mainly six types: Oval, Long, Round, Square, Heart and Diamond [33].

Y. Zhao. et. al. [26] proposed a novel face beautification system in video. Method categorized In three steps : (i) Beautification of 3D Face Mesh (ii) Face Image Warping and (iii) Filtering. Kinect sensor is to collect data. The Kinect sensor allows to capture a 2D image and a depth map at 30 frames per second. Kinect sensor capture user motion that instructed to perform various expression in front of the sensor. The depth maps often contain high noise levels and missing data so provide depth maps offline with algorithms to generate a set of personalized blend shapes. To beautify the blend shapes provide an algorithm that only requires manual editing of a few blend shapes. By applying the linear PCA model on the beautified blend shapes, reconstruct a beautified 3D face mesh for every image frame in an input video. Image warping patch id defined that is larger than the face region, which could reduce the warping artifacts along patch boundaries so used Content preserving warping algorithm to reduce the computation. At last they used real time bilateral filtering to remove wrinkles, freckles, and unwanted blemishes. Beautification techniques takes more space and time for beautification in mobile application. X. Fan et. al. [27] consider the issues of mobile storage size limitation and provide a beautification method that is efficient in both time and space. Chin shape is more attractive in face so they change the chin shape and improve the attractiveness of face. To convert original shape to target shape used Laplacian as the constraint and recursively apply the Laplacian constraint to the contour points from the coarse to fine scales. Finally, apply warping algorithm based on triangular meshes to generate a beautified face image. A data-driven approach to aesthetic enhancement of such shapes is proposed by T. Leyvand et. al. [28]. It improve the aesthetic appeal (or the attractiveness) of human faces in frontal photographs (portraits). An optimization of a beauty function modeled by a support vector regression (SVR). SVR is an induction algorithm for fitting multidimensional data and it can fit highly non-linear functions. Our challenge was twofold: first, the modeling of a high dimensional non-linear beauty function, and second, climbing that function, while remaining within the subspace of valid faces. Visual Enhancement of Users (VENUS) system proposed by S. Melacci et. al. [30] to improve the attractiveness of face shape using golden ratio calculation. VENUS system automatically enhance male and female frontal facial images exploiting a database of celebrities as reference patterns for attractiveness. Firstly automatically localize the landmark in face image using Active shape model (ASM). Then, it is enhanced moving the face features towards those defined by the K similar beautiful faces. Q. Liao. et. al. [29] proposed a 3D face geometry enhancement method based on the revised Neoclassical Canons, symmetry, golden ratios, and revised facial profile measurements. In order to preserve the facial feature details, used Laplacian editing tools to deform face models. They proposed a new method to grade the attractiveness of a human face. As a result, our method enhances the attractiveness of a 3D face model while keeping similarity between the input model and the new version. Table 3. Shows the parametric comparison of face shape beautification technique based on various parameters such as method and model used, nature of application, beautification in image or video, nature of input, external device requirement, filtering technique used and warping process.

Table-3
Comparison of Existing Face Shape based Beautification Techniques

Reference Number	Method Used	Model used	Nature of Application	Beautification process in	Nature of input	External Device Used	Filtering Technique used for face Beautification	Warping process used
Vıdeo Face Beautıfıcatıon [26]	Principal Component Analysis (PCA)	3D Face Model,	Video	Real Time	Video	Kinect sensor	Bilateral Filtering	Yes
An Efficient Mesh-based Face Beautifier on Mobile Devices [27]	Laplacian and warping algorithm	Active Shape Model (ASM)	Image	Real Time	Image	Mobile Device	No	Yes
Data-Driven Enhancement of Facial Attractiveness [28]	support vector regression (SVR)	ASM	Image	Offline	Image	No	No	Yes
Enhancing the Symmetry and Proportion of 3D Face Geometry [29]	Nonlinear least-squares method	3D face Model	Image	Offline	Image	No	No	No
A template-based approach to automatic face enhancement [30]	Visual ENhancement of USers (VENUS), Catmull–Rom splines (CRSs), K-nearest neighbors (KNN)	ASM, point distribution model	Image	Real time	Image	No	No	Yes

Enhancing the symmetry and proportion of 3D Face Geometry [29]	Nonlinear Least Square	3D face Model	Image	Offline	Image	No	No	No

5. Conclusion

The popularity of face beautification in photos and videos has increased in recent years and the statistical data shows that it is growing day by day with its application in film production, mobile application and cosmetic surgery. Some people experience plastic surgery for medical reasons and some choose cosmetic surgery to look younger or improve the face attractiveness. The procedures can significantly change the facial regions both locally and globally, altering the face color, face appearance, facial features, texture, and face shape. The main problem with cosmetic surgery is that they are more expensive, painful and unable to visualize our face modification prior to performance of the surgery. In digital era, computer vision applications provide the dynamic virtual mirror that is proven as god's boon for user because that allows to change their face beauty in real time and quickly. Face beautification index measure with many parameters such as face shape, face texture, face skin color. Based on that we categorize face beautification technique in to three categories: Face Texture Beautification, Face Feature Beautification, and Face Shape beautification. We studied various face beautification technique in image and video and evaluated parametric comparison of this techniques. Based on our survey we show that beautification technique works in offline as well as in real time. In real time, beautification process is more challenging task because many parameters are considered such as illumination condition, occlusion, shadow, face tracking therefore limited existing beautification technique available for real time beautification. We discussed automatic face beautification technique that does not require manual face beautification, correction and touchup for the face makeup. Although face beautification is a subjective matter nowadays more and more research is going on in improvement of face attractiveness. The Golden Ratio based technique is popular to improve the face beauty.

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