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2-D to 3-D Facial Mapping & Body Modeling

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Abstract: *Computer Vision along with Image processing is one of the most interesting and rapidly developing fields in computer science. It has many applications like face detection and recognition, character recognition, finger print matching, body imaging etc. One of the main application areas in image processing methods is to extract the pictorial information for human body interpretation. Body imaging is the method of generating 3D body data of a subject. This process involves receiving one or more images of the subject from a digital imaging device (Cameras in Smart phones, tablet or PC) and partitioning those images into a plurality of segments. Then the segments of one or more images are analyzed to determine the probability that the subject is located in the segment. Then the process of body imaging continues with identifying one or more distributions within each partitioned image, where each distribution relating to a property of those images is selected. Then to produce one or more unique probability maps representing the subject, the probabilities and distributions are utilized. Then followed by comparing one or more unique probability maps with a database of representations of 3D bodies is carried out to determine the best mapping between each unique probability map. Finally the representation determined from the database is used to generate 3-D body data of the subject based on the best mapping.*

Keywords: *3D Modeling, Body Imaging, Image recognition, Digital Measurement, Image Processing.*

I. Introduction

This research paper proposes a new method of 2-d to 3-d facial image mapping and face modeling. This is a major step towards enhancing the security using facial image reconstruction and recognition. Here an algorithm to map a 2-d image of a human face to a 3-d warped model and to fill the blanks generated in the process is implemented parallel to a system to measure the whole body and find clothes made for that body. Further, it also allows men and women the ability to design their own unique custom fitted clothes. All of it is selected by the user, made perfectly by the vendor to match the user requirements and hence becomes an epitome of user friendly technology. The proposed system will have applications that are virtually limitless. To list some of them;

1. Security: Law enforcement agencies can use this system to recognize felons whose faces are captured in CCTV cameras more effectively.
2. Clothes vendors (Online/Offline): Customers can measure themselves and use those parameters to purchase better suited clothing
3. Medicine: Surgeons can use this system to develop 3-d Face model in case of severely damaged faces for reconstructive surgery.
4. Virtual Reality: People can build their avatars that would enhance the gaming experience.
5. Robotics: Robots can be built with more human faces that can later be programmed with necessary expressions.

II. Literature Survey

With the dramatic increase in types of data and respective formats, the need to integrate and share data across systems has become vital. Digitizing information makes it easier to preserve, access, and share. Main advantage of digitizing information is that record, storage, playback, modification, and editing can be performed without lowering the quality. Virtual, augmented, and mixture reality techniques have recently been popularized, which is based on various technologies as well as computer vision [12] and graphics. For example, past actors and actresses have been reproduced by computer animation. However the cost for accurate human body modeling [1] is still remain expensive, as it requires special equipment to measure the shape and color, and thus designers have to take long time for the modeling.

Texture mapping [4] properties manage texture map [13] projections for selected surfaces, polysurfaces and meshes. Object representation using texture mapping has become a common technique for visualizing complicated color shapes. Reasons for the recent popularity of image-based [14] rendering techniques include the recently increased availability of special hardware architecture for the texture mapping, and its application to both computer vision and graphics. A 3D human body reconstruction method using a generic body model and 2D images [9] has been proposed. This approach is simple and efficient, although it requires a special background when the pictures are taken. Photo cloning [10] is an efficient image-based rendering technique that generates individualized 3D human body models from photographs of people, without the need of any special equipment. Therefore it can easily immerse the virtual world by using photo cloning. The editing operation is the key area of virtual reality technology. A 3D clothes modeling technique based on the photo cloned human body enables the editing operation in the virtual world. For example, extracted clothes models can be replaced in the virtual world, and can be applied for various fields as well as e-commerce.

Human body modeling [3] plays vital roles in various fields, for example, industrial and medical applications as well as computer graphics [16]. Currently image based rendering techniques have been popularized, because the texture mapping gives visually real models. The development of a photo cloning system, which uses front, profile and rear view photographs and generates individual 3D human body/face model based on a generic model is still progressing. The basic concept of the photo cloning is that the lost 3D information on the photographs can be recovered by the correspondence between the photographs and the generic body model. Here is a brief description of the edge detection [2] based novel technique for the human body modeling.

III. Methodology

The image capture from different angles and illumination, pre processing, database generation, processing algorithms, comparison system(classification), avatar generation, user review, queries, clothes fitting, fitness estimation system. Each image captured, will be processed by the algorithm that is intended to be designed. This process separates person and background, and finds the body underneath (reasonably thin) clothing. A unique 3D model is then built of the person scanned. This is presented as a 'mannequin', along with over 100 2-d to 3-d facial image mappings.

(a) (b)

Fig. 1. Body posture used for modeling the skeleton and key joints

Fig. 1 (a) shows the generic body that consists of the skeleton and the skin surface, where contours surrounding the skeleton define the surface model. This body model is compatible with MPEG-4. [12] The skeleton is compatible with the h-anim 1.1 specification [1], and 94 skeletal joints are used to describe the skeleton.

We choose some important joints as key joints shown in Fig. 1 (b). These joints give a hierarchy of skeletal parts, and define the origins of each local coordinate system in order to describe the skin parts. The basic skin model is defined by the contours, and the skin surface is deformed accordingly when the skeleton moves. Finally this skin model can be easily converted to polygonal mesh.

First, we define feature points which give the rough silhouette on the photographs to fit the skeletal model as shown in Fig. 2. d. Positions of these feature points are determined by interactive GUI. Here relation between the key joints and the feature points is known, so that x-y-z coordinates of the key joints can be estimated from the feature points located in the front, profile and rear view pictures. Furthermore, positions of remaining joints defined in the h-anim 1.1 [1] skeleton are calculated by using these key joints, and then the skin contours are modified by this skeletal deformation. Consequently the fitted skeleton and contours can be generated. Next, we describe how to make an initial skin model. Each part is represented by a polygonal mesh which has some control points. These points are marked based on the light intensity gradient on the photograph.

[7] These control points are placed at their standard positions to represent the shape characteristics. Hence the skin model can be deformed by moving these control points. Furthermore, several control points are located at the boundaries between two parts, so that surface continuity [4] is preserved when the posture of the generic body is changed.

(a)

(b)

(c)

(d)

Fig. 2. a. Image of a face b. Standard posture for body modeling. c. Clothes fitting and face modeling d. Silhouette formed using edge detection.

The accuracy of the initial skin model is insufficient, so we modify it by using the body silhouette extracted from the pictures. Here we detect the silhouette of the human body on the pictures and then fit the skin model to the silhouette. To get the silhouette, we use the following algorithm.

- Apply Canny edge detector [5] for the pictures and fit line segments into edge pixels to form edge segments.
- Evaluate a connection of a pair of edge segments.
- An evaluation function for the connection Ec is defined by parameters such as angles between two segments, edge magnitudes given by Canny edge detector [5], and the feature points located on the pictures.
- Silhouette extraction [8] this can be considered as a path searching problem. An evaluation function Ep is defined to assess the goodness of a path.
- The prepared model is overlapped onto the existing standard 3-d model.
- The distances are computed for each feature point and the model is expanded or contracted to match the subject feature values.

Here the following procedures are used.

1. Choose an edge segment.
2. Find a proper edge segment to connect and move to this edge segment.
3. Repeat step 2. Until the edge segment reaches the feature point, because the path terminals are given by the feature points.
4. Assess the goodness of a path by calculating Ep
5. Repeat step 1 to 4 for each edge segment and finally the best path is determined by finding the maximum of Ep.

An exact silhouette is detected by the proposed method. Finally the contours defining the skin surface are modified by using this silhouette. It can be confirmed that a visually real 3D human body model can be constructed by our method without using special equipment. Fig. 3 shows the extracted silhouette and the modified photo cloned human body. The result is shown in Fig. 3. It can be seen from Fig. 2. (a) and Fig. 3. That the model generated is highly accurate.

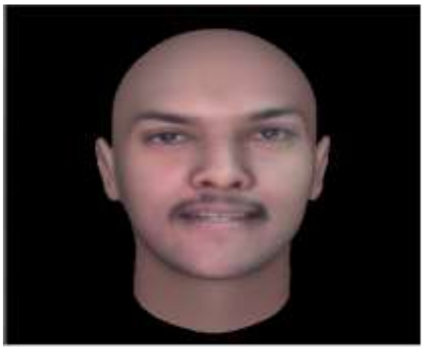

Fig. 3. Resultant 3-D human face model built using the proposed system

IV. Conclusion

The above approach narrates a method and system for determining 2-d to 3-d facial image mappings using images of the body taken from different directions or angles. And these images are subjected to comparison with the database of existing known 3-D models to obtain the best fit mapping. From this mapping, body shape specific data can be determined, which can be used in various innovative ways such as tracking fitness, population studies, diagnosis of physical disorders (such as posture detection, metabolism, obesity etc) and in helping to treat the said disorders or self assessment towards fitness, clothing measurements etc.

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