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Single Image 3D Beard Face Reconstruction Approaches

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ABSTRACT

3D face and 3D hair reconstruction are interesting and emerging applications within the fields of computer vision, computer graphics, and cyber-physical systems. It is a difficult and challenging task to reconstruct the 3D facial model and 3D facial hair from a single photo due to arbitrary poses, facial beard, non-uniform illumination, expressions, and occlusions. Detailed 3D facial models are difficult to reconstruct because every algorithm has some limitations related to profile view, beard face, fine detail, accuracy, and robustness. The major problem is to develop 3D face with texture of large, beard, and wild poses. Mostly algorithms use convolution neural networks and deep learning frameworks to develop 3D face and 3D hair. The latest and state-of-the-art 3D facial reconstruction and 3D face hair approaches are described. Different issues, problems regarding 3D facial reconstruction, and their proposed solutions have been discussed.

KEYWORDS

3D Facial Beard, 3D Facial Hair, 3D Facial Reconstruction, 3D Printing, Convolution Neural Network, Cyber-Physical Systems, Deep CNN, Facial Recognition, Human-Computer Interaction, Large Poses

INTRODUCTION

Facial beard and facial hair play an important role in the individual expressions of the human. Hair and faces are essential parts of human virtual characters because virtual characters (computer-generated characters) are providing naturalism or realism, video film, and gaming industry. Hair is an essential piece to build digital human characters and fulfil the respective requirements. Currently, face-capture technology does not easily accommodate facial-hair features. Facial hair is an important step in the 3D reconstruction of real facial geometry and cyber-physical systems.

Currently, the advancement in field of machine vision and computer graphics plays an important role in the cyber-physical systems like autonomous mobile systems and robotics systems. 3D face reconstruction is an important task for solving security problem in the

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departmental stores, supermarket, crowded and tourist places. 3D face reconstruction from single photo addresses various challenges like profile, wild, occluded, and facial beard poses. Traditional approaches are used to obtain the 3D morphable model (3DMM) coefficients and render the respective 3D faces from a single photo. These methods are time consuming, need high complexity and not efficient. Recent approaches are using convolution neural networks (CNNs) and they are more efficient and have achieved remarkable success in 3D facial reconstruction from single photo. 3D face reconstruction from a single image faces many issues and problems such as lack of diversity in facial expression, occlusions, facial beard poses and environment conditions. Some algorithms are suggested and proposed that is going to solve the issues of large poses, wild poses, occluded poses, robustness, and detailed reconstruction. All foundational 3D face reconstruction approaches are mostly focus on profile view, occlusion and robustness but not focus on facial beard pose. The chapter emphasizes on 3D face reconstruction and the facial hair reconstruction approaches.

There are numerous approaches for 3D face shape reconstruction that reconstructs the 3D model only for frontal poses, medium poses, and uniform illumination while many challenges come when there is large pose, and occlusion occurred. The various approaches that are using single photo as an input cannot get the better result as compared to multiple images on input. The computational cost of 3D face reconstruction from multiple images is high. 3D face reconstruction from a single image is still ill-posed problem and researchers have done research for solving different issues.

The earliest methods are used 3D reference faces, landmark-based facial model and shape from shading techniques for recovering 3D facial geometry. These days, the 3D single image facial reconstruction is seldom used for modern facial recognition applications. 3DMM and CNNs are frequently used in the 3D single image facial model. CNNs applications include natural language processing, occluded pedestrian detection, image classification, decoding facial recognition and image reconstruction etc.

3D hair reconstruction plays an essential part in facial recognition and reconstruction of facial geometry. Some approaches are required user interactions, depth information for annotation the head region and hair (Chai, 2015) (Chai, 2013). In some approaches, 3D hair is reconstructed via structured light pattern (Chen, 2018). Recently, deep-learning approaches (Chao, 2016) (Zhou, 2018) are contributing to the field of 3D hair reconstruction. There are very few achievements that was reported over 3D facial hair reconstruction.

The traditional methods utilized the 3D reference faces (Hassner, 2006) (Hassner, 2013) and these old approaches are focused and emphasized on robustness instead of fine details. Shape from shading approaches (Li, 2014) give importance to accuracy and detailed reconstruction. The 3DMM fitting approaches are widely used in these days that are proposed by Vetter and Blanz (Blanz, Vetter, 1999).

Later, facial landmarks detectors (Jourabloo, 2016) (Zhu, 2016) are used for 3D facial reconstruction, and these are emphasized on accuracy. Currently, deep convolution neural (Jackson, 2017) (Tran, 2017) (Tran, 2018) are used for recovering of 3D facial shape from a single image. These deep CNNs approaches are still in a challenging phase and improving robustness, accuracy, and lower the computational cost. A mobile 3D facial reconstruction method (Chinaev, 2018) and coarse-to-fine method proposed by (Jiang, 2018). It reconstructs the high-quality 3D facial geometry, but holistic face is generated while reconstructing the 3D facial geometry. The proposed self-supervised bootstrap (Xing, 2018) approach is the upgraded version of volumetric regression network (Jackson, 2017). The proposed approach model-free (Feng, 2018) is a latest method for 3D facial reconstruction. ReDA (Zhu, 2020) used the face parsing masks, multi-scale convolution and UV maps for 3D face reconstruction. Deep 3D portrait (Xu, 2020) is unsupervised CNN-based approach that reconstructed the head with hair and ear. MFIRRN (Li, 2021) method is more accurate and detailed-rich.

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