Chapter 58
3D Face Modeling for Multi–Feature Extraction for Intelligent Systems

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ABSTRACT

In this chapter, we focus on the human robot joint interaction application where robots can extract the useful multiple features from human faces. The idea follows daily life scenarios where humans rely mostly on face to face interaction and interpret gender, identity, facial behavior and age of the other persons at a very first glance. We term this problem as face-at-a-glance problem. The proposed solution to this problem is the development of a 3D photorealistic face model in real time for human facial analysis. We also discuss briefly some outstanding challenges like head poses, facial expressions and illuminations for image synthesis. Due to the diversity of the application domain and optimization of relevant information extraction for computer vision applications, we propose to solve this problem using an interdisciplinary 3D face model. The model is built using computer vision and computer graphics tools with image processing techniques. In order to trade off between accuracy and efficiency, we choose wireframe model which provides automatic face generation in real time. The goal of this chapter is to provide a standalone and comprehensive framework to extract useful multi-feature from a 3D model. Such features due to their wide range of information and less computational power, finds their applications in several advanced camera mounted technical systems. Although this chapter focuses on multi-feature extraction approach for human faces in interactive applications with intelligent systems, however the scope of this chapter is equally useful for researchers and industrial practitioner working in the modeling of 3D deformable objects. The chapter mainly specified to human faces but can also be applied to other applications like medical imaging, industrial robot manipulation and action recognition.

INTRODUCTION

Human face image analysis has been one of the challenging fields over the last few years. Currently, many commercially available systems can interpret face images in an efficient way but are generally limited to only one specific application domain. For instance, face recognition systems focus on identifying the person by reducing the facial expressions and synthesizing the facial pose to frontal. As a general rule of thumb, they try to isolate the sources of variations and enable the system for one particular application. This approach is not quite useful for advanced intelligent systems. Currently, cameras are becoming a useful tool in human life and are the vital constituent of most of the intelligent systems. Over the availability of advanced hardware, better computational power and GPUs, graphics tools are being usefully embedded in the computer vision applications to enhance the system performance. This resulted in development of the systems with underlying 3D computer vision applications which provide even more details than the conventional 3D methods for object reconstruction, analysis and manipulation. Image textures on the other hands provide a wide range of information for object analysis. A well-realized graphic object provides detailed configuration of the objects in 3D. Such realization provides sufficient information about shape, pose, light source and textures in an image. Moreover these attributes could be synthesized over time to get detailed dynamics and improved realization with additional temporal information. In this regard, we present a technique to develop a unified set of features extracted from a 3D face model. These features are successfully used for higher level facial image interpretation in different application domains. These features are extracted with the help of a coarse 3D wireframe model. We also study current outstanding issues in human face realizations and information interpretation. These issues are head pose, lighting conditions, facial expressions and real time rendering. The

extracted features are made stable over these variations and are capable to be used in different applications. The structural hierarchy of this chapter leads towards multi-feature extraction. We proceed step-by-step by providing essential knowledge about the topic. Some sections also provide generic examples which are not only the key constituent of our model based approach but also equally useful for computer vision object modeling.

These applications not only apply to the face image analysis in challenging environments but also emphasize on insufficiency of the traditional approaches for face image analysis. For instance, traditional face recognition systems have the abilities to recognize the human using various techniques like feature based recognition, face geometry based recognition, classifier design and model based methods (Zhao, Chellappa, Phillips, & Rosenfeld, 2003) but on the other hand similar features are not sufficient for gender recognition or facial expressions recognition. Models due to their wide range of information in minimum parameter descriptors provide a better solution. In this regard, model based approaches have been very successful over last few years. Currently the available models used by the researchers are deformable models, point distribution models, rigid models, morphable models and wireframe models (Zhao W. & Chellapa, 2006).

BACKGROUND

In the recent decade advancement in the field of camera technology, their mountability on mobiles and availability of high computational powers in personal computers have increased the demand of the user to extract more information from the images for higher applications. For instance, face detection cameras, smile-capture cameras and face recognition in notebooks. Future systems will be relying more on the facial image analysis, especially socially inspired robots need to know

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