Journal of Fiber Bioengineering and Informatics 8:3 (2015) 423–431
doi:10.3993/jfbim00137

Virtual Mannequins Retrieval Based on Cluster-based Panoramic Views ⋆

Kuansheng Zou [a,*], Zhaojun Zhang [a], Jianhua Zhang [a]
Chee-Kooi Chan [b], Zengqiang Chen [c]

[a] *School of Electrical Engineering and Automation, Jiangsu Normal University, Xuzhou 221116, China*
[b] *Institute of Textiles & Clothing, The Hong Kong Polytechnic University, HK*
[c] *Department of Automation, Nankai University, Tianjin 300071, China*

Abstract

With the rapid development of 3D scanners, graphic accelerated hardware and modeling tools, the application of 3D model database is growing in both numbers and sizes, e.g., 3D head and body scan datasets. In this paper, a novel method by using cluster-based panoramic views is proposed for retrieving 3D virtual mannequins. First, a Young Chinese Female Virtual Mannequin (YCFVM) database is established by analyzing various 3D body scan data; second, panoramic views of virtual mannequins are obtained, and the Fourier and Wavelet features of the panoramic views are extracted; third, a multi-scale indexing of the YCFVM dataset is generated for fast matching by using fuzzy clustering for the Wavelet features; finally, the Fourier descriptor is embedded into the feature matching with the generated indexing for obtaining more accurate retrieval results. Experiment results show that the proposed method can achieve better retrieval performance than other descriptors used for virtual mannequin retrieval.

Keywords: 3D Model Retrieval; Virtual Mannequin; Panoramic Views; Fuzzy Clustering

1 Introduction

Three-dimensional (3D) laser scanning systems can generate a large amount of data point clouds from the surface of a human body standing in a standard anthropometric pose. In order to do a further study on the human shape, a human body database called CAESAR (Civilian American and European Surface Anthropometry Resource) was established [1], the main aim of which was to provide better fitted commercial clothing products. For fitting commercial products, consumers expect that they can use a virtual mannequin that is as real as his or her own body shape to try on clothes online, thus, retrieving similar 3D body models from 3D human database had provided

⋆This work was supported by the Natural Science Foundation of Jiangsu Province (No. BK20140241), the Natural Science Foundation of Jiangsu Higher Education Institutes of China (No. 13KJB520007), and the Natural Science Foundation of China (No. 61305149, No. 61304175).

*Corresponding author.
Email address: zoukuansheng@jsnu.edu.cn (Kuansheng Zou).

a try to achieve this target. Wong et al. [2] proposed a novel 3D head model retrieval framework specifically to facilitate better classification and retrieval. Godil et al. [3] described a framework for similarity based retrieval from a 3D human database based on both body and head shape representation. The 3D human database used in their study was the CAESAR anthropometric database. Paquet et al. [4] used a cord-based method to search similar 3D human models by using CAESAR database, however, there was no retrieval performance evaluated, since the CAESAR database was not classified into original categories. In brief, effective human body retrieval is a meaningful research work with huge market value.

The main contribution of this paper is listed as follows: a Young Chinese Female Virtual Mannequin (YCFVM) database is established at first, the shape of 3D virtual mannequin can be analyzed by using this database; an effective method for retrieving 3D virtual mannequins is proposed based on the cluster-based panoramic views. It proved better performance compared with other retrieval methods; a novel combination of the two descriptors is proposed by embedding fuzzy clustering into them. Combining different descriptors together is also a hot topic recently. The mainly used methods are fixed weights of each descriptor. This paper proposed an inner integration of two descriptors by using fuzzy clustering.

The rest of the paper is organized as follows: after over-viewing the related work in Section 2, the Young Chinese Female Virtual Mannequin (YCFVM) database is described in Section 3. The proposed method using the cluster-based panoramic views for virtual mannequin retrieval is proposed in Section 4. The experimental results are given in Section 5. Finally, the conclusion and further work are drawn in Section 6.

2 Related Work

Various methods have been proposed for retrieving general 3D models, the commonly adopted methods are histogram-based [4–10] and 2D view-based [11–14]. Histogram-based approach relies on the idea of accumulating feature information to obtain a global shape descriptor. A cord is defined as a vector that goes from the center of mass of a human body to the center of mass of a given triangle, modeling its surface [4]. It is thus assumed that a triangular mesh represents the surface of the human body. The distribution of the cords is represented by the following three histograms; the first histogram represents the angular distribution between the cords and the eigenvector with the highest eigenvalue; the second histogram represents the angular distribution between the cords and the eigenvector with the second highest value; the third histogram represents the distribution of the radius of the cord. A D2 descriptor is a probability distribution histogram of the two randomly selected points from the object's surface [5], but it sacrifices discriminative accuracy. Then many combined shape descriptors have been proposed based on group integration, such as the Beta/Distance (BD) and Alpha/Beta/Distance (ABD) [6]. The Concentric ABD (CABD) and Symmetrical ABD (SABD) [7] and the combined shape distributions [8] were introduced to improve the ABD descriptor, because they can exploit more location information of random points on the surface of 3D models. A novel 3D model retrieval method using fractal D2 Distribution is proposed to improvement the shape distribution–based retrieval method [9].

Histogram-based methods collect numerical values from certain attributes of the 3D model such as the local or global features and are efficient and easy to implement. Although most of them lack the fine grain discrimination required for retrieval, the retrieval performance can be greatly