



# Automatic upright orientation and good view recognition for 3D man-made models

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## ABSTRACT

Many graphics applications require that 3D models automatically be presented upright and from a good view. We propose a method that simultaneously recognizes upright orientation and good view for 3D man-made models. The strategy is to determine the best base on which a 3D model can stand upright from a small set of candidate bases. Every candidate base is composed of clustered facets of the simplified convex hull of the given 3D model. Next, a proposed UV-measurement selects the best base from the candidate bases using weighted feature-based evaluation functions based on geometrical, physical, and visual aspects. Our method has been tested using a public 3D model database and compared with previous methods. As experimental results show, our method outperforms previous work in both efficiency and accuracy.

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## 1. Introduction

For computer graphics applications, 3D models are necessary to enrich the virtual environment. These 3D models may be created using different modelling tools or systems with their own particular properties such as a customized coordinate system. Different coordinate systems cause 3D models to have different upright orientations, resulting in the cumbersome task of selecting and manipulating 3D models. Therefore, determining the upright orientation of the 3D model automatically can facilitate not only model manipulation but also thumbnail (good representative view) generation for object selection. Moreover, the automatic recognition of upright orientation and representative view of the 3D model are fundamental for techniques like 3D shape matching and retrieval [1], 3D model recognition and classification [2], visualization [3,4], selection of thumbnails for 3D shape repositories, etc. In this paper, we propose a method to obtain both the upright orientation and a good representative view of many classes of 3D man-made models.

Most 3D man-made models must have a supporting base on which the model stands upright. The problem of a model's upright orientation is considered as a question of selecting the best supporting base from a small set of potential supporting bases, as has been done in previous work [5]. One appropriate way to obtain potential supporting bases is from the facets of the convex hull of a

3D model; the potential supporting bases, called candidate bases, are the coplanar facets of the convex hull. Therefore, it is essential to compute the convex hull in order to recognize possible supporting bases. A model simplification method [6] is applied to simplify the input 3D model first. Then, the facets on the convex hull are clustered according to their normals and areas, and those coplanar facets in the cluster are grouped as a candidate base for each cluster.

All the candidate bases will then undergo an evaluation procedure, called UV-measurement (upright-view measurement), to select the best one. The proposed UV-measurement aggregates all weighted feature-based evaluation functions from geometric steadiness, physical stability, and view stability aspects. Geometric steadiness is concerned with the centralization of centroid and equilibrium geometrically, physical stability evaluates friction and torque to see if the model could be in a static equilibrium state physically, and view stability measures which representative view is the most similar to other sample views. Once the best base has been determined, we obtain an upright 3D model presented from a good view.

A number of 3D man-made models from a public database of 3D polygon models, the Princeton shape benchmark [2], was used to evaluate the effectiveness of our method. Based on the UV-measurement, with the novelty of leveraging the representative view feature to obtain both the upright orientation and a good view, the experimental results demonstrate that nearly 80% of tested 3D man-made models can be correctly orientated upright and presented as a good view. Compared with previous work on upright orientation [5] and good view selection [7], the efficiency and accuracy of our proposed algorithm is superior.

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