

A Search Engine for 3D Models of Museum Artefacts

Jing Chen, Lorraine McGinty & Noel O'Connor*

School of Computer Science & Informatics, University College Dublin (UCD), Ireland

*School of Electronic Engineering, Dublin City University (DCU), Ireland
{jing.chen,lorraine.mcginity}@ucd.ie and {oconnorn}@eeng.dcu.ie

Abstract. The National Museum of Ireland¹ has about 5 million artifacts distributed across different physical locations. Essentially this means that only small fraction of these are accessible to the public at any time. Digital Libraries support the 3D browsing and retrieval of cultural museum artefacts and offer a potential solution to this problem. This paper describes a final year project where the objective was to build a search engine that: (1) could operate over a digital library storing digitized 3D model representations of objects, and (2) could be integrated with the existing *DigiFact*² system architecture based in CDVP³ at DCU.

Key words: 3D Model Retrieval, Shape Distribution

1 Summary of Approach

Motivated by the rapidly increasing of digitized 3D models and the growing need for more advanced digital library services to allow for increases accessibility [1,2], this work looks at how to represent, index, search and retrieve 3D objects. Two datasets (VRML models) were used. One contains 57 models that are freely downloadable from <http://www.informatik.uni-leipzig.de/~vranic/CCCC/>. Another, containing 17 objects, which were scanned by using a specialised *capture rig* available in the CDVP. An adaptation of the *Shape Distribution* [2] approach introduced by Princetons 3D model search engine was implemented and tested by this work. This method uses geometric distributions as a basis for similarity and retrieval, it is a generalization of geometric histogram that represents 3D models as a probability distribution sampled from a shape function measuring properties of the 3D model. Five alternate shape functions [2] were implemented and evaluated as part of this work. They were:

- A3: Measures the angle between 3 random points on the model surface.
- D1: Measures the distance between a fixed point (e.g., centroid) and one random point on the surface.

¹ <http://www.museum.ie>

² Digitization of Museum Artefacts Facilitating Search and Retrieval

³ Centre for Digital Video Processing

- D2: Measures the distance between two random points on the surface.
- D3: Measures the square root of the area of the triangle between three random points on the surface.
- D4: Measures the cube root of the volume of the tetrahedron between four random points on the surface.

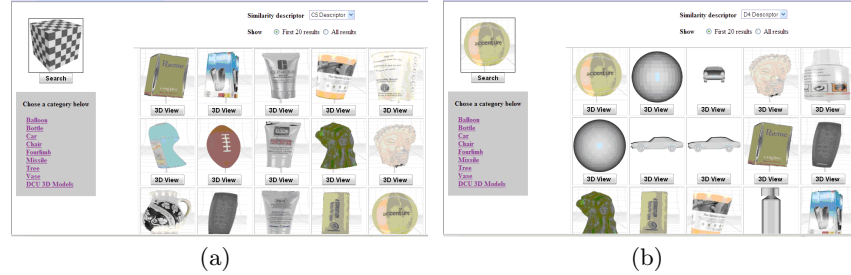


Fig. 1. Screenshot of Search Interface: (a)Models from DCU; (b)Retrieval results of tennis ball model from DCU with D3 descriptor

2 Experimental Testing Summary

Fig. 1 shows the *query-by-samples* search interface to the final working 3D search engine of museum artefacts that was ultimately developed and used by real users to compare the effectiveness of using each of the shape functions outlined. One of the tests carried out was a *bullseye test* whereby if there are A number of models in database, where n shapes in N categories, then each model is compared to every other shapes in the database, and the number of correct matches in the top X retrievals is counted. There are m possible correct matches per shape queried. The retrieval rate is the total number of correct matches divided by the total number possible, which is n [3]. This test showed that shape functions A3, D1 and D4 were the best in 6 out of 8 categories (i.e., 75% of the time); the best shape function overall was D4, it achieved best results for 37% of categories, and Accuracy ranges of bet 40% and 80% in each categories; meanwhile, D2 is the worst shape function overall, the accuracy range bet 30% and 70%, and it was not the best descriptor for any individual category.

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