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A COMPARISON STUDY FOR 3D OBJECT RESEARCH BY THE CONTENT BASED METHODS

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ABSTRACT

In this paper, the method that we propose is a part of indexing and retrieval of 3D models in large databases, in this context we are particularly interested in a comparative study between the 2D/3D approach methods, Each method at its own technical to characterize the 3D object by a set of different images automatically extracted of the 3D model, this study concerning the views-based approach and the level cuts approach. To index these images we will use a 2D descriptor to extract the feature vectors of each model set. We calculate the similarity measuring using the Hausdorff distance. To retrieve the similar 3D objects of robustly manner we test the methods in the NTU database that we finally permit to find the efficient method that representing the 3D object.

Keywords- shape retrieval, views-based approach, level Cut approach, contour approach, metric distance.

I. INTRODUCTION

The recent development in advanced techniques for modeling, digitizing and visualizing 3D models has made 3D models as plentiful as images and video. Therefore, it is necessary to design a 3D model retrieval system which enables the users to efficiently and effectively search interested 3D models. The primary challenge to a content-based 3D model retrieval system is how to extract the most representative features to discriminate the shapes of various 3D models. To answer in these problematic, he must develop a new feature permitting to manipulate effectively the 3D objects. The nature of 3D objects requires an establishment of indexing and retrieval specific methods to these data. Many methods have been proposed by the community and lead to the establishment of a system for describing 3D objects based on their shape and make queries by similarity.

II. DESCRIBING 3D SHAPE BY CONTENT

1. Mesh representation

In the following parties all implementations manipulate the triangular meshes. Since the focus of our work has been on changing meshes. The Triangle meshes that we will use frequently constitute the support of representation of the 3D objects. they are represented the major part of the quantity of information describing the 3D model and are more efficient in the calculation, less expensive and able to represent the 3D object faithfully. Another problem of the method is a requirement that all triangles of mesh models must be correctly oriented, which is usually not the case if the models are retrieved from the Internet.

2. Pose Estimation

The 3D object is often found in an arbitrary position (scale, position and orientation), which requires a pretreatment step before extracting the vectors descriptors. First, we must make this object invariant to scale space and then using the ACPC [1] method to make the 3D model invariant in the orientation.

3. Views-Based Extraction

This type of method [2][3][4] based his description solely on the information contained in the projection of the 3D object on a 2D plane, most of this approach uses not one, but several projections to describe the shape of the object in different viewpoints. To better characterize the 3D object, he must to extract an important number of viewpoints, we take in account the pose normalization, the projection area, the image size, and in our case we extract 300 views, in a single axis definite as shown in the Figure 1.

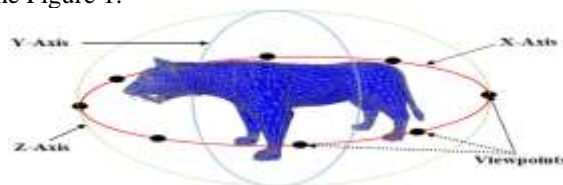


Fig. 1. Extraction of 100 views on the X-axis

The features extraction of views based are obtained by a precision, in order to transform these views in binary image to ease the extraction of vectors descriptors of these images; the Fig. 2



Fig. 2. Example of views extraction

shows the X-axis that we extract the viewpoints around the 3D object.

The retrieval method of 3D model in a database from a viewpoints is certainly the process more intuitive search. Despite this apparent simplicity, it is a major scientific problem.

4. Level Cut Extraction

In this study [5] propose a method for indexing and retrieval of 3D models in large databases based on binary images extracted from the 3D object called “level cut” LC. These cuts are obtained by the intersection of the set of the plans with the 3D object. A set of equidistant parallel plans generates by the intersection with the 3D object a set of cuts that used to indexing the 3D model. There is based on these cuts to describe the 3D object.

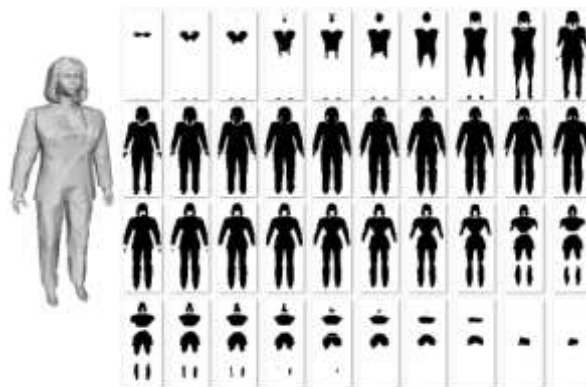


Fig. 3. Example of level cut extraction

To increase the value of the comparison between the characteristic views and cuts level, we also extract 300 cuts that was used in the approach by views on the same axis.

5. Contour Based Extraction

To overcome the 3D object representation problem by the contour, we extract the shape contour automatically from all views-base set and the level cuts. Many works are done using the segmentation methods [6][7] to extract the contour of the shape in the of strong and faithful manner. The main interest to tackle has this comparative study is to know and learn the true appearance and real image of each method and its ability in research on the most similar 3D objects.

III. SHAPE FEATURE EXTRACTION

To construct the vectors descriptors of the 3D model, using a binary image 2D descriptor to extract the signature of each images set. In our case we will use the seven moment's invariant's Hu [8], these signatures constructed a set of vectors descriptors associated with the 3D object.

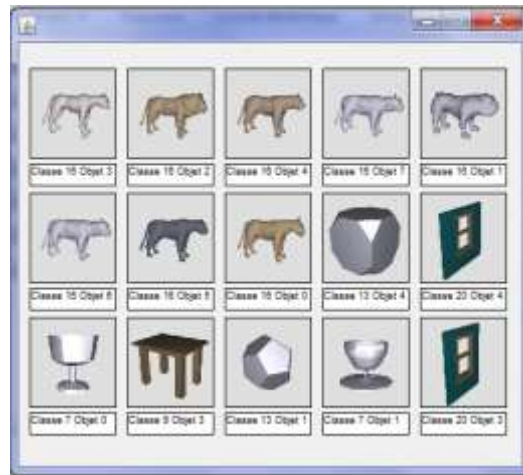
IV. SIMILARITY RESEARCH

The research of 3D object by content requires having an automatic method to measure the similarity between two 3D objects, the principle of this method is based on the hypothesis that the similarity measuring between two 3D objects return to calculate the distance between this two objects. As we are using the X-means to extracting the CLC set, the vectors descriptors do not have the same size for each model, so the Euclidean distance is not valid for our method. There are two distances that could adapt with our descriptors, the Hausdorff distance and the Earth Mover Distance (EMD) [9]. The EMD seems very expensive in terms of computation, then Hausdorff distance is the most adaptable with the proposed vectors descriptors, also, it is the most used in this kind of problem.

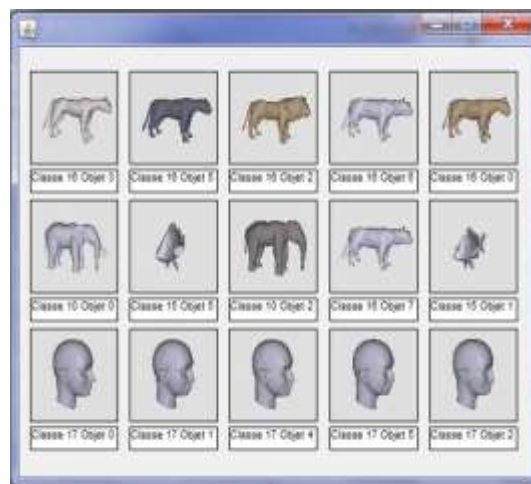
V. EXPERIMENTS AND RESULTS

1. Test Database

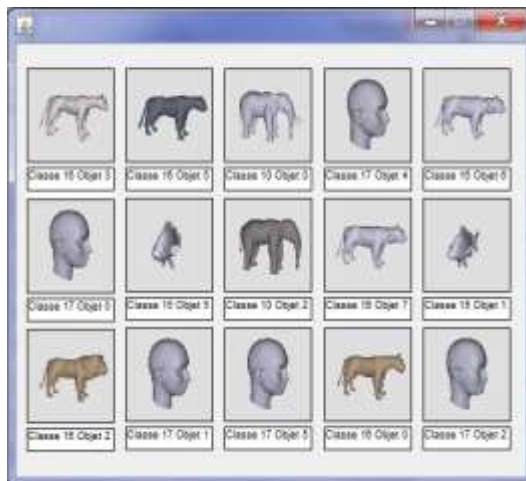
Our experiments were performed on a NTU (National Taiwan University) 3D Model Database provides 3D models for research purpose in 3D model retrieval, matching, recognition, classification, clustering and analysis. The database containing 10911 3D models, which are free, downloaded from the Internet, all 3D models are converted into Objet File Format (.off) in the database using a Java platform. In order to evaluate the performance of the shape similarity measure, we design experiments performing 3D model retrievals on the test database. The first model on the left is considered a query as the example shown in Fig. 4.



(A): 3D Research method by cut-region



(B): 3D Research method by view-region



(C): 3D Research method by cut-contour



(D): 3D Research method by view-contour

Fig. 4. 3D shape retrieval in our Search engine using the four methods

Our result above shows a search engine that we have built, this system permit to retrieve in the database the most similar 3D objects, such as the 3D object in the top left consider a query, and the 14 3D objects are the nearest neighbors takes an order from left to right and top to down. The comparison between the query 3D object and the others objects in the database returns to compare their vectors descriptors obtained from the cuts set that represent each 3D object.

2. Performance and Result

We compared the classification performance the four methods for each one of the different shapes categories, we have calculated the average Recall-Precision graph by using all shapes of the test database by a query object in the Figure 5.

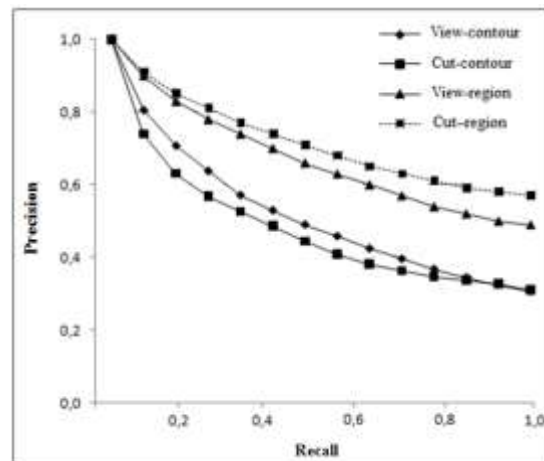


Fig. 5. Precision-Recall graph of the four methods

The obtained results in our search engine permits to classify the four methods of the 2D/3D approach in the context of k nearest neighbor, such as the first method by cut region based (A) is considered to the best method at level to the proper representation of the 3D object, the second method by views region based (B) also gives results more or less satisfied, the weakness of this last method is the projected image from the 3D object in hidden parts. The contour also permit to search the similar 3D objects, but it has a small representation of the 3D object(C) and (D), finally, we can say that the internal and external quantity of the information in the image is very important in the domain of indexing and retrieval.

VI. CONCLUSION

In this paper, we have presented a comparative study between the content based methods of the 2D/3D approach based on binary image extracted from the 3D object, such as, each used method represent the 3D objects in the database by a specifics images set, to extract the vector descriptor of these images, we used the 2D Hu moments descriptor, in order to measure the similarity between the 3D models, shows the taxonomic study of the four methods at level of the quality and quantity of the obtained information, this comparison shows the robustly and efficiency method in the part of the 3D object representation.

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