3D Global Search System from "Genome of Things" project.

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Abstract

According to growing of 3D printing technologies, the number of 3D model data on Web is rapidly increasing. Also many 3D data repositories for 3D printing are available today and there is a few 3D model search engine. We developed the 3D model search engine, which can search the data from whole Web. In our system, the crawler gets 3D model data on Web and stores it to database. Users can search 3D model with tag information of the data; filename or keyword on the page where the data is linked. The system also offer similar shape search where users can search 3D model that has similar shape to query data that users selected. We implemented the simple shape match algorithm using the voxelized data where the coincidence rate of voxels is calculated. We also developed the browser based simple Computer Aided Design (CAD) function for editing the 3D model data.

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According to growing of 3D printing technologies, the number of 3D model data on Web is rapidly increasing. Also many 3D data repositories for 3D printing are available today and there is a few 3D model search engine. We developed the 3D model search engine, which can search the data from whole Web. In our system, the crawler gets 3D model data on Web and stores it to database. Users can search 3D model with tag information of the data; filename or keyword on the page where the data is linked. The system also offer similar shape search where users can search 3D model that has similar shape to query data that users selected. We implemented the simple shape match algorithm using the voxelized data where the coincidence rate of voxels is calculated. We also developed the browser based simple Computer Aided Design (CAD) function for editing the 3D model data.

Introduction

An additive manufacturing, especially 3D printing technology is becoming very popular recently. Due to the achievements on dissemination of personal 3D printers, the very numbers of 3D mesh model data is published on the web today and many repositories for 3D printing are available today: MakerBotThingiverse (http://www.thingiverse.com), NIH 3D Print Exchange (http://3dprint.nih.gov/), sketchFab (https://sketchfab.com), Smithsonian X 3D (http://3d.si.edu), NASA 3D Resources (http://nasa3d.arc.nasa.gov/). There are some 3D model search engine crawling the multiple web sites like that mentioned above: Yobi3D (https://www.yobi3d.com/), yeggi (http://www.yeggi.com/).

Under these situation, we now start "Genome of Things" project. In that project, we are now planning to develop some systems. For example, 3D search engine crawling on global web, 3D corroborative editing system for creative use of 3D model, 3D pictorial books and so on. Through developing such systems, we would like to consider about data format as "genome of things", distribution and evolution of such data in future. For example, we imagine such genome of things as data format that is not just compressed data but also has flexibility to be adaptive for an environment where is used or user's preference, can apply an intergenic crossing-over, and can code and decode from things.

In this paper, we propose global 3D search system from this "Genome of Things" project.

System design

We developed global 3D search system. In this system, web crawler crawls on global web obtaining information about 3D model data and store these information and voxelized 3D model data to database (Figure 1). Comparing to surface mesh model like stereolithography file (Figure 2(a)), voxel model (Figure 2(b)) has some advantages. For example, using it, it becomes easier to design inner structure and it suits to physical simulation of 3D printed object (Masumori and Tanaka (2015)). User can search 3D model data on global web by this search system. Users can not only search by tag linked to the data and can also search by similar shape search. Moreover, users can simple editing of 3D model data and download the edited data, if the license of the data consent to such usage. The following section, we explain about the detail of such individual function of our system.

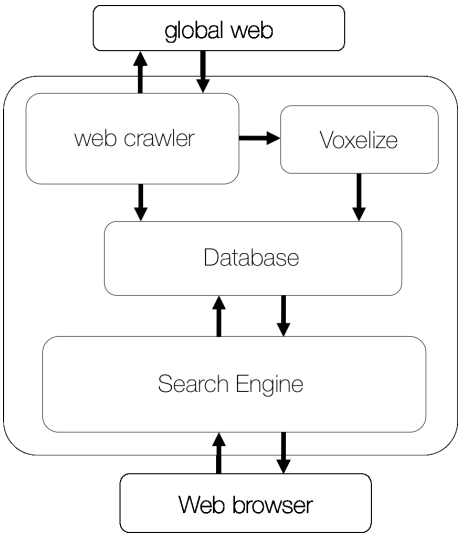
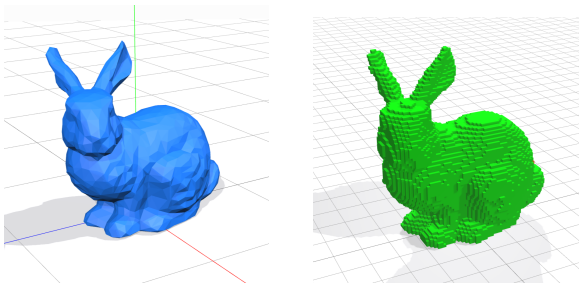


Figure 1: Overview of 3D Search System.



(a) (b)

Figure 2: Example of 3D model. (a) Surface mesh model. (b) Voxel model.

Search engine

Our system currently offers a tag searching and a similar shape searching as a way of searching a 3D model. In tag searching, user enter a word and system returns 3D models which has something to do with the word using information about file name or keyword from original web page where the data is published (Figure 3). Users can show the result in 3D view (Figure 4), and pick and place the 3D objects freely like a building block. Currently, although system just turn result by such simple way, we plan to enhance the result of tag search by machine learning increasing the accuracy of the tag or keywords linked to 3D model.

There are many previous researches about method for calculating a similarity of 3D shape (Osada et al. (2002)), (Kazhdan et al. (2003)), (Chen and Tian (2003)), (Furuya and Ohbuchi (2009)). Although these research propose prominent approach which offer very accuracy of results, we propose more simple approach not only for accuracy of the results but also for extracting users imagination. In our algorithm, a voxlelized data where each voxel is distributed in a reticular pattern, is used for calculating rate of similarity. The similarity between two voxel model data is defined by following equation.

$$Similarity = \frac{Number\ of\ coincident\ voxels}{Number\ of\ non\ coincident\ voxels}$$

Figure 5 shows example of the results of our method. As shown in this figure, this method has sufficient performance for search engine. This simple algorithm might be less precise than shape match algorithms using other feature values in previous research. However, the search results can stir user 's imagination because it includes not only quite similar shape to the query data but also comparatively different shape.

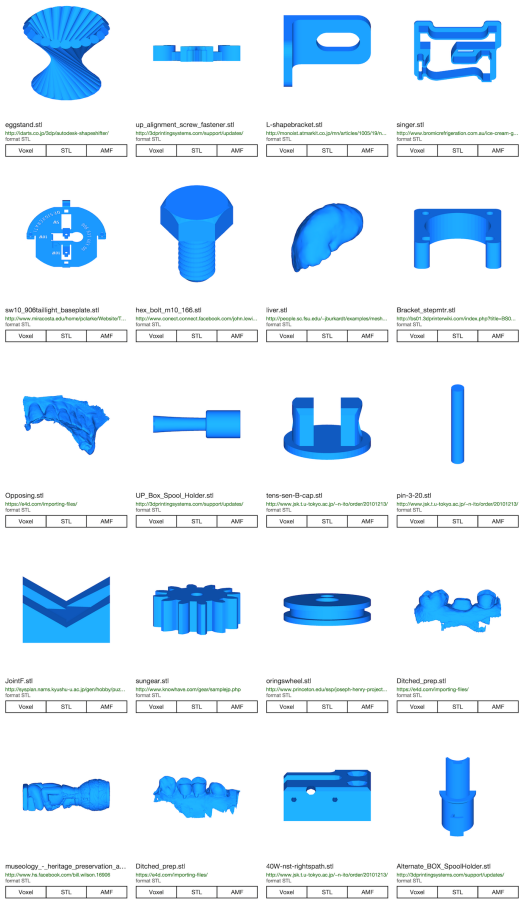


Figure 3: Sample of search results.

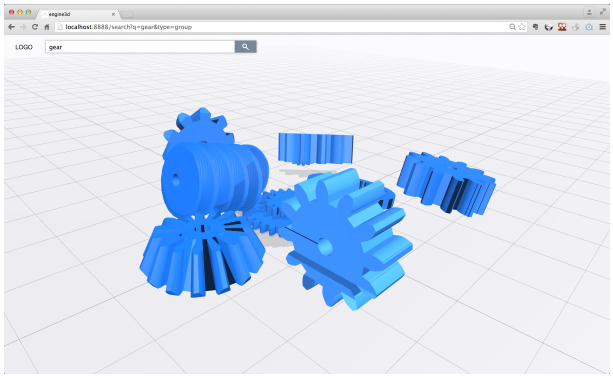


Figure 4: Sample of search results in 3D browsing mode.

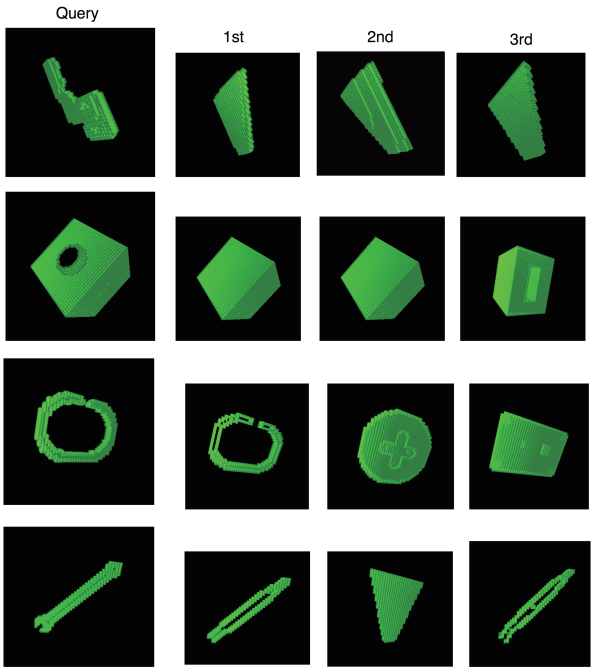


Figure 5: Example of results of similar shape search.

3D model editor

In our system, users can edit the 3D model data from the searching results using simple editor. Currently, we mainly offer three way of editing: painting, shape editing and tag editing. In painting mode, users can paint on the surface of 3D model (Figure 6).

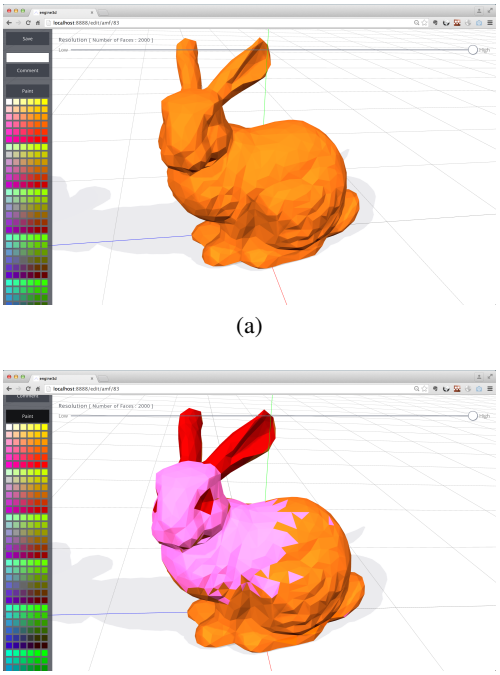
In shape editing mode, there are some way of editing the shape of 3D model. For example, users can edit the shape like claying or curving on 3D mesh model (Figure 7) and users can also apply some effects to the 3D model; balloon effect (Figure 8).

Uses can also edit on 3D voxel model adding and removing a voxel (Figure 9).

In taging mode, users can tag some information on parts of 3D model (Figure 10). These tag information can be used for searching a part of object in future, for example, it can be possible to search ”ears” from all objects and remix the 3D object using such parts of the models. These edited 3D model data can be download, if the original license of the data consent to such usage.

Discussion

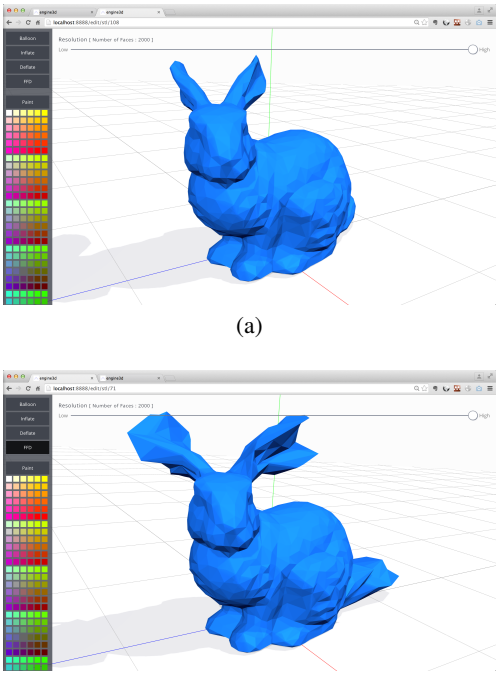
In this paper, we proposed our 3D global search system where users can search and edit 3D models. Although the system is currently in demo level and there are not many 3D model is stored to our database, we continue to develop the system and crawling and obtaining much information about 3D model data from global web. This system is developed as one of the applications from “Genome of Things” project.



(a)

(b)

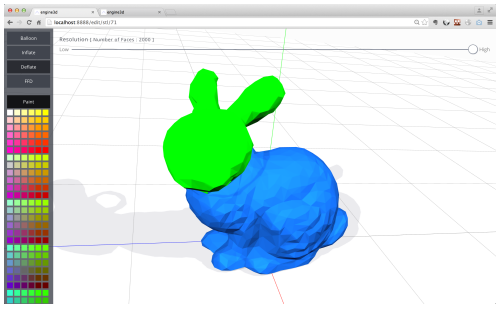
Figure 6: Example of color editor function. Users can paint on surface of mesh model. (a) original mesh model (b) Colored mesh model.



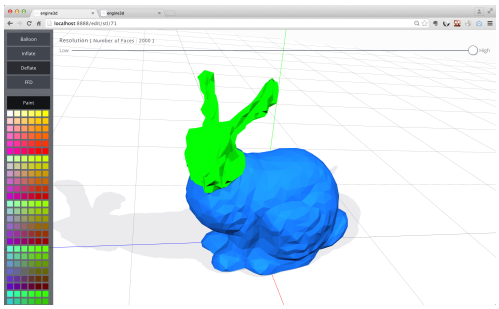
(a)

(b)

Figure 7: Example of mesh shape editor. users can edit the shape like claying or curving on 3D mesh model. (a) Original model. (b) Edited model.

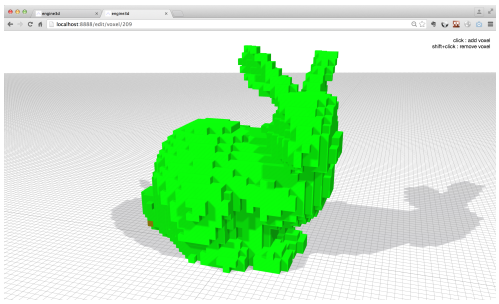


(a)

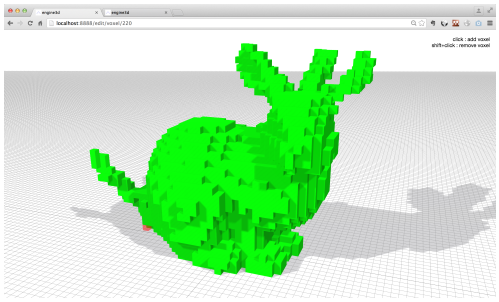


(b)

Figure 8: Example of effects to 3D model. (a) Example of ballon expansion effect 1. (b) Example of ballon shrinking effect.



(a)



(b)

Figure 9: Example of voxel model editor function. (a) Original model. (b) Edited model.

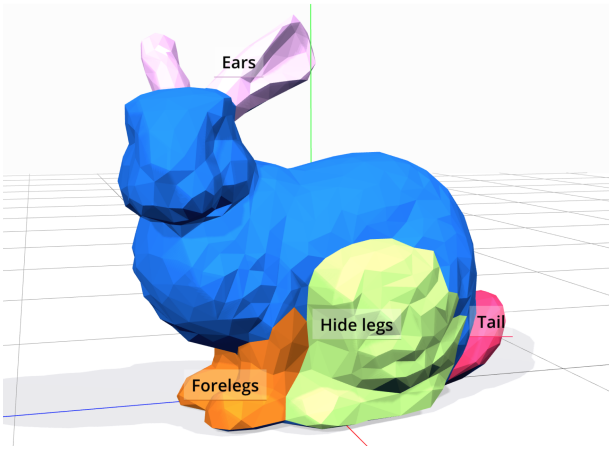


Figure 10: Example of taging mode

Although there are many problems about rights of original data and second usage of that, we also would like to consider about these problems thorough this project. Our motivation in this project is considering and designing a noble data format and way of coding and decoding of the data as "Genome of Things".

Acknowledgements

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