# 3D Image Browsing: The Planets

Qi Zhang Simon Zaaijer Song Wu Michael S. Lew
LIACS Media Lab, Leiden University
Niels Bohrweg 1, 2333 CA Leiden, The Netherlands
qifuzhang@gmail.com, szaaijer@liacs.nl, s.wu@liacs.leidenuniv.nl, mlew@liacs.nl

## ABSTRACT
In this paper, a method of browsing a large collection of images in a 3D environment is presented. Planetary bodies are used as a metaphor for browsing the image collection, where each planet represents a cluster of related images from the dataset. Salient point descriptors are used to cluster the imagery into planets. For each planet, maximum salient overlap is used to select a representative image. The user can move in 3D space through the planetary solar system. From a large distance, representative images painted on the planets are displayed. From a short distance, the images within the cluster are shown on the planet.

## Categories and Subject Descriptors
H.1.2 [**Information Systems**]: Human factors

## General Terms
Experimentation, Human Factors.

## Keywords
3D image browsing, interfaces

## 1. INTRODUCTION
Browsing large collections of images is an important part of content based image retrieval [1,4] and utilizes techniques from related fields such as pattern recognition and computer vision. Within this work, we were curious about the answer to this question: "Can we make image browsing fun and interesting to the layman?" Several modern web search engines allow users to browse through billions of images and people at home often peruse through their own collection of photos to find something that reminds them of moments from their past. The traditional way to view these images is by showing them on a 2D plane, aligned along some form of grid such as in Google Image search.

In this project, a way to view a large amount of images in a 3-dimensional environment was developed. The solar system was used as a metaphor for the process of browsing image collections where it is assumed that each planet has semantically similar imagery.

The images were clustered using the TopSURF library [2] to form planets.


*ICMR '14*, Apr 01-04 2014, Glasgow, United Kingdom
ACM 978-1-4503-2782-4/14/04.
http://dx.doi.org/10.1145/2578726.2582613

From a far distance only a single image on the planet is shown (see Figure 1), but from nearby, the other images associated with the planet are visible across its surface.

Within the area of image browsing and search, a frequently used evaluation measure is the search/browsing time and from that conclusions are made essentially to assert that the best system has the lowest search/browsing time. However in some contexts, the search time may not be the most important factor. For example in magazine browsing, it could be argued that skimming a webpage may be faster than physically going to a magazine stand and browsing through the diverse magazines. In this case, the experience of browsing is fun for many users. We assert that the user experience is actually the most important factor and that the user experience may or may not be correlated with search/browsing time depending on the particular context or application.

Thus, this system does not have the goal of being the fastest search/browsing method. It is intended that the user experience is fun and interesting in exploring an image collection.

## 2. PLANETS METAPHOR
The research community has used 3D metaphors to browse large image collections and several interesting and relevant 3D based approaches such as image cubes and image cities are described in the literature [5-10].

**Figure 1. A screenshot showing several planets from afar.**

Using a metaphor of travel through the solar system is a contribution of this work. Two fundamental parts of the system include clustering and selection of representative images which are briefly described next.

### 2.1 Image Clustering
The SURF [11] algorithm was introduced as a "speeded up" approach for detecting and describing salient points. It is based on sums of 2D Haar wavelet responses. The TopSURF [2] library is a multi-platform open source library for using SURF salient points in a bag-of-words model using the tf-idf weighting. It does

the clustering and analysis of the clusters to determine which ones have the most utility. TopSURF also provides a useful distance measure to compare two images, allowing the dataset to be clustered based on resemblance. The dictionary and descriptors are stored to the disk, greatly reducing the loading time for the next time the program runs on the same dataset.

## 2.2 Representative Images

To intuitively navigate the dataset of images, the planets show a representative fixed single image while the viewer is at a far distance. The representative image is shown as if projected on the planet, allowing the user to see it entirely regardless of the angle at which the planet is viewed.

There are many possibilities for choosing a representative image. We decided to be consistent as possible with the salient point approach and select the image which has the greatest overlap with the largest number of images in the cluster with respect to the salient points.

As the viewer gets closer to the planet, the representative image fades to show the other images in the cluster. These are all spread out over the surface of the planet (see Figures 2 and 3).

## 2.3 Implementation

The project was written in C++ and used OpenGL for rendering. SDL was used for the window creation and input handling. The TopSURF library [2] was used for the clustering and loading of images and textures. When the program is executed, it will begin by showing an empty galaxy.

As the images are examined, clustered and loaded, planets will appear along with the loaded images on the surface.

The thresholds for the clustering and the transition from the representative image to the images within the cluster are adjustable by the user. 3D movement can be performed by keyboard or by "mouse-look" which is standard for most 3D games.

Additional options are available for the following:

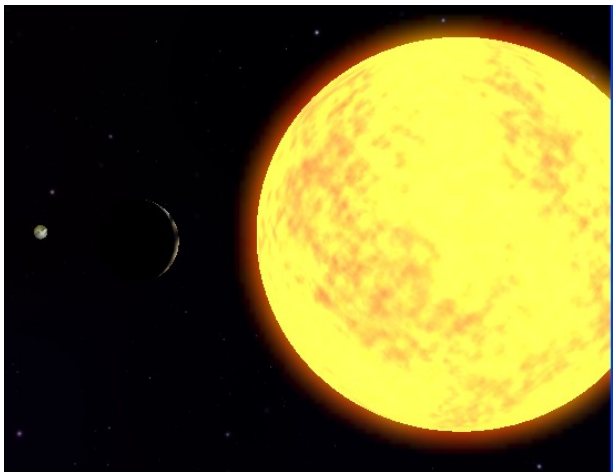
- a nearest planet "hyper-jump" which will move the user quickly to a close planet.

- an overview "hyper-jump" which will move the user to a reference point in the solar system to have an overview of the planets.

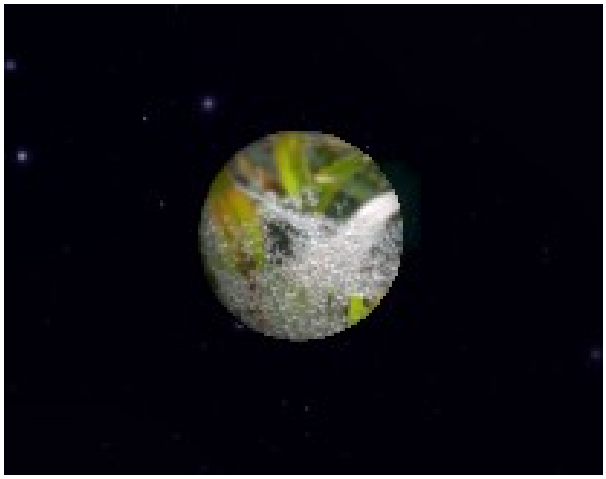
- gravitational based clustering where the clusters are created by extending the planets metaphor so that gravitational force is related to content-based similarity between the cluster and an image.

# 3. USER FEEDBACK

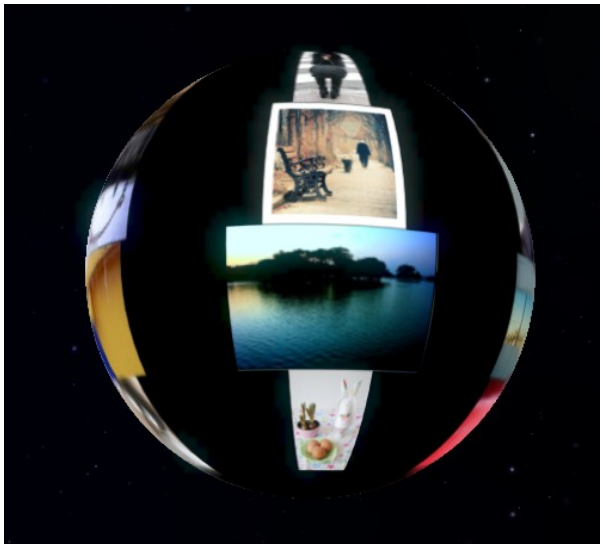
The central question for this project was: Can we make image browsing fun and interesting to the layman? Using a locally created image database composed of 25,0000 images (from the MIRFLICKR collection [3]), we setup a test for our system which consisted of an Intel quad core processor, 4GB RAM and 2GB graphics card.



(a) Distant view of the solar system



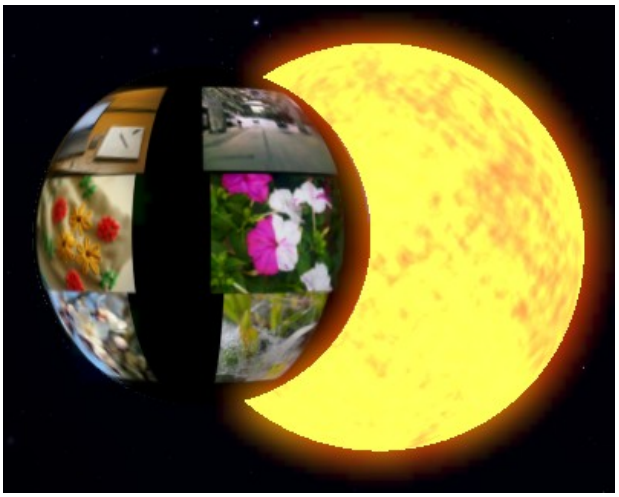
(b) Planets are initially displayed with a representative image



(c) Images within a cluster on the planet

**Figure 2. Images in (a) - (c) show the planets from far to close distance.**

(a) A planet filled with people photos



(b) A planet filled with nature photos

**Figure 3. Other views of planets in the solar system**

We asked two groups of high school students (53 in total) (who visited our university open days) to use the demo for 15 minutes where they were asked to "find the most interesting image." Their feedback is shown in Table 1 below.

**Table 1. User Feedback on The Planets Demo**

| | very negative | negative | neutral | positive | very positive |
|---|---|---|---|---|---|
| How was your experience? | 0 | 0 | 2 | 20 | 31 |
| Would you want to use it again? | 0 | 0 | 2 | 14 | 37 |

## 4. CONCLUSIONS

This system was designed to be a demonstration/prototype of an intuitive and fun approach for browsing image collections by laymen. Our intention for this system was not to minimize the search time but instead to focus on providing a good user experience. Overall, based on the user feedback, we considered the planets demo to be a success and will be developing it further.

In the future, we will be adding additional functionality for content-based browsing through the imagery including splitting up planets into more clusters and reclustering based on interactive search paradigms which take into account user preferences and interactive learning. We will be considering diverse methods of fly-throughs over a planet and also how to extend the metaphor to galaxies and higher level astronomical concepts. Furthermore, we are interested in deeper and better methods to assess the user experience .

## Acknowledgments

We would like to thank Leiden University, LUMIR and the China Scholarship Council for their continued support.

## REFERENCES

[1] Datta, R., Joshi, D., Li, J., Wang, J. 2008. Image retrieval: Ideas, influences, and trends of the new age. *ACM Computing Surveys*, 40 (2), ACM Press.

[2] Thomee, B., Bakker, E.M., Lew, M.S. 2010. TOP-SURF: a visual words toolkit. *Proc. ACM International Conference on Multimedia*, pp. 1473-1476, Firenze, Italy.

[3] Huiskes, M., Thomee, B., Lew, M. 2010. New Trends and Ideas in Visual Concept Detection, *Proc. ACM International Conference on Multimedia Information Retrieval*, ACM Press.

[4] Thomee, B., Lew, M.S. 2012. Interactive Search in Image Retrieval: A Survey. *International Journal of Multimedia Information Retrieval*, vol. 1, no. 2.

[5] Schoeffmann, K., Ahlstrom, D., Beecks, C. 2011. 3D image browsing on mobile devices, *Proc. IEEE Symposium on Multimedia*, IEEE Publishing.

[6] Gomi, A., Itoh, T. 2010. MIAOW: a 3D image browser applying a location- and time-based hierarchical data visualization technique. *Proc. ACM International Conference on Advanced Visual Interfaces*, ACM Press.

[7] Nakazoto, M., Huang, T. 2001. 3D MARS: Immersive virtual reality for content-based image retrieval. *Proc. IEEE International Conference on Multimedia and Expo*, IEEE Publishing.

[8] Chiu, P., Girgensohn, A., Lertsithichai, S., Polak, W., Shipman, F. 2005. MediaMetro: browsing multimedia document collections with a 3D city metaphor, *Proc. ACM International Conference on Multimedia*, ACM Press.

[9] Snavely, N., Seitz, S., Szeliski. 2006. Photo tourism: exploring photo collections in 3D. *Proc. ACM SIGGRAPH*, ACM Press.

[10] Zheng, Y., Gomi, A., Itoh, T. 2011. ImageCube: A Browser for Image Collections Associated with Multi-dimensional Datasets, *Proc. IEEE International Conference on Information Visualization*, IEEE Publishing.

[11] Bay, H., Ess, A., Tuytelaars, T., Van Gool, L. 2008. SURF: Speeded up Robust Features. *Computer Vision and Image Understanding*, vol. 110, no. 3.