WWW visualization giving meanings to interactive manipulations

H. Shiozawa and Y. Matsushita

Faculty of Science and Technology, Keio University,
3-14-1 Hiyoshi, Kohoku-ku, Yokohama 223 Japan

The Natto View visualizes the WWW space as a graph structure and provides dynamic focus+context operations with 3D interactive techniques. Information nodes are placed on the floor plane by their attributes. As the user lifts a focused node up, the nodes to which it links are lifted up together, and thus complex networks are disentangled dynamically. The Natto View supports not only the visualization but also the interactive and dynamic operations on users' demand.

1. INTRODUCTION

By exploring through the large World Wide Web (WWW) space, users might get disoriented and confused. Overview diagrams are one of the best tools against the problem. However, for any real-world hypermedia system with many nodes and links, the overview diagrams represent too complicated and large networks to be really useful. In this paper we illustrate the Natto View, a new interactive visualizing method for hyperspace. Natto is a kind of Japanese food made of soybeans in a ferment. As it is very sticky, if you pick a bean up, some ones nearby follow together, and others nearby following ones also follow, and so on. Our new visualization is based on the metaphor of natto.

2. PROBLEMS

The following are the problems of traditional interactive 3D visualizations for large and distributed information systems.

2.1. The Support of the User's Attention

Much past works of 3D view adopt the metaphors of white boards [3] and buildings on a map [1], and perspective views from that metaphors to support focus+context technique. However, this can not provide the maximum effect of fisheye lens, because the perspective technique restricts the view for it has to provide the natural view for human. Moreover, the expression of real fisheye lens should give a sense of incompatibility to most people.

2.2. A Lack of Interactive Manipulation

Especially in the visualization of 3D graph, it is only possible for an user to move or to magnify inside the already existing information space, and not possible to conduct fully the interactive manipulation such as to move or to change the data object itself and giving an analysis to such relationships. We propose the technique to support the analyzing of data by interactive and trial and error manipulation which were insufficient in past visualizations.

2.3. A View of a Space Walker

Past views of graph arranges nodes just like the stars in a space, and an user can rotate the view or move inside the view freely [2]. However, giving too much freedom to an user leads to losing the sense of direction inside 3D space.

2.4. Indicating the Information of Node Attributes

In the past works, the information of each node (such as file names, file sizes, and so on) is indicated inside the node itself or on the labels near the node. However, since the size of the node is limited, if the detailed attributes should be labeled on the node, its size must be enlarged. As a conclusion, if the attributes of a node is various like a hypertext, the number of nodes drawn on a screen is very limited.

2.5. The Continuity of the Position of Information

If we simply apply the graphical fisheye lens view [4] or any 3D visualization to huge information space like WWW, an user has to wait for the layout optimization every time the user performs an access to a new node. More, there is a possibility that the position of a node moves largely after each optimization. This harms extensively to the quality of response and the manipulation.

3. THE NATTO VIEW

This section illustrates the features of the Natto View with screen shots.

3.1. 3D Visualization and Semitransparency

The Natto View shows WWW structure as a graph in 3D graphics. Document nodes and hyperlinks are expressed respectively as spheres and line segments. Each document title is written with the sphere. Nodes are drawn in three colors: yellow, brown and orange, which indicate respectively 'not yet visited', 'already visited or once focused' and 'focused now'.

We utilize semitransparent colors to draw a lot of hyperlinks, since the node placing method of the Natto View crosses links more than layout optimizing methods. Links coming from the focused node are drawn in semitransparent green and the others are drawn in semitransparent white.

3.2. Lift-up Operation

In the Natto View, the third dimension or z-axis is given a role of the dimension of interest, that is, the more interesting the node is, the higher it is placed and thus the more visible its neighbors are. By this appropriate semantic of third dimension, users are less disoriented and confused than perfectly arbitrary 3D operations. At the start of program, it gives each node an initial position, whose unique xy-coordinate is calculated by a certain function described after, and the value of z-position is roughly 0.

The 'lift-up' operation is the most characteristic and novel feature of all interactive visualization systems until now (Figure 1). As the user lifts a focused node up, the nodes to which it links are lifted up together, and complicated networks are disentangled dynamically. Explaining a few more detail, if a node is lifted up to level x, its destination

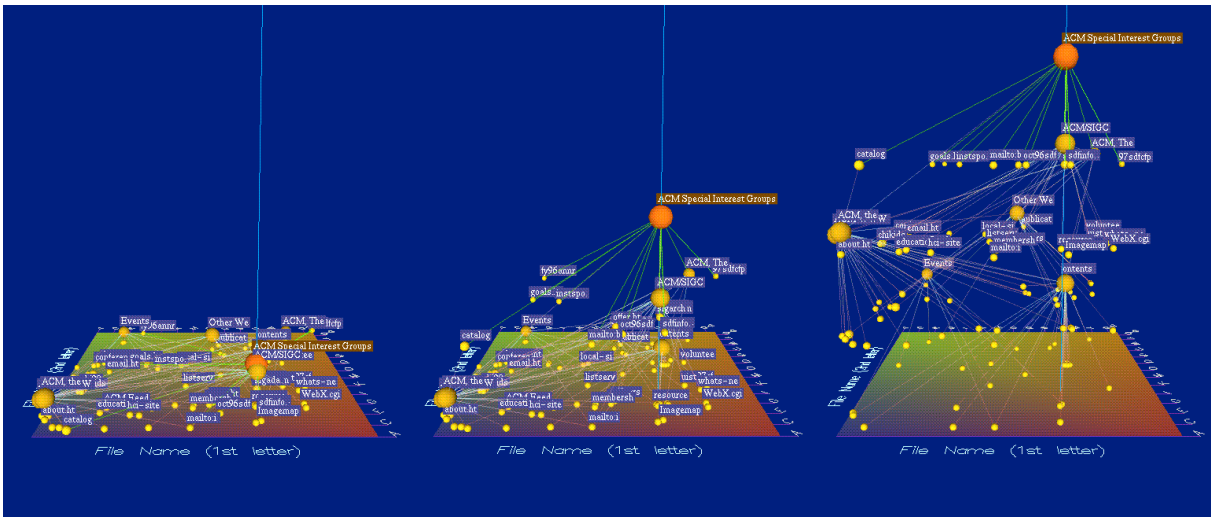

Figure 1: Lift-up operation

nodes lifted up to level $x-1$ and others linked from following ones to $x-2$, and then this process is continued repeatedly until nodes in level 0. The number of lifting steps is unlimited.

By this lift-up operation, users can control their own views according to quantity of their interest in the focused nodes. Such quantitative reflection of degree of interest is a very important feature. However, until now, almost all 3D visualizations have insufficiently supported it.

3.3. A Semantic Space

The Natto View gives a meaning to the dimension other than z-axis the attributes of the nodes made up of HTML text files. To x- and y-axis and the size of the nodes, some attributes which could be extracted from a document is assigned by a selection of user. Former graphing techniques used to place the attributes on the nodes itself, but by placing the nodes along the coordinates according to the attributes, it lowers the size of the nodes.

This is the realization of the semantic space proposed by Wexelblat [5]. The semantic space suggests the information to be visually arranged according to its property and the operation on the screen to have its meaning according to the selection or the filtering of information, and this is done by mapping the characteristics of information to the visual dimension. The size and the colors of the objects are examples of composition of semantic space other than the coordinates.

The attributes the Natto View uses to arrange the nodes are (1) the title, (2) the name of the file, (3) the file size, (4) the total number of outgoing and incoming links, (5) the number of outgoing links, (6) the number of images, (7) the time from the last modification, and (8) the percentage of Japanese words. User can correspond any of the three to x- and y-axis and the size of node, and watch the information space closely

by rotating the view. For example, by default, the size of the node corresponds to the logarithm of the total number of links.

Because the standardized meaning has been given to the manipulation to every direction by the semantic space, it gives the user a sense of direction. Besides, the *floor* which shows the parameters of coordinates acts as a guide for user to find out which way he is looking at.

3.4. Other Operations

Some other operations are also provided by the Natto View. Users can browse the focused document through WWW browser with clicking and selecting the menu. Also 3-dimensional operations such as translation and rotation concerning each axis are supported. The function of marking enables users to set marks at any node. Marked nodes are drawn in green with their descriptive words.

4. CONCLUSION

Currently, almost all 3D visualizations use perspective to support focus+context strategy. In other words, conventional 3D visualizations assign a role representing DOI (degree of interest) to the visual variable of distance between the viewpoint and data objects. However, we think perspective is less appropriate than using size variable like 2D visualizations. Because, when the user approaches certain information to focus it, unfortunately the viewable field becomes smaller.

The Natto View proposes to use the visual variable of position, or height, for DOI mapping. Since height is quantitative and such operation results in protecting disappearance of nodes' view, users can control node heights roughly in proportion to their DOI. In addition, height has intuitive meaning that the higher is the more important, thus operational semantic is also provided. These are the advantages of the Natto View over other 3D visualizations.

REFERENCE

1. M. C. Chuah, S. F. Roth, J. Mattis, and J. Kolojejchick, SDM: selective dynamic manipulation of visualizations, *Proc.ACM UIST'95*, pages 61–70, 1995.

2. K. M. Fairchild, S. E. Poltrock, and G. W. Furnas, SemNet: three-dimensional graphic representations of large knowledge bases, In R. Guindon, editor, *Cognitive Science and its Applications for Human-Computer Interaction*, pages 201–233. Lawrence Erlbaum Associates, 1988.

3. J. D. Mackinlay, G. G. Robertson, and S. K. Card, The perspective wall: Detail and context smoothly integrated, *Proc.ACM CHI'91*, pages 173–179, April 1991.

4. M. Sarkar and M. H. Brown, Graphical fisheye views, *Comm.ACM*, 37(12):73–84, 1994.

5. A. Wexelblat, Giving meaning to place: Semantic spaces, *Cyberspace: first steps*, chapter 9, MIT Press, 1991.