THE CONCEPT NETWORK MODEL DATABASE

Image Database for extending design

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Abstract. This paper proposes a new design methodology and a system to support the design process on making concept from verbal words to concrete shapes by extending architects' imagination. Our system is using the image archive database that can be an effective means for novel ideas.

1. Getting Ideas

The environmental design needs to consider from various angles not only the design objects but also the surrounding area and the human activity etc. Because design activities are to do it for the human being, we should understand who use it, how they use, what they need, what are their matters of interest etc. Whether ideas architects have cherished for ages or they hit upon, giving some hints may let them think widely and endeavor to reach conception with experience of various emotions, climates, etc. To get ideas, we would like to begin from setting up a lifestyle of people who will be affected with the designed environment. We apply the method called *Scenarios Scripting*.

2. Scenarios Scripting

Developing concepts to images or making some new concepts is an information conversion process. To get good idea in this conversion is not easy if architects have no any reference in this process. There are methods of a general design to extract conversion states from the experience or the other plans. We used the *Scenarios Scripting* design method to develop concepts and images. It is not started to think from functions and shapes of a plan directly, but to consider about the specific lifestyle of people who will utilize it in the future. The idea is made from what kind of action by using or living there (Norman, 1988).

2.1. WRITING SCENARIOS FROM THE INTERNET – EXAMPLE

Nowadays, the Internet is rich repository of human knowledge. It holds knowledge of various fields as multimedia data. Actually the Internet is important resource for conception of architects. Especially, photographic images are powerful hints for inspiration. For example, we have developed a design process supported with image archive in the Internet.

Okayama City Project, still going on, is an actual project to design a city core with *Scenarios Scripting* method for urban renewal. First, the following concepts were set up:

- Where many people gather and live
- The interchange of profitable information and friendship
- Where the tradition and the culture will be succeeded, and
- The residents can participate the urban plan

Our hints of concepts are from a lifestyle of women who are single with 30 generations and work for multimedia SOHO. The scenarios was represented these concept. The various activities in their lifestyle were referred for prediction of needs in the design.

For getting the information of the lifestyles, one of the methods that we propose is using the picture retrieval engine to collect the pictures, which matches the key words from WWW and image database. Figure 1 is a result of retrieval that ‘women and computer’ selected as keywords. We found many images concerning about women and computer. Almost of them were what we had expected, secretaries using computer, working girl with computer, and so forth. But also unexpected images found in them. Note middle of bottom line in the figure. There is a girl using a computer and supported by a backpack on the lawn (Figure 2). This image inspires us and as a result we created scenarios that the main characters single 30ish woman, live in high-rise apartment building and work for multimedia SOHO (Figure 3).

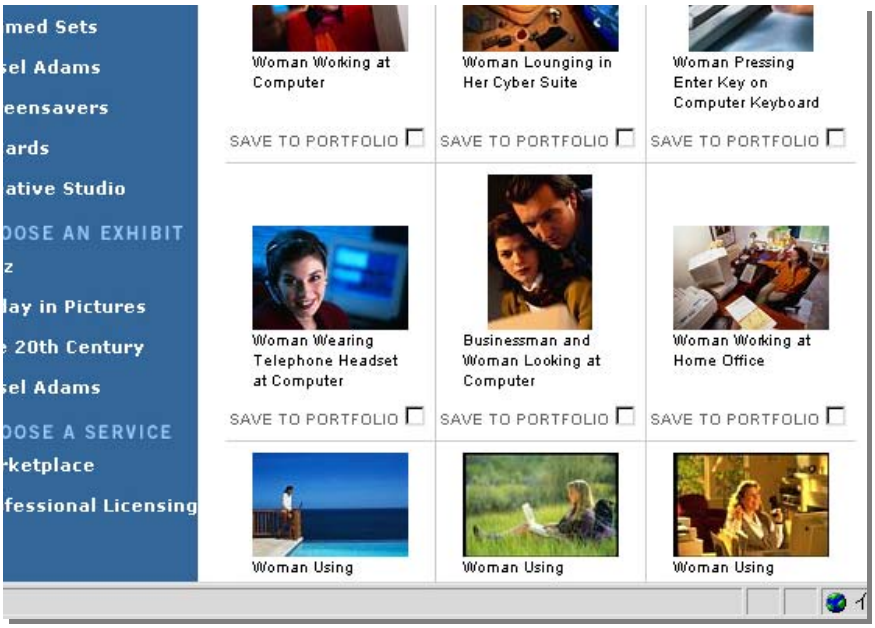

Figure 1. Result of retrieval with keywords ‘women and computer’

Figure 2. One of unexpected results

Figure 3. Apartment for women working for multimedia SOHO

3. Collection of Images for Inspiration

As the example above, image archive will be helpful to get ideas. Such images can be collected from the Internet by search engines. Images and verbal words perform different role, they have their own merits (Paivio, 1971; Nelson et al., 1974). Figure 4 is summarized of the process of inspiration using photographical images from the Internet.

- Choose initial keywords related the basic concepts,
- Retrieve images that express the concepts,
- Examine the images and extend imagination from the images,
- Focus on people in the images, examine what they do, and find the details,
- Add the acquired idea as explicit words,
- Retrieve images by above words again, and repeat this process.

Because the resource of the Internet has not taken altogether to manage, we have no way but retrieving with the keyword attributes with search engine sites. WWW search engines are designed to narrow down the flood of data retrieved from the Internet including useless noise. But for inspiration we need also some unexpected information for getting unconventional idea i.e. unique conception. We propose database system managing method enabling to vent and narrow the information for creating the design images.

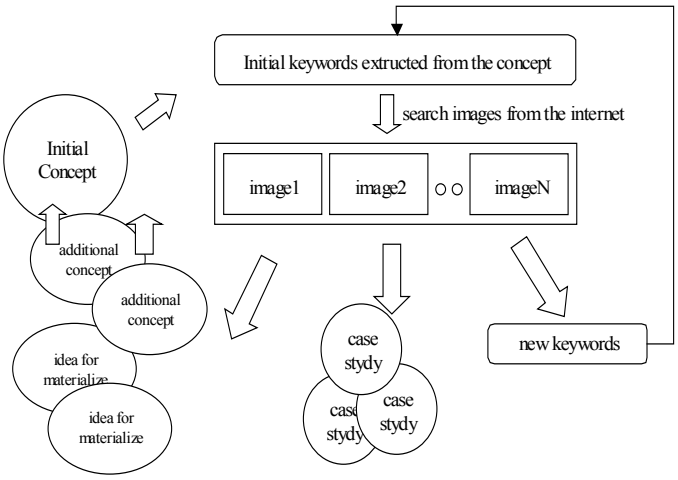

Figure 4. Inspiration from image database

4. Image Browsing with Associative Network

We need retrieval data vast having rich information enough not to lack the essence and also narrow to find meaningful information. Our model is based on the traditional semantic network model (Collins and Loftus, 1969).

Definition: Atom
Atom is a word as keywords for retrieval such as ‘women’ or ’computer’...
It is denoted like as *a*.

Definition: Atom-Set
A set of atoms is denoted like as **S**. The number of elements of **S** is denoted as **|S|**.
In Special, a set of all atoms (in keyword space) is denoted as **U**. |**U**| is assumed finite value. (CWA: Close World Assumption)

Definition: Normal Form
The condition of retrieval is displayed as conjunction of atoms with logical operator (AND, OR). Generally, search engines in the Internet have capability to process such

a logical expression. In this paper, *AND* operator is denoted by '^', *OR* operator is denoted as '+' and negative unary operator is denoted by '~'.

For any atom a, both a and $\sim a$ are called *literal*. For literals $p_{i1}, p_{i1},\ldots,p_{im}$, assume term F_i and G_i is following form:

$$F_i = p_{i1} + p_{i2} + \ldots + p_{im}$$
$$G_i = p_{i1} \wedge p_{i2} \wedge \ldots \wedge p_{im}$$

If forms *F and G* are following style, *F* is called *conjunctive normal form* and G is called *disjunctive normal form*.

$$F = F_1 \wedge F_2 \wedge \ldots \wedge F_n$$
$$G = G_1 + G_2 + \ldots + G_n$$

Any logical expression can be transformed to these normal forms.

Definition: Weight between atoms

Atoms (keywords for retrieval) relate one another. These relationships may be similarity. Ex. 'Computer', 'PC' and 'Playstation' belong to a same category. They may be what one atom is associated with other. Ex. 'Computer' is associated with 'The internet' and 'Word Processing'. Further, association is chained. 'Word Processing' is associated with 'Paper', 'Paper' is associated with 'CAADRIA', 'CAADRIA' is associated with 'SYNGAPOLE'.

Let the measurement of such relativity denote *weight* of relativity link between atoms (W_{ij}). See Figure 5. This term is named from synaptic connections.

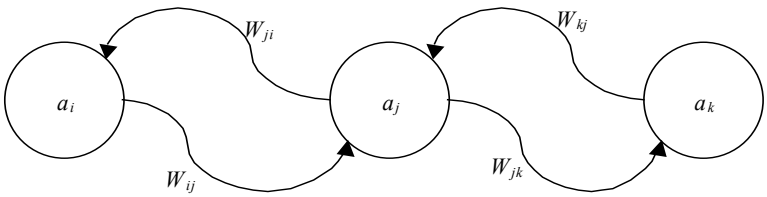

Figure 5. Weight between atoms

W_{ij} means weight of relativity link from *i*-th atom to *j*-th atom. Note that W_{ij} is not always equal W_{ji}. For normalization, W_{ij} is in [0,1]. Weights among each atom are able to be understood as probability of association

Definition: Derived atom set

A matrix of W_{ij} for all i and j is called *associative transition matrix*. Denoted by **W**. The n-th (n > 0) power multiplies of **W** means weights after n-th association. The elements of **W** is also able to be denoted W_{ij}. For distinction from direct associative link, W^n_{ij} denotes it. Starting from an initial atom (a_o), a set of associated atoms is denoted by $\mathbf{D}^{(n)}(a_0) = \{ a_i \mid W^n_{0i} > 0\}$. Intuitively, domain of set $\mathbf{D}^{(n)}(a_0)$ increases according to association as figure 5. But, in associative relation link set there may be closed loop (circuit) such as 'Computer' > 'PC' > 'Handheld' > 'Computer'. Such loop will become a reason to be expected Fixed Point Set. But, such FPS will be generally too large. To set bounds of the domain, the threshold value assumed no weight must be decided. The threshold value will be given on starting retrieval in the condition.

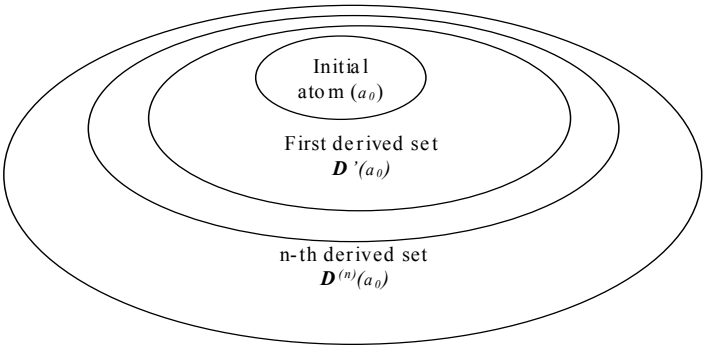

Figure 6. Growing up derived set

When $|\mathbf{D}^{(n)}(a_1)| > |\mathbf{D}^{(n)}(a_2)|$, a_1 is more general keyword than a_2. For example, search with keyword 'Computer' hits 25068 images. On the contrary, search with 'Automaton' hits only 35 images (www.altavista.com). In this case, Size of first derived set from 'Computer' is far larger than 'Automaton' because 'Computer' is more popular and generic keyword. On choice of keywords, we must consider the size of result domain. Generic meaning atoms and disjunctive condition will cause vast domain of results, on the contrary, specific meaning atom and conjunctive condition will cause narrow domain of results. Generic images related initial concepts would be gotten with retrieval with a_0 and $\mathbf{D}'(a_0)$. Images related initial concepts but unexpected ones would be searched with atoms contained in around $\mathbf{D}^{(n)}(a_0) - \mathbf{D}^{(n-1)}(a_0)$.

5. Learning Algorithm

Next problem is how weights of link should be changed. Sources where the system gets relationship between atoms are limited. The candidates are the initial keywords entered by users, the text data contained in result pages picked up by search engine, and the fact database defined according to a prior rule.

The keywords entered simultaneously by users would have thin relation between each other. Ex. 'Computer' and 'Woman' seem to have no necessity of relation. But as there is situation dealt at a time, weight of link between two atoms should be increased a little bit. On the other hand, results of retrieval have more necessity. Ex. The result of retrieval with keyword 'Computer' and 'Woman' contains 'SOHO', 'telephone', 'Baby', 'grass' and so forth. With unexpected result such as 'Baby', 'grass', value to weight of links these atoms to 'Computer' and 'Woman' are added like as human synaptic connection growing.

The rule of addition to the weights should not be linear. Learning is asymptotic process and forgetting is destined (Craik and Lockhart 1972; Gregg, 1986). The forgetting rule means, in this case, that obsolete links become useless. Human learning model has studied for many years and thick results have published (etc.). But our goal does not aim to modeling of human intelligence. We adopted following simple asymptotic and forgetting rule.

$$\Delta W = \Delta (1-W) - \Delta\Delta t W$$
$$0 <= W <= 1$$

s.t. and Δ are coefficients for adjustment,
Δt is time span from previous access.

6. Structure of the system

6.1. OVERVIEW OF THE SYSTEM

Now, the system is mainly written with perl and.PostgreSQL. PostgreSQL is one of relational database management system, roles associative network to hold *associative transition matrix.* See Figure 6 describe overview of the system.

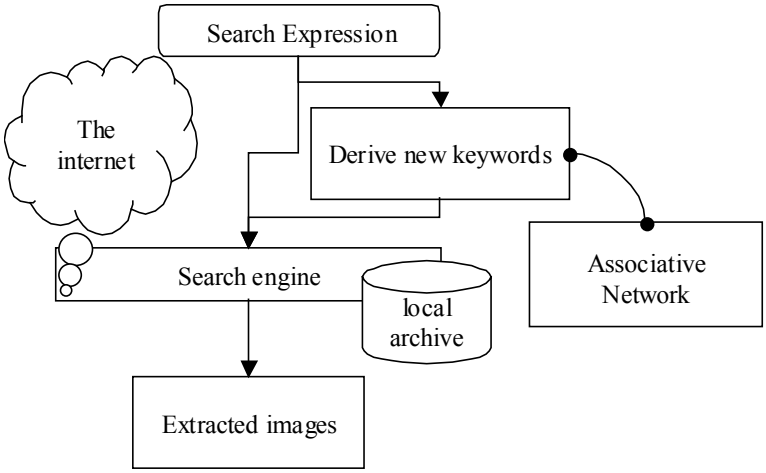

Figure 7. Describes overview of the system.

The local archive holds images managed by DBMS with appropriate keywords.

6.2. COLLECTION FROM OTHER IMAGE ARCHIVE SITES

When you would like to retrieve images from general search engines of the Internet, like Altavista, you can do this with specific GET method of HTTP. For example, Altavista can be used with URL binding keyword to variable 'q' and 'simage' to variable 'stype' as following:

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http://www.altavista.com/cgi-bin/query?stype=simage&q=keyword
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When you choose the page from many result pages, spell 'stq' binding with number that the page number multiplied by 12 (number of images displayed in one page). It is easy to get image data from the result. On inspecting HTML document gotten via HTTP, you will find IMG tag for thumbnails and can extract URL of them. All we must do is to display in WWW browser with anchors for learning CGI.

7. Evaluation

An evaluation of the system must take a long time. The measurement of an evaluation of such kind of system is complex. Evaluation for a long term will tell the real advantages.

8. Future Studies

The point of this paper is how we can get the image describing the human life, which is affected by the design area. In this paper, we are trying to do it with photographical image archives. From technical point of view, the key is association from keywords to keyword. The data structure, the learning algorithm (Bruza, 1996) and the retrieval method (Kawano, 1999) for realization of it should be exercised ingenuity. It is supposed that the cognitive science esp. pictorial memory and understanding contribute them. Anyway point is what ideas we can get. Pragmatic study will lead up to success.

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