Supporting Community Knowledge Building Using Talking-Virtualized-Egos Metaphor

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Abstract: In this paper, we describe the CoMeMo-Community, a system that supports community knowledge building using the Talking-Virtualized-Egos (TVE) metaphor. The virtualized ego is a software agent that functions as an alter ego. It works as a medium for conveying one's knowledge to others by interacting with other virtualized egos or community members over a network. This interaction among virtualized egos visualizes knowledge interaction in a community. We performed an experiment to examine (a) how people generate associative representation from ideas, (b) how community knowledge evolves through the clear expression of ideas, and (c) how people act in such a knowledge-creating process. The subjects were 45 students who attended a lecture on artificial intelligence at our institute. In this three-week experiment, we observed the following: (a) Collaborative knowledge building. Some subjects created new information based on the information published by other subjects. (b) Topic Change. Although most of the published information was about "Nara" at first, as time passed the topic changed to "agent" and "computer." And (c) Creation of new human relationships. One participant was able to make friends using this system.

1 Introduction

Various new network societies have been produced by the expansion of information communication networks, innovation of multimedia technology, and the spread of the personal computer to the individual level. The network community (hereinafter, "community") is such a society. The community is a group of people who have overcome various restrictions of time and space in the real world, a social organization that is gently connected by fixed intention or cooperation. Since it consists of many people of different backgrounds, the community is flat and dynamic, and shares certain activity information.

It is important for community members to acquire and share their information in order to encourage activity. In many cases, a common concern promotes an active interchange of ideas and information between people. In order to find such a common concern, people actively provide information to each other. In such a dynamic community, although the opportunity to meet with various people over a wide area is increased, it is not easy to uncover similar and common information. Moreover, the common concern is not fixed and changes through interaction between community members. This means that individual knowledge develops simultaneously. However, it is difficult for members of the community with few opportunities to meet together to anticipate a change in the common concern. We believe that it is important to pursue this change in order to promote an active interchange within the community.

We have therefore developed the CoMeMo-Community system, which supports knowledge sharing in a community[1, 2]. This system supports mutual understanding between community members and the sharing and developing of their interests and knowledge.

In Section 2, we discuss the knowledge inter-

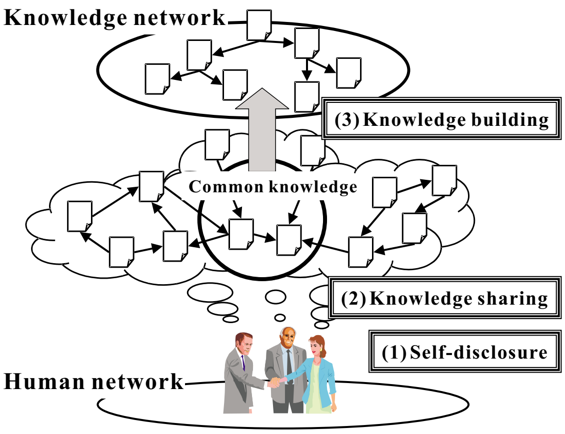


Figure 1: Knowledge interaction.

change in social interaction and its support with an intelligent system. In Section 3, we provide an overview of the CoMeMo-Community and describe the Talking-Virtualized-Egos (TVE) metaphor. In Section 4, we report on experimentation with our system. In Section 5, we discuss related works. Finally, we conclude our paper in Section 6.

2 Knowledge interchange in social interaction

In this section, we discuss the validity of mutually disclosing information in a community and the usefulness of supporting such shared information with an intelligent system.

2.1 From self-disclosure to knowledge sharing and building

The first stage of community activity is getting to know one another. People usually start communicating with each other by talking about themselves. Such communicative action is called *self-disclosure*. It has a personal function, called *reciprocity of self-disclosure*, in which the receiver of the self-disclosure tends to return the same degree of self-disclosure to the sender[3]. When the speakers come to trust each other, their self-disclosure changes from revealing outside information (e.g., name and affiliation) to revealing inside information (e.g., interests and troubles). This helps create the *human network*. As their interaction becomes more active, their mutual understanding increases. Thus, each can recommend to the other useful information that they are interested in. We believe that the quality of communication between community members changes as they establish relationships. In other words, the form of communication changes from self-disclosure to knowledge sharing as their familiarity increases. Moreover, if the community members can find common knowledge or interests while knowledge sharing, they can expand it into a more useful and larger pool of knowledge through knowledge building, which is the process of gathering and connecting knowledge fragments. We refer to this built knowledge as the *knowledge network*. The knowledge network grows as knowledge sharing and building becomes more active. Thus, in order to support community activities, we think that it is necessary to support a series of processes from the formation of human relationships (the human network) to knowledge building (the knowledge network) (Figure 1). We believe that the co-evolution of human and knowledge networks plays an important role in community activities.

Nakata[4] discusses intelligent support for constructing social knowledge in group and community settings. He states that an essential step in creating social knowledge is to capture the individual's interests. New knowledge should emerge from the sharing of individual knowledge. He also argues that social knowledge is a mediator that brings people together. These views are similar to our theory of the co-evolution of human and knowledge networks in that shared knowledge plays the role of mediator among community members and inspires the creation of new knowledge.

2.2 Usefulness of supporting knowledge interchange in a community

It is important for community members to facilitate the exchange of information, such as their opinions, feelings, thoughts and ideas, in order to encourage their activities. We believe that it is significantly beneficial for community members to be able to see and interpret such information visually while they exchange it. We also believe that the relationships between members become friendlier if a connection between the information published by each is visualized.

2.2.1 Clarifying individual opinions and feelings

It is said that self-disclosure helps people clarify their opinions and feelings. Moreover, it promotes their own self-understanding by causing them to repeatedly think about themselves. However, people find it difficult to manage their opinions and feelings, because they are obscure, complex and heterogeneous. We think that enabling a person to visualize their ideas with the computer will help to clarify their opinions and feelings.

2.2.2 Generating confidence

The effect of self-disclosure on the receiver can be influenced by many factors such as timing, method of disclosure or situation. No matter how you may have made a self-disclosure to a person who is not interested in receiving it, you cannot expect to receive a self-disclosure in return. On the contrary, you may cause your partner discomfort, and the effect of your self-disclosure is unpredictable. However, since a community is a group of people who have certain interests and concerns in common, self-disclosures can be effective at initiating activities in the early stages of community formation. Moreover, if published information accumulates on a computer, the receiver can obtain it at her/his convenience. If the system visualizes relationships that are not obvious to the eye, unexpected relationships between people can be discovered. This facilitates the formation of new relationships, which in turn facilitates the establishment of the human network.

2.2.3 Collaborative knowledge building

We anticipate that reciprocity will work not only in self-disclosure but also in knowledge sharing. This means that the receiver of the knowledge will return the same degree of knowledge to the sender. When people obtain knowledge from others, they not only learn various things about the others, but also derive new ideas from unexpected information. If these new ideas were available to the public, other people could also form new ideas. If such an activity repeated itself, the amount of knowledge in a community would continuously grow. We believe that such knowledge exchange will become more active if a computer can be used to easily share information.

3 CoMeMo-Community: A system for supporting community knowledge building

3.1 Externalizing personal memory using associative representation

Associative representation is a knowledge medium in which nodes are connected by links that have direction and are capable of many-to-many mapping[5]. The basic entities of associative representation are the *unit* and the *association*. A unit is either a *concept* or an *external datum* (e.g., image, audio file). A concept has a label. An external datum has a label and a URL. A *key unit* is a node from which a given link originates. A node at which a given link terminates is called a *value unit*. An association is a single link that connects one or many key units with one or many value units that represent memories triggered by the given key units. A key unit for one association may, of course, be a value unit for another, and vice-versa.

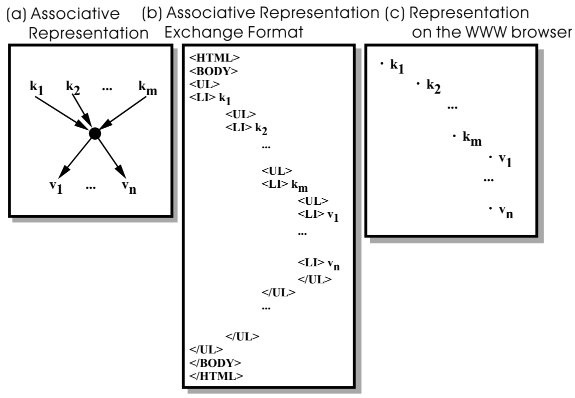


Figure 2: Example of associative representation and associative representation exchange format.

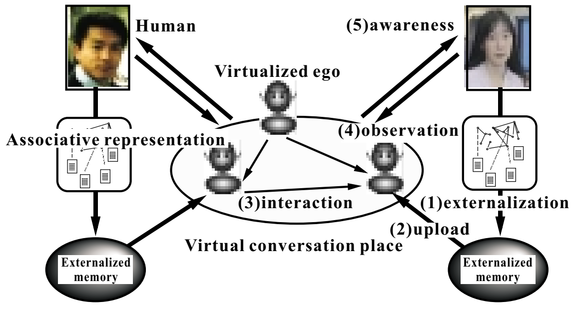


Figure 3: Framework of CoMeMo-Community.

In the diagrams in this paper, a dot represents an association and an arrow connected to a dot represents the direction in which the association flows (Figure 2). Text and occasional images represent units. An associative representation can be seen as a special kind of semantic network, with an open semantic structure. Furthermore, associative representation is based on many-to-many mappings, unlike typical semantic networks that are based on one-to-one mappings.

As Woods[6] pointed out, links in semantic networks may have various meanings. The kind of relation that is made between objects is left up to the user. The semantics of the relations in an associative representation need not be explicitly stated, but users may include semantic descriptions on labels. By keeping the semantic relations largely implicit, the method of representation can be made compact and robust.

We propose an associative representation exchange format (Figure 2(b)). An associative representation exchange format is the description form of associative representation, which uses

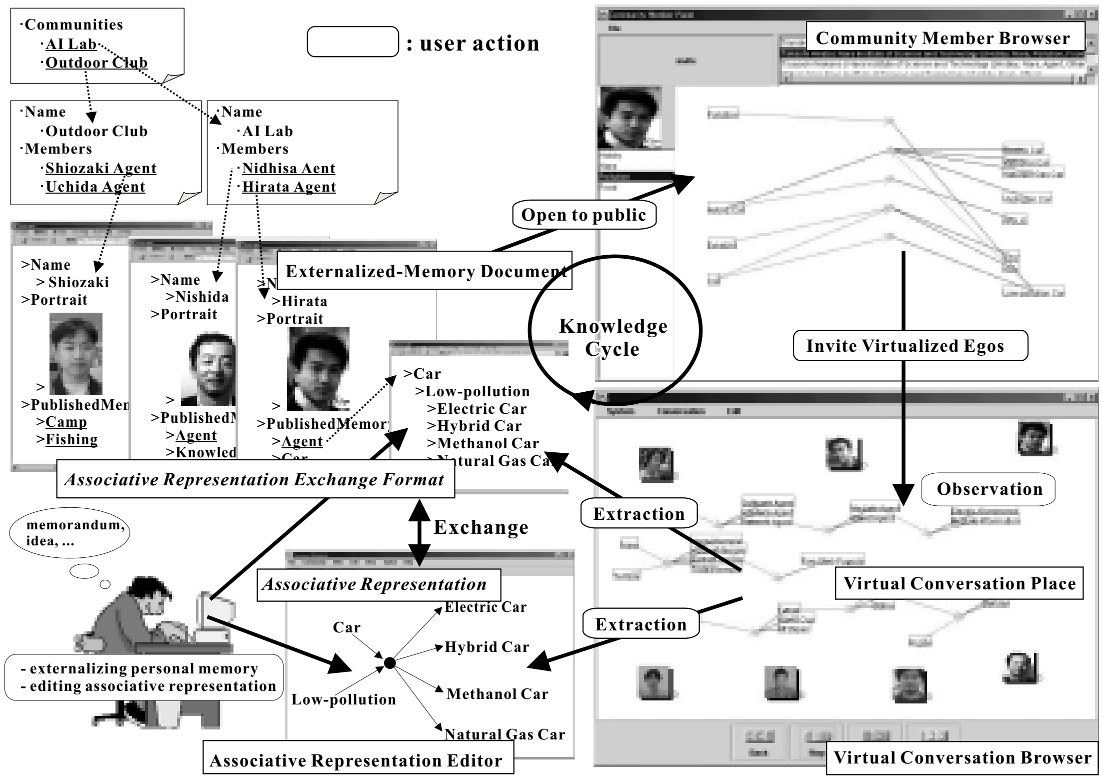


Figure 4: Circulation of knowledge in CoMeMo-Community.

HTML (Hyper Text Markup Language). By using HTML, which is currently a widely used method of knowledge representation, users can easily circulate associative representation on networks, especially on the WWW (World Wide Web), and describe public information using ordinary tools. The externalized memory described using the associative representation exchange format is called the externalized-memory document.

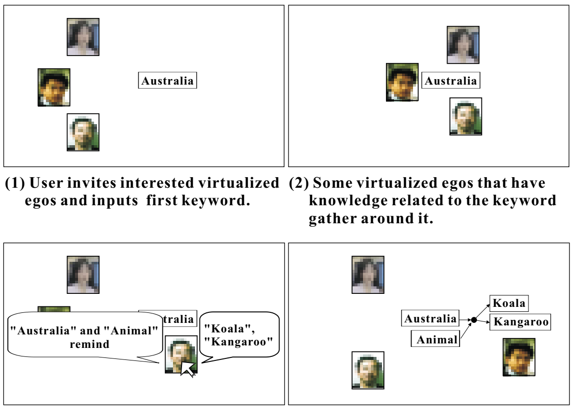
3.2 Overview of CoMeMo-Community

The framework of the CoMeMo-Community is shown in Figure 3. Each member in the community externalizes their memory using associative representation, accumulates it as externalized memory on the system, and interacts with other members through her/his own virtualized ego. The virtualized ego is a software agent that functions as an alter ego. It works as a medium for conveying one's uploaded externalized memory to others by interacting with other virtualized egos or community members over a network. We call the interaction between virtualized egos the Talking-Virtualized-Egos (TVE) metaphor. This provides community members with an asynchronous communication, and enables the user to observe a community or an individual from the viewpoint of a third party. This helps the user learn many things, for example, what others know and what interests they share in common, since the connection between each member's externalized memories is presented as images. Thus, observing the TVE metaphor facilitates awareness in the community. We believe that the TVE metaphor enables community members to discover and create human and knowledge networks in a community.

Figure 4 shows components of the CoMeMo-Community and the circulation of knowledge in the system. The user externalizes her/his memory as externalized memory and edits it using associative representation. Some externalized memories that can be open to the public are made available to the community using externalized-memory documents. An example of how published externalized-memory documents are organized is illustrated in the upper left of Figure 4. All externalized-memory documents are connected by hyperlinks. The user can also extract information from virtual conversations on the community browser.

3.3 Visualizing knowledge interaction using TVE metaphor

The mechanism of the TVE metaphor is shown in Figure 5. First, the user invites interested virtualized egos to the virtual conversation place and inputs one or more keywords as the topic



(1) User invites interested virtualized egos and inputs first keyword.
(2) Some virtualized egos that have knowledge related to the keyword gather around it.
(3) Selected virtualized ego reacts and inputs new keywords related to the original keyword.
(4) Virtual conversation continues.

Figure 5: Example of Talking-Virtualized-Egos (TVE) metaphor.

(Figure 5 (1)). Each virtualized ego monitors the keywords on the virtual conversation place as to whether it has externalized memory related to the keywords. If it has related information, the virtualized ego gathers around the keyword (Figure 5 (2)). The user can discern the information that each gathered virtualized ego has by pointing at the facial images with a mouse, which displays the externalized memory possessed by the virtualized egos with balloons (Figure 5 (3)). Then, the selected virtualized ego links the information as a new keyword by copying the information from its externalized memory. The new keywords are added to the right of the original keywords using associative representation. Some virtualized egos will then approach the new keywords again (Figure 5 (4)), continuing the activation cycle. In this way, virtualized egos collaborate with each other to generate knowledge networks by alternately reproducing information fragments from their externalized memory. The user can interrupt the virtual conversation and input new keywords on it if inspired to do so.

4 Experiment

We conducted an experiment over a three-week period to determine the efficacy of the system in facilitating community knowledge evolution. The experiment focused on the following areas.

1. How people generate associative representation from their ideas.

2. How community knowledge evolves through the clear expression of ideas.

3. How people can participate in the knowledge creating process.

4.1 Method

Subjects: Forty-five Master of Engineering students who attended a lecture on artificial intelligence at our institute.

Apparatus: CoMeMo-Community (Associative Representation Browser, Community Member Browser and Virtual Conversation Browser (see Figure 5).

Procedures:

1. All subjects accessed the registration and filled out its forms using a Web browser. They downloaded and installed the CoMeMo-Community in their own PC.

2. The subjects edited their own externalized-memory documents by using the Associative Representation Editor.

3. The subjects browsed their own and others' externalized-memory documents using ordinary web browsers or the Virtual Conversation Browser.

4.2 Results and discussion

The results of the experiment were evaluated from the snapshots of all the members' externalized-memory documents, the log of user operations and reports from the subjects.

4.2.1 General comments from subjects

Most subjects answered that, in general, they were able to understand the associative representation that other members published. This suggests that it is possible to convey an idea using associative representation to others who share a certain amount of background knowledge. Although there were negative comments about the operation of the system, there were many affirmative opinions about the support of mutual understanding by memory indication, and the ability to share interests and knowledge. Submitted reports contained comments such as, "I could obtain unknown information from others" (10 subjects), "My thought was inspired by another association" (15 subjects) and "I could discover the relationships between people by observing the TVE metaphor" (12 subjects). These comments suggest that this system helps people to activate their knowledge and create relationships between community members.

The following three features became apparent through this experiment.

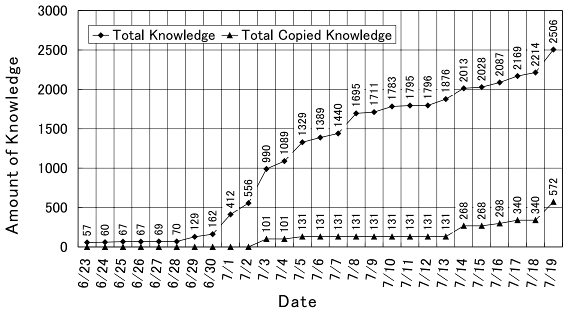


Figure 6: Transition of the amount of knowledge of the whole community.

4.2.2 Collaborative knowledge building

The daily additions to the amount of community knowledge in the experiment term are shown in Figure 6. The amount of copied knowledge per day is also shown. The amount of knowledge shown on the vertical axis is the total amount of published information as of midnight of that day. Knowledge is measured by the number of words published in externalized-memory documents. Total knowledge amounted to 2506 words by the final day of the experiment. The total amount of copied knowledge was 572 words by the last day, which accounted for about 23 percent of the total amount of knowledge.

Although, the amount of total community knowledge seemed to increase continuously, few subjects actually created their externalized memory gradually. It seems that the subjects input their ideas when they had made up their mind. Thirty-six subjects edited their knowledge in the experiment, and only two subjects registered to a community. The subjects published much more information in the second access than in the first. It therefore seems that each subject participated in a community for a time and published information gradually while observing the published information of the other subjects. Overlapped topics gradually appeared as mutual information was inputted a little at a time. Published information was then concentrated in its topic (refer to the following paragraph).

Interesting shared knowledge creation: Although each individual subject had limited knowledge, connecting and uniting their information created interesting shared knowledge (community memory). For example, virtualized ego A inputs "robot" when prompted by "control". Virtualized ego B recalls "bipedal robot" from "robot," and in turn recalls "Honda". Furthermore, virtualized ego C is reminded of and responds with "motorcycle" and "car" from "Honda". Finally, virtualized ego D inputs "exhaust gas" and "pollution" when reminded by "car". Thus, in this system, small pieces of knowledge provided separately by each subject create interesting community knowledge when combined. Therefore, this system is especially effective for increasing the scope of knowledge.

Collaborative knowledge building: During the second half of the experiment term, the interesting information collected by virtual conversation was copied, new information was created based on the copied information, and this newly created information was re-published to the community. Ten subjects took part in such action. These subjects responded that their interest in the experiment was increased when another subject added a new association to their published information, which is one form of community knowledge building that we aimed to achieve. This suggests that this system is effective for supporting community knowledge building.

4.2.3 Contents of published information

Figure 7 shows the trends in the published information by category (research, hobby, local information, and other). Published knowledge could be divided into four categories, research, such as agent or computer, hobby, such as travel, music, and sports, local information, such as Nara or Kyoto, (this category included a lot of information about a subject's hometown), and other. The amount of local information published increased considerably as the experiment progressed.

Concentration and change of topics: The contents of the published information differed in the first half (from June 23 to July 7) and the second half (July 8 to July 19) of the experiment term (see Figure 7). Almost all of the information in the first half was local information about Nara, but information about research topics such as agent and computer increased in the second half. About 40 percent of the total published information was local information about Nara.

Some subjects reported that they had felt that the published information concentrated on Nara, the agent, etc., and when a certain subject published the topic of a computer or hobby, other subjects who were interested in those topics were allured and began to publish new information related to those topics. It seems that subjects developed new topics from the concentrated topics, thereby prompting more subjects to participate . Thus, in virtual conversation, topics changed in a manner similar to the way such change occurs in everyday human conversation.

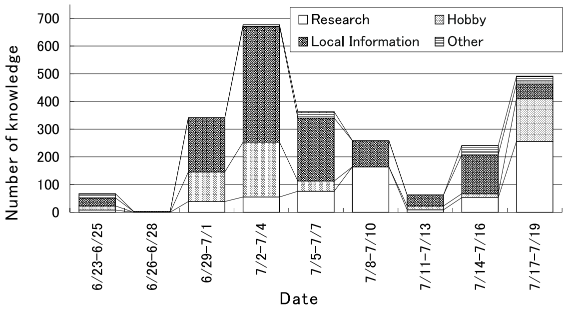


Figure 7: Trends of published knowledge.

When the name of a place was inputted, it often prompted the input of that area's features, which then prompted the name of a new place. For example, Nara invoked the large statue of Buddha, which invoked Kamakura. Nara also invoked study travel, which invoked Nagasaki, Hiroshima, and Kyoto. This is an example of a certain saturated topic shifting to other topics through association.

Local information that is not commonly known unless the subject lives or visits the area was also shared. In particular, much word-of-mouth information was provided, such as sightseeing tips, traffic guidance, and special products. It appears that this system is effective at drawing out word-of-mouth information.

Published information for each subject: The contents of the published externalized-memory documents for each subject are shown in Figure 8. The average amount of published information was 58 words, excluding subjects who only registered. Four subjects published information in all four categories.

The amount of published information differed among the subjects. This appears to be caused by the difference of each subject's system environment (e.g., the performance of a system and a network). Therefore, a function that allows the user to set up the operation of a system according to her/his system environment may be necessary.

4.2.4 Establishing new human relations

Through this system, one subject was actually able to make friends with a person who has the same interests. Some subjects commented that they were surprised that their virtualized ego interacted more with the randomly chosen virtualized ego than the virtualized ego which was created by their friend, and that they could, through this system, know another's thoughts better than if they met that individual in person. The conversation among the virtualized egos in the virtual conversation place was continued among the subjects in everyday life.

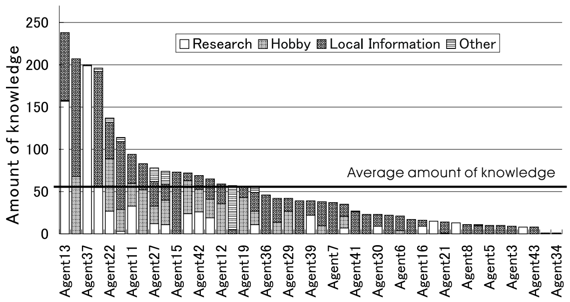


Figure 8: Contents of published externalized-memory document for each subject.

Since this system displays knowledge along with the virtualized ego, the human relationships in a community can also be visualized. It is easy to interact with someone you meet for the first time if a common interest is found in advance.

Shared knowledge plays the role of mediator to bring people together. We expect this system to make a big contribution to the formation of human relationships.

5 Related work

Ishida[7] pointed out that the metaphor of community has become important given the advance of global computer networks such as the Internet and mobile computing. He also said that it is necessary to support the following five different functions for encouraging social interaction in communities: (1) Knowing each other; (2) Sharing preference and knowledge; (3) Generating consensus; (4) Supporting everyday life; and (5) Assisting social events.

Our system supports functions (1), (2) and (3). In order to support everyday life, we are planning to develop intimate computing which enables people to externalize and accumulate personal memory using associative representation at any time and any place[2].

The Community Viewer[8] and Community Organizer[9] use the distance in space to visualize the relations among people in order to help them establish useful human relationships. These systems use a person's responses to given keywords to compute the relationships among people. However, these systems may visualize restricted human relations, because the calculation of a relationship depends on what keyword or category the system provides. Our approach does not directly visualize human relationships. Instead, it deals with the dynamic changes of a person's preferences and interests with keywords that the person makes available to a community. This approach allows users to discover unexpected or potential human relationships in a community.

RefferalWeb[10] and IKNOW[11] illustrate social networks using a graph, where the nodes represent individuals and a bridge between nodes indicates a direct relationship between individuals. RefferalWeb extracts human relationships from published documents, while IKNOW extracts such relationships from common vocabularies and links between the web sites of participants. Our system does not display a human network, but instead shows a knowledge network by graph, where the nodes represent each community members" externalized memory. A human relationship can be understood by observing the process of the generation of the knowledge network using the TVE metaphor.

C-MAP[12] is a personal mobile assistant that provides visitors touring exhibitions with information based on their spatial/temporal locations and individual interests. This system also aims to support the formation of communities based on shared interests among visitors and exhibitors. We are interested in this system's approach because it personalizes demonstrations or presentations from user data obtained by the mobile assistant to support social events, for example, an exhibition or a conference.

6 Conclusion

In this paper, we discussed the usefulness of revealing information about an individual to other members in order to encourage social interaction in a community. We then described a framework for sharing the knowledge that each community member has through a process of self-disclosure. From this framework, we developed a system called the CoMeMo-Community, which supports community knowledge sharing based on associative representation and the TVE metaphor. We performed an experiment to examine how effective the system is in facilitating community knowledge building. In this three-week experiment, we observed the following: (a) Collaborative knowledge building. Some subjects created new information based on the information published by other subjects. (b) Change of topic. Although most of the published information was about "Nara" at first, as time passed the topic changed to "agent" and "computer." And (c) Creation of new human relationships. One subject was able to make friends using this system.

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