A Wearable Interface for Visualizing Coauthor Networks toward Building a Sustainable Research Community

Susumu Kuriyama Masao Ohira Hiroshi Igaki Ken-ichi Matsumoto
Graduate School of Information Science, Nara Institute of Science and Technology
8916-5, Takayama, Ikoma, Nara, JAPAN 630-0192
tel.+81(743)-72-5318 fax.+81(743)-72-5319
{susu-ku, masao, hiro-iga, matumoto} @ is.naist.jp

ABSTRACT
In this paper, we introduce SCACS, a Social Context-Aware Communication System that facilitates face-to-face communications between old-timers and newcomers in a research community. SCACS provides users with information on coauthor relationships collocutors have in order to help users understand collocutors' research background and relations to own. While the system works so as to help newcomers get better understandings on the research community by meeting old-timers—*central to the community*, it also works to recruit newcomers who might bring new ideas and research topics, in order to make the community sustainable. One of the contributions of the paper is to show an example of a fusion of social networking and ubiquitous computing technologies, which have attracted a considerable amount of attentions in the last few years. In contrast to exploiting social interactions in real world to enhance experiences of social networking services in virtual world, SCACS collects information on social networks (e.g., coauthor relationships networks) from virtual spaces (that is, databases), and then visualizes them to facilitate face-to-face communications among people in physical environments through using wearable interfaces. Instead of providing users with complex social network graphs, SCACS transforms network graphs into tree maps so that users are able to better understand the *community*.

Categories and Subject Descriptors
H.4.3 [**Information Systems Applications**]: Communications Applications; H.5.3 [**Information Systems Applications**]: Group and Organization Interfaces–*Collaborative computing*

General Terms
DESIGN, Human Factors

Keywords
Social Networking, Ubiquitous Computing, Legitimate Peripheral Participation, Community Support, Icebreaker

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1. INTRODUCTION
Continual growth of a community depends on how newcomers can engage in the community [6][13]. In case of research communities, especially, newcomers would play a role of driving force for bringing new ideas and research topics to communities [4]. Although the key to construct newcomers' identities (for legitimate peripheral participation: LPP) to a community is access by newcomers to all things that the community and its members imply [6], it is difficult for them to understand how the community is organized, what are core questions for the community, who are major personalities, and so on.

Toward supporting to build a sustainable research community, we have been developing a prototype system called SCACS (a Social Context-Aware Communication System) that serves as *icebreaker*—facilitates face-to-face communications between old-timers and newcomers in a research community. SCACS provides users with visualizations of collocutors' coauthor relationships in order to help users understand collocutors' research background and relations to users themselves.

Our approach to design such the system is to combine social networking technologies with ubiquitous computing technologies. The studies on enhancing user experiences in virtual or real world by integrating the both technologies have attracted a considerable amount of attentions in the last few years. The next section describes related work.

2. RELATED WORK
There are two types of researches related to the integration of social networking and ubiquitous computing technologies.

One is that studies on augmentation of user experiences in virtual world (i.e. social networking services) based on social interactions in real world. For instance, Trace [2] exploits physical co-presence at social events for creating social networks in virtual world, and supports follow-up activities after events. iBand [5] motivates users to exchange information about users based on the common gesture of the handshake, that results in expanding users' social networks.

The other is that studies on enhancement of face-to-face communications and creation of social networks in real world by using information on common interests or friends which is preserved in virtual world. For instance, Sparks [1] facilitates users' conversations by projecting words related to shared interests on the floor close to users' feet. SpotMe [11] helps users meet people they are searching at conferences by using information from people databases. Our study is categorized into the later type.

3. Design

3.1 The Architecture of SCACS

Figure 1 shows the system overview of SCACS. SCACS consists of the following components: *SNS Sever*, *Environmental Sensor*, *Potable Computer*, and *Display Device*.

SNS Server: collects information of coauthor relationships from bibliography database websites such as DBLP (http://dblp.uni-trier.de/) and Citeseer (http://citeseer.ist.psu.edu/), stores them and provides an interface so that system's users can accesses to the multiple information sources in an integrated fashion.

Environmental Sensor(s): are various kinds of sensors embedded in an environment to capture physical and environmental contexts [8] such as users' location and direction. Using contextual information captured by sensors, *Potable Computer* estimates users' state identifies persons to whom users should communicate, and so forth. Currently we suppose to use Webcam, GPS, RFID, and gyro instruments as *Environmental Sensor*s.

Potable Computer: integrates the information which is provided by *SNS Sever* and *Environmental Sensors* above, and visualizes context-aware information on social relationships through *Display Device*.

Display Device: displays the information sent from *Potable Computer*. Figure 2 is an example of using HMD (Head Mound Display) as *Display Device*. According to the situation the system is used (e.g., formal vs. informal settings, many people exist or not, and so forth), users can use PDAs or mobile phones as *Display Device*

Although we are interested in applying SCACS not only to research conferences but also to various kinds of meeting places, in this paper we describe SCACS in the context of face-to-face informal communications between elderly and come-lately researchers in research conferences.

3.2 Visualizations of Social Networks

SNS Server of SCACS gathers coauthor relationships to represent social networks. In general, social networks are often represented as directed or undirected graphs. It is greatly useful to use un/directed graphs to analyze social networks from a macroscopic perspective. Our prior study also used undirected graphs to support to analyze social networks in a large-scale online community [8].

In case of representing complex networks such as coauthor relationships, however, un/directed graphs are very difficult to understand, at a glance, what the networks mean, who has relations to whom and so on, without historical context of the networks (community). Especially, in face-to-face informal communication at research conference (e.g., coffee break), network graphs as a mean of representations of social networks (coauthor relationships) will not be suitable to understand collocutors' research background and relations to system's users.

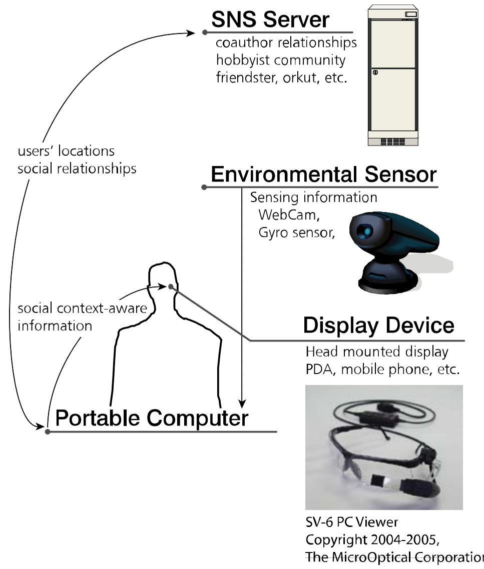

Figure 1. SCACS Overview.

Figure 2. User Interface with HMD and Webcam.

To represent such the complex networks in a face-to-face communication setting, we decided to use the tree map technique [10], which is alternative to the traditional visualization for complex hierarchical tree structures. Because the tree map technique is for visualizing hierarchical structures with a root node, we cannot apply the technique to network structure visualizations simply. We deal with this problem by incorporating the viewpoint, which settles "who sees whose social networks," in tree map visualizations.

Figure 3 is an example of transforming a coauthor relationship network into a tree map. The upper side of Figure 3 is an undirected network graph representing a coauthor relationship. Numbers on edges are numbers of coauthored papers between two nodes. Figure 3 supposes that Masao sees Masahide's coauthor network in a face-to-face communication setting through using HMD. For Masao, Masahide can be seen as the root node in the hierarchical structure because Masao would like to know he have written papers with whom to understand his research background. Masahide has 6 coauthors—6 nodes with one degree of him, and 40 papers in total.

Firstly, *Potable Computer* of SCACS arranges the 6 nodes into the two dimensional space as the top level of a tree map such as the bottom of Figure 3. The ratio of the rectangle size corresponds to the ratio of number of coauthored papers. Because Masahide have written 15 papers with Ken-ichi, the rectangle size for Ken-ichi is arranged to be largest. The colors of rectangles are used for

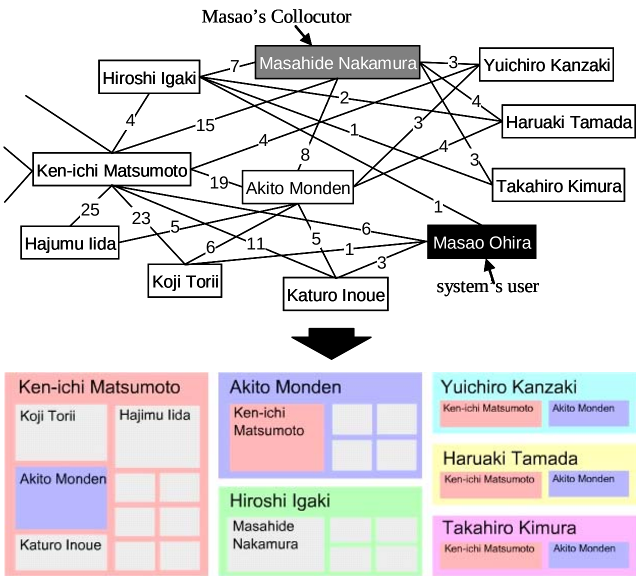

Figure 3. Transformation into a tree map

indicating people's identities in a consistent manner. The grayed rectangles means they are absent or the collocutors themselves.

Next, the system searches coauthors of Masahide's coauthors excepting Masahide and count numbers of their papers. Then, based on the same procedure above, the system arranges coauthors of top-level coauthors into the each area of top-level coauthors. For instance, the area for Ken-ichi, who is Masahide's coauthor and has 10 coauthors excepting Masahide, is arranged as the left bottom of Figure 3.

In the current implementation for the tree map visualization of coauthor networks, the system dose not show coauthors with very few papers in comparison with other coauthors with many papers and coauthors with over 3 degrees of a root node because users are likely to know collocutor's research background but not such the coauthors who are probably not common interests between them.

3.3 Interactions: A Scenario

Figure 4 and Figure 5 show examples of visualizations provided by *Display Device* and suppose a situation where a newcomer, Masao first meets old-timers, Masahide and Hiroshi of a research community. Note that Masao has the wearable interface such as Figure 2 but Masahide and Hiroshi only have RFID tags used to identify system's users.

In Figure 4, in a coffee break at a research conference, Masao found Masahide who presented very interesting work and approached to talk to him. At first, Masao used

Masao: *"Hi, your talk was so interesting because my research is greatly related to yours…"*
Masahide: *"Thank you very much. So, what kinds of research do you engage in?"*
Masao: *"My major is human-computer interaction and CSCW. Especially, I am interested in …"*
Masahide: *"I see. Your research interests are exactly similar to mine. So, un…(silence for a few seconds)… Have you read…"*

At this point, Masao found that there were well-known names in *Public View* and then switched a view from *Public View* to *Private view*. In *Private view*, users can see highlighted names of coauthors with which mean all of users (in this case, both Masahide and Masao) have written papers before.

Masao: *"Oh, have you ever written papers with Ken-ichi Matsumoto?"*
Masahide: *"Yes. He was one of my colleagues at the laboratory where I worked three years ago..."*
Masao: *"Oh, really? He is a supervisor for my doctoral research"*
Masahide: *"That sounds good to you! He is one of leading researchers in this area. How is he doing? Oh, if you are a Ken-ichi's student, Hiroshi also must be in your university?"*
Masao: *"You know, Ken-ichi is busy all the time. And Hiroshi, yes!, he is a post-doc of my lab and he is also attending this conference!"*

Although the scenario above is an ideal story we created intentionally, we believe that things similar to the scenario would happen by using information on coauthor relationships. Coauthor relationships are well-known as "*Small World*" where everyone can be reached through a short chain of social acquaintances [12]. For old-timers, newcomers might bring new ideas and topics but are difficult to talk with because they are not sure of shared interests or common points with newcomers. For newcomers, old-timers are also difficult to talk with because they are very famous in a community and cannot imagine that they have common coauthors (or coauthors of coauthors).

As the scenario we showed above, we expect that SCACS would help old-timers and newcomers in a community communicate each other without much hesitation. We also hope that the fusion of social networking technologies and ubiquitous computing technologies would lead research communities to keep sustainable growth.

4. CONCLUSION AND FUTURE WORK

We introduced SCACS (a Social Context-Aware Communication System) that facilitates face-to-face communications between old-timers and newcomers in a research community. SCACS provides users with the visualizations of coauthor networks based on the tree map technique so that old-timers and newcomers can construct mutual understandings. We expect that the system would play a role of *icebreaker* at least.

The paper showed our initial step toward supporting sustainable community building by combining social networking technologies and ubiquitous computing technologies. We need to test the system through actual use in academic conferences in the near future. We also deeply reconsider the visualizations of coauthor networks as a communication facilitator because of the issue on *presentation of self* [3].

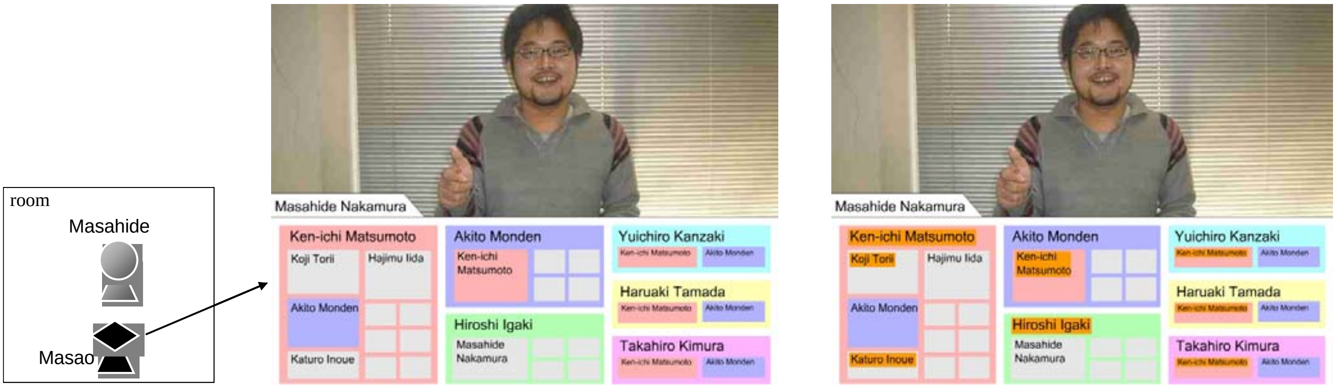

Figure 4. Public View (left) and Private View (right) of Two Persons Mode.

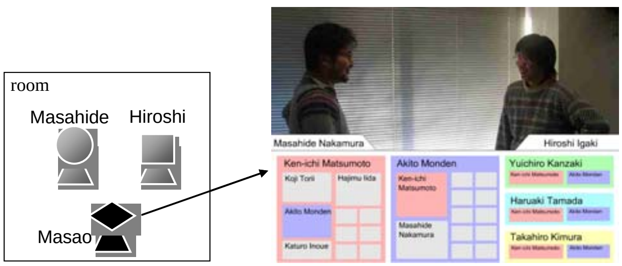

Figure 5. Public View of Three Persons Mode.

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6. REFERENCES

[1] A. Chew, V. Leclerc, S. Sadi, A. Tang, and H. Ishii. Sparks. In *CHI '05: CHI '05 extended abstracts on Human factors in computing systems*, pages 1276–1279, 2005.

[2] S. Counts and J. Geraci. Incorporating physical co-presence at events into digital social networking. In *CHI '05: CHI '05 extended abstracts on Human factors in computing systems*, pages 1308–1311, 2005.

[3] danah michele boyd. Friendster and publicly articulated social networking. In *CHI '04: CHI '04 extended abstracts on Human factors in computing systems*, pages 1279–1282, 2004.

[4] D. B. Horn, T. A. Finholt, J. P. Birnholtz, D. Motwani, and S. Jayaraman. Six degrees of Jonathan Grudin: a social network analysis of the evolution and impact of cscw research. In *CSCW '04: Proceedings of the 2004 ACM conference on Computer supported cooperative work*, pages 582–591, 2004.

[5] M. Kanis, N. Winters, S. Agamanolis, A. Gavin, and C. Cullinan. Toward wearable social networking with iband. In *CHI '05: CHI '05 extended abstracts on Human factors in computing systems*, pages 1521–1524, 2005.

[6] J. Lave and E. Wenger. *Situated Learning: Legitimate Peripheral Participation*. Cambridge University Press, Cambridge, UK, 1991.

[7] D. W. McDonald. Recommending collaboration with social networks: a comparative evaluation. In *CHI '03: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 593–600, 2003.

[8] M. Ohira, N. Ohsugi, T. Ohoka and K. Matsumoto, Accelerating cross-project knowledge collaboration using collaborative filtering and social networks, In *International Workshop on Mining Software Repositories (MSR2005)*, pages 111–115, 2005.

[9] A. Ranganathan and H. Lei. Context-aware communication. *IEEE Computer*, 36(4):90–92, 2003.

[10] B. Shneiderman. Tree visualization with tree-maps: 2-d space-filling approach. *ACM Trans. Graph.*, 11(1):92–99, 1992.

[11] SpotMe. http://www.spotme.com/

[12] D. J. Watts: *"Six Degrees: The Science of a Connected Age"*, W W Norton & Co Inc., 2003.

[13] E. Wenger. *Communities of practice: learning, meaning, and identity*. Cambridge University Press, Cambridge, UK, 1999.