6 Collaborative and Distributed Media

6-1 Experiences in UKARI Project

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The UKARI project was promoted in NICT Keihanna Center from May, 2003 to March, 2006, which was aiming to build a ubiquitous environment at home and to verify usefulness and effectiveness of life in such home. In this article, not only the research result but also the process to have promoted the research project is described based on the experiences.

Keywords
IT penetration at home, Home network, Collaborative and distributed middleware, Voice interaction, Human interface, Communication support

1 Introduction

The UKARI Project, which was launched by the Communications Research Laboratory (CRL, presently the National Institute of Information and Communications Technology) in May of 2003, has continued to the present despite the dramatic changes brought about in the organization with the change from CRL to NICT and the inauguration of the new president. This paper will summarize the aims and major achievements of the project, as well as the philosophy behind the project and my impressions as a participant in research activities and as the leader of the entire project. The technologies associated with the project have been summarized elsewhere[1][2], and further details will be presented in papers to follow[3]-[5].

Use of the Internet is now widespread, and e-mails and web browsing are now common elements of our daily lives. In response to such changes, the business community is now starting to investigate the feasibility of introducing home networks and home servers into ordinary residences. However, it is my impression that most of these discussions have reflected only a business perspective, and fail to include the views of the common person who will ultimately use these networks. I had a vision of what a home network was to be three years prior to the launch of the UKARI Project and had proposed an architecture under the acronym AMIDEN, and examinations of its specifications had been undertaken by several business companies.

At the same time, having had experience in image processing, I was aware of the concern that network cameras may be used for surveillance purposes. What caused me the most discomfort were models in which the individuals observed were different from those who were monitoring the image. My solution to this problem was the concept of having control over our own photographic image, a concept I included under the rubric of “environmental media”. With this concept in mind, studies were carried out to create media that would casually watch over people, featuring structures that would permit those being observed to have control over the acquired information. We also saw the need to define clearly the sort of feedback those observed could expect to receive from the environmen-

tal media.

The problems of surveillance cameras are mostly associated with the issue of privacy, and I believe that the concept of environmental media can circumvent these problems. Increasingly I felt the incentive to construct a system of environmental media within a limited, private space in order to determine whether or not a framework in which you acquire your own information for your own benefit is truly feasible. This incentive was the source of my proposal for the theme of "IT penetration at home" when I first heard of the call for project themes by the CRL.

2 Establishment and management of the project

The project was ultimately launched as a three-year undertaking starting in May 2003 and initially consisted of four project members. Discussions then proceeded on how best to make progress with our plans, leading to calls for the cooperation of various businesses, researchers, and students. The project had two main aims. One was to construct an information system for IT penetration at home and the other was to execute real-life experiments on the established system. Although it was generally agreed that a three-year period was most likely to be insufficient to establish a new research project and to complete real-life experiments, we wanted all of the researchers involved to recognize the significance of completing this real-life experiment.

Being a non-permanent member of CRL, it may have been foolhardy of me to lead a project that involved the construction of an information system all the way through to real-life experiments. With this in mind, I recognized that the most important factor to success in this sort of project is solidarity within the group. I thought it necessary to give a new name to the project, as well as to create an organizational system under which we could invite external researchers to participate without compromising the working relationships among permanent research members. These considerations led to the selection of the name "UKARI". We solicited the opinions of several groups on the name, which was ultimately agreed upon by all members, enhancing the sense of solidarity within the group. The name UKARI is a Japanese modification of the acronym for the English phrase "Universal Knowledgeable Architecture for Real-Life appliances". As we undertook the process of selecting a name for the project, the group was meanwhile divided into a group to construct the home informatization system (the "platform" group) and a group to carry out the real-life experiments on potential services to be provided to users (the "service" group), as we pursued the project's aims through a two-tiered strategy. This policy was adopted to maximize the efficiency of the project's execution, and studies were for the most part carried out independently within each group. However, in some instances this structure led to miscommunication between the two groups. Further, the structure of these groupings — one aimed at providing services to users and one concerned with providing support for these services — led to the generation of conflicting interests between the two groups. These problems were, however, resolved through plenary meetings.

3 General concept of research

It is an old saying that "houses become homes over time". I interpret this to mean that there is a certain rhythm to people's daily lives, and a house eventually becomes adapted to this rhythm. The introduction of the home network to the household in the context of the informatization of homes will add a new layer of increasing compatibility between a house and its residents, and will expedite the above adaptation process accordingly. In addition, since information associated with residents' daily lives may be stored digitally, this information can be carried over to a new house when residents move, increasing their comfort in their new home from day one. This was the goal of my vision, as presented schematically

in Fig. 1.

Under the actual concept of the home, the house was considered to behave like a robot in some ways. This robot observes the daily lives of the residents inside and identifies their rhythms, in order to offer various services to support these lifestyles. During the process, various types of information on the people living inside the house are stored and the associated contexts are identified. These contexts will contribute to improving lifestyle support services, and will be constantly updated. In terms of hardware, software, and services provided in such homes, the concept aims for the establishment of the so-called "ubiquitous home" (Fig. 2).

This is a house that promotes communication between its residents. One of the major factors leading to the decline in information sharing among family members is seen in the individual ownership of home electronics, brought about as a result of technological advances. As a result, family members have come to share only the space of the house. The need for communication between residents is accordingly reduced. In order to reverse this trend, I have proposed a framework in which the family shares an interface robot; this framework has been realized through the "Phyno" interface robot (Fig. 3).

This concept may only be validated and confirmed by tests performed under actual day-to-day conditions. Although my wish was to conduct experiments lasting about a year, studies in the fields of information technology must produce quick results. When I had the opportunity to talk with a professor of agriculture, I was deeply impressed by the fact that most experiments in the field of agriculture are conducted on a yearly basis, since researchers must wait for the cycle of flowering and fruit. I felt a bit envious of the physical requirements imposed on such experiments, limitations that would allow researchers to reject demands for faster results. Meanwhile, since the effective duration of our entire project was two years, I was aware from the very start that our real-life

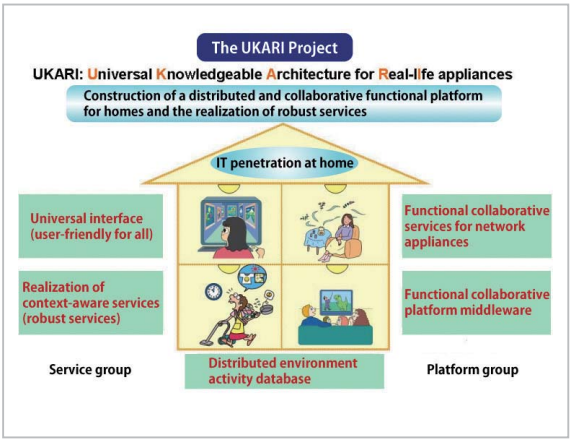

Fig.1 *The UKARI project*

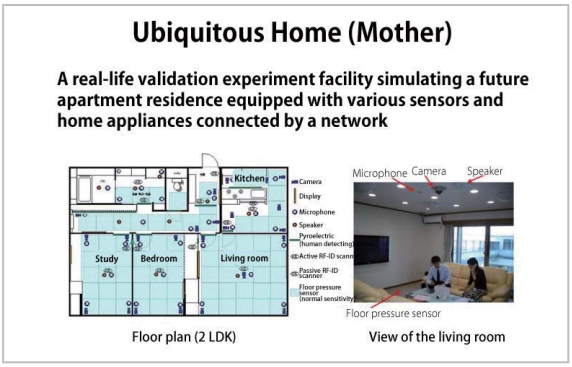

Fig.2 *Ubiquitous home (Mother)*

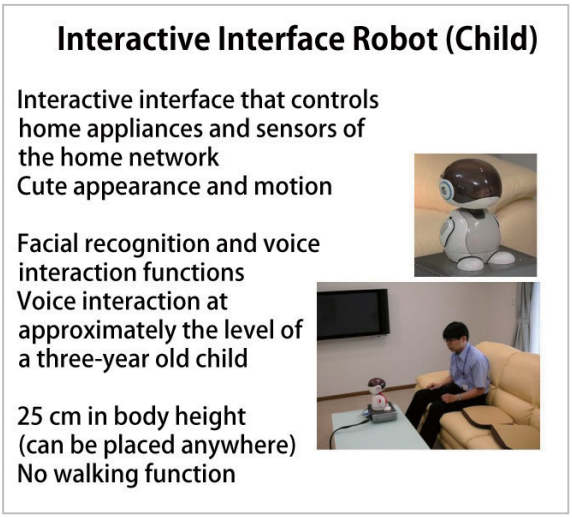

Fig.3 *Interactive interface robot (Child)*

experiments could only last from two weeks to one month at the maximum, taking into consideration the stress that would be placed on the participants.

I had no idea what kind of information I would be able to extract from the data we gathered during our real-life experiments. To be honest, I didn't even really consider the

issue until we began designing the experiments. In the end, in addition to being able to discern the daily patterns and rhythms of the inhabitants, I came to expect that the data would tell us a variety of interesting and useful things. I think if we had been given more time this would have proven true, but the short period of the project severely limited the extent to which we were able to analyze the large amounts of data gathered and thus limited what we could find out.

I had chosen to include, as a clear goal for this project, real-life experiments conducted in actual homes.

4 Platform group: Expectations and realities

In the platform group, discussions began with the significance of establishing a home network from the perspective of the common person, whether home servers will ever become widespread, and whether home severs are of interest only to engineers. As a result of these discussions, the group reached a consensus that the common platform for the networking of home information appliances should be capable of both distributed and collaborative functions. On this point, I would like to clarify the relationship between the present project and the "AMIDEN" project I was formerly involved with. The basic strategy of AMIDEN also centered on both functional distribution and collaboration, with design specifications formulated accordingly. However, I failed to secure a grant for that project from the Ministry of Economy, Trade, and Industry. The businesses that had participated in AMIDEN were against carrying the project over to the CRL due to intellectual property issues, and participating researchers also questioned the significance of a project that would focus only on implementation. Thus, I abandoned the concept as laid out in AMIDEN, and started discussions from scratch. Led by the present project group, the specification schemes were designed and realized as middleware in the form of the "UKARI Core". The architecture and principle of operation of the UKARI Core are presented in Fig. 4. The completed product was essentially similar to AMIDEN, but the process of creating it nonetheless resulted in a feeling of solidarity among the project members and contributed to the establishment of our current research system. However, to be frank, I was pained to have to consume nearly one year of a three-year project to conduct these deliberations anew.

After that, however, the project progressed smoothly due to the collaborative spirit that had arisen within the group. Implementation experiments with actual home information appliances were conducted, and the weaknesses of the UKARI Core were identified. The results of these experiments led to the production of the so-called "UKARI Kernel". By this point, the initial goals of the AMIDEN system had been far surpassed, thanks, I believe, to the specific efforts of the members of this project. The basis of these achievements was the

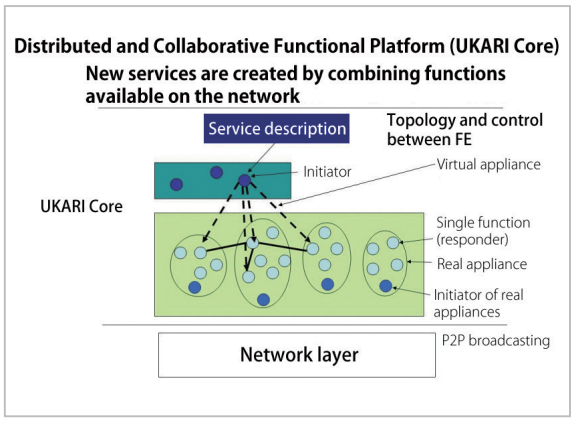

Fig.4 *Distributed and collaborative functional platform (UKARI Core)*

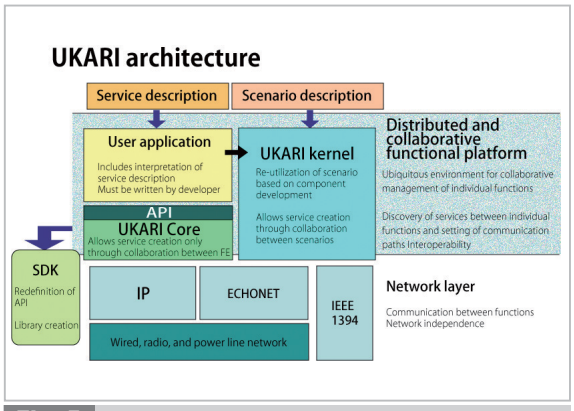

Fig.5 *UKARI architecture*

function thesaurus. Researchers in the group united their efforts in exhaustive discussions of the functions of home information appliances, and organized these functions typologically. The results are now subject to patent application. Through these efforts the functional prospects have been clarified, leading to the development of the UKARI Kernel. The overall scheme has since been compiled in the UKARI architecture (Fig. 5).

Another achievement generated in the foregoing process can be described as "access management". Engineers worked generally to pursue greater user convenience and carried out their studies accordingly, to arrive at a system that will allow connections "at any time, anywhere, through any device". These engineers devoted their time to creating a framework that will allow a new home appliance to be instantly connected to the home network and immediately begin to provide services. In recent years, however, concern has arisen regarding appliances that belong to guests. People have guests, and the home network will have to recognize that electronic appliances belonging to these guests are not to be treated exactly as those owned by family members. The need thus became clear to incorporate access management into the UKARI Kernel, opening the door to an entirely new research theme.

5 Service group: Expectations and realities

The service group began their research by focusing on the issues of the effectiveness of various lifestyle support services in homes and on research into a user-friendly interface, assuming a network which connects certain parts of various home appliances on a per-function basis. Since the group's research was conducted in parallel to the development of software by the platform group, the functions developed by the service group were implemented by the platform group's software, and systems for the functions were constructed on an IP network.

The interface robot was designed based on the unique concept of imitating a three-year-old, reproducing the cuteness of a child, and this led to the broader use of a mother-child metaphor (Fig. 6). A member of the team commented that conversations involving children would promote intra-family communication, leading to the establishment of a powerful theme for the entire project. I would have been perfectly satisfied simply with the development of a new and useful service, and so this theme was a welcome and unexpectedly invaluable addition. With this concept established, the development of various services progressed smoothly. Figure 7 shows the entire module configuration developed in the project. Using these services, we were able to conduct a real-life validation experiment before the project entered its final year. In the third year, we acquired data for different fami-

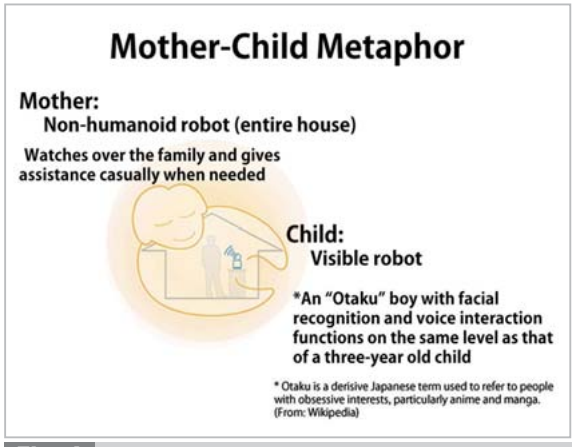

Fig.6 *Mother-child metaphor*

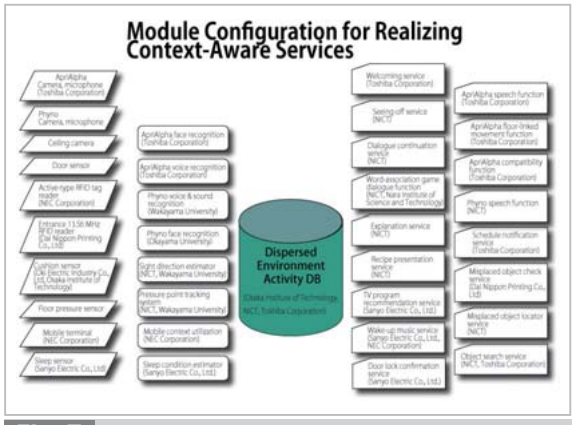

Fig.7 *Module configuration for realizing context-aware services*

ly structures and age groups. We also received various proposals from participants in the real-life experiments. These proposals were reviewed and reflected in the services to the full extent possible, in order to maximize the usefulness of the services provided. Although initially there were doubts as to whether we would actually be able to perform the validation experiments, the system was sufficiently complete in the final year to enable these to take place, in a reflection of the high abilities of the project group. I would like to thank all those who participated, including the researchers from business companies.

Looking back, I have one regret: I had only vaguely thought about the results of the real-life experiments — I thought the conclusions would be obvious. The data acquired for a single experiment reached a total of approximately 4 TB. Since the daily activities of the participants are videotaped using 30 cameras for 2 weeks, it is impossible to watch the videotapes in their entirety. It was too late when I realized that the data acquired could not be fully utilized. The period of three years was, in this sense, largely insufficient, and left many researchers, including myself, feeling that the project was only half finished, coming to an end just as results were coming in. Although I humbly accept criticism for my failures in project planning, there are some issues one can only realize in the course of research. Nevertheless, I do regret that the data could not be used more effectively.

6 Conclusions

It has been acknowledged from the planning stage that a three-year period was insufficient for this project, and so I believe that a final evaluation of the project now is premature. However, the UKARI Project is technically completed, and so I would like to present my evaluation.

During the project, the Ubiquitous Home Workshop was held three times, and due to intensive public information activities, the project came to be widely recognized by its final year; we received a number of related proposals for international collaborations. I deeply regret that these collaborative efforts must now be interrupted with the completion of the project. For example, a workshop was established to study the interconnectivity of home appliances, and a new research project for observing human activity in a room installed with multiple sensors had begun. I believe these projects provide clear evidence of the timely nature of our project. The actual achievements of our research consisted of 61 workshop presentations, 25 presentations at international meetings, and five academic papers (including those that were submitted after completion of the project). In addition to our academic achievements, we have also carried out open sourcing of the UKARI Core and Kernel, have publicized the data from the real-life experiments, and have established plans for marketing the robots.

At the launch of the project, I reflected on the role of national research institutions such as NICT (CRL) and came to the conclusion that unlike research activities at universities, my project should focus more on the practical application of the achievements of research I had conducted at the university. I established the project based on the construction of a ubiquitous environment and real-life experiments of services provided in such an environment, using the distributed and collaborative "AMIDEN" architecture, which had formed one of my prior achievements at my university. Since no one at the CRL at the time was working on such a theme, I did not expect the project to produce immediate academic research results. Thus, my plan consisted mainly of data acquisition, paving the way for standardization, real-life experiments, and project-type research schedules. I believe the achievements of the UKARI Project are worthy of some praise when one considers the general expectations of a three-year project begun from scratch by a newly assembled group of researchers. However, compared to an average three-year research project, I must confess that the number of academic papers is

small and that there were no new technological findings per se. It is my opinion that a different evaluation system, based on objective criteria, is required for projects aimed at validation of technologies.

During the course of the project, I requested cooperation from other groups at NICT, but failed due to the high sense of independence and strong barriers between such groups. In the US, collaborative studies within a single organization are extremely common, and there is a notable rush to prototyping. I strongly believe that the limitations on cooperation must be overcome if NICT is to become internationally competitive as a research organization. The design of the ubiquitous home had to be completed within one month after approval, and the lack of time to review the design ultimately resulted in wasted money required for repairs.

The first pillar of the project was the construction of the "UKARI architecture" to establish a home appliance network with both distributed and collaborative functions and the corresponding development of services using this architecture. The second pillar consisted of real-life experiments to identify and confirm problems to be overcome in practical application of the "UKARI architecture", such as the appropriate dialogue strategy (developed from the perspective of the user), a strategy for promoting intra-family communication, and issues of privacy within the family. I believe these will continue to be important issues in the future.

Power-line communication was considered in terms of system construction at the very start. However, the idea was dropped due to the lack of cooperation from other groups at NICT. The issue of intellectual property protection also arose due to the fact that the research concept was associated with research I had conducted at my university. The paperwork involved consumed a great deal of time and labor, and hindered the progress of the project. There was also the problem of contracts that had to be drawn up to obtain the cooperation of businesses, which significantly slowed the progress of joint research. Although I requested a more strategically minded handling of the situation due to the short term of the project, conventional frameworks could not be overcome. Initially, I had hoped to pave the way for the standardization of the system, but a lack of human resources, directors, and experience forced me to abandon the idea. When a project leader is forced to handle all of the above affairs by himself, he will have no choice but to give priority to pursuing the research activities themselves. If I had been notified of the actual circumstances that I would find myself in at the start, I believe I would have approached the project with an entirely different strategy from the planning stage.

The paperwork involved in the execution of the real-life experiments was also time-consuming, and delayed the start of the experiment. Timing is crucial for a short-term project. The real-life experiments themselves were conducted smoothly with the cooperation of the participants. I repeat here my regret that the data obtained could neither be examined nor analyzed sufficiently. This, in fact, would have been the most interesting part of the project, and it was with this analysis in mind that I had originally undertaken the project. I can say that this project has made me acutely aware of the labor and costs involved in conducting real-life experiments.

Through it all, the project was a good experience for me. It has made me keenly aware of the fact that the human factor is what ultimately determines the fate of research. When talented human resources are deployed strategically, the entire group will be energized and the project will progress surprisingly smoothly. The lack of such human resources will only lead to increasing chaos. It appears to me that the ability to assess the abilities of others and to observe human relationships is as indispensable as the abilities required to conduct successful research. However, unlike in other sciences, many intangible factors are involved when humans are the subjects of observation, and simplification is

more difficult. These issues may be familiar to researchers in the humanities and sociology. This project has given me the opportunity to become acquainted with many people who have enlightened me in many ways, and I would like to thank everyone who participated in this project.

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Three dimensional Modeling, Environmental Media, Communication Support System